Biology: Honors

Grade Level	9
Course Number	300
Subject Area	Science and Technology

Course Description

This course is offered as the first year Science course upon entering the high school. The central theme will be the study of relationships between living organisms and the environment. Topics include: tools of the biologist, ecology, matter and energy in the web of life, cell structure and function, principles of genetics, evolution, diversity and adaptation among living organisms, and vertebrate anatomy and physiology. The course is in-depth and runs at an accelerated, rigorous pace.

Content Standards

1. The Chemistry of Life

Central Concept: Chemical elements form organic molecules that interact to perform the basic functions of life.

1.1 Recognize that biological organisms are composed primarily of very few elements. The six most common are C, H, N, O, P, and S.
1.2 Describe the basic molecular structures and primary functions of the four major categories of organic molecules (carbohydrates, lipids, proteins, nucleic acids).
1.3 Explain the role of enzymes as catalysts that lower the activation energy of biochemical reactions. Identify factors, such as pH and temperature, that have an effect on enzymes.

2. Cell Biology

Central Concepts: Cells have specific structures and functions that make them distinctive. Processes in a cell can be classified broadly as growth, maintenance, and reproduction.

2.1 Relate cell parts/organelles (plasma membrane, nuclear envelope, nucleus, nucleolus, cytoplasm, mitochondrion, endoplasmic reticulum, Golgi apparatus, lysosome, ribosome, vacuole, cell wall, chloroplast, cytoskeleton, centriole, cilium, flagellum, pseudopod) to their functions. Explain the role of cell membranes as a highly selective barrier (diffusion, osmosis, facilitated diffusion, active transport).
2.2 Compare and contrast, at the cellular level, the general structures and degrees of complexity of prokaryotes and eukaryotes.
2.3 Use cellular evidence (e.g., cell structure, cell number, cell reproduction) and modes of nutrition to describe the six kingdoms (Archaebacteria, Eubacteria, Protista, Fungi, Plantae, Animalia).
2.4 Identify the reactants, products, and basic purposes of photosynthesis and cellular respiration. Explain the interrelated nature of photosynthesis and cellular respiration in the cells of photosynthetic organisms.
2.5 Explain the important role that ATP serves in metabolism.
2.6 Describe the cell cycle and the process of mitosis. Explain the role of mitosis in the formation of new cells, and its importance in maintaining chromosome number during asexual reproduction.
2.7 Describe how the process of meiosis results in the formation of haploid cells. Explain the importance of this process in sexual reproduction, and how gametes form diploid zygotes in the process of fertilization.
2.8 Compare and contrast a virus and a cell in terms of genetic material and reproduction.

3. Genetics

Central Concepts: Genes allow for the storage and transmission of genetic information. They are a set of instructions encoded in the nucleotide sequence of each organism. Genes code for the specific sequences of amino acids that comprise the proteins characteristic to that organism.

3.1 Describe the basic structure (double helix, sugar/phosphate backbone, linked by complementary nucleotide pairs) of DNA, and describe its function in genetic inheritance.
3.2 Describe the basic process of DNA replication and how it relates to the transmission and conservation of the genetic code. Explain the basic processes of transcription and translation, and how they result in the expression of genes.

Distinguish among the end products of replication, transcription, and translation.

3.3 Explain how mutations in the DNA sequence of a gene may or may not result in phenotypic change in an organism. Explain how mutations in gametes may result in phenotypic changes in offspring.

3.4 Distinguish among observed inheritance patterns caused by several types of genetic traits (dominant, recessive, codominant, sex-linked, polygenic, incomplete dominance, multiple alleles).

3.5 Describe how Mendel's laws of segregation and independent assortment can be observed through patterns of inheritance (e.g., dihybrid crosses).

3.6 Use a Punnett Square to determine the probabilities for genotype and phenotype combinations in monohybrid crosses.

4. Anatomy & Physiology

Central Concepts: There is a relationship between the organization of cells into tissues and the organization of tissues into organs. The structures and functions of organs determine their relationships within body systems of an organism. Homeostasis allows the body to perform its normal functions.

4.1 Explain generally how the digestive system (mouth, pharynx, esophagus, stomach, small and large intestines, rectum) converts macromolecules from food into smaller molecules that can be used by cells for energy and for repair and growth.

4.2 Explain how the circulatory system (heart, arteries, veins, capillaries, red blood cells) transports nutrients and oxygen to cells and removes cell wastes. Describe how the kidneys and the liver are closely associated with the circulatory system as they perform the excretory function of removing waste from the blood. Recognize that kidneys remove nitrogenous wastes, and the liver removes many toxic compounds from blood.

4.3 Explain how the respiratory system (nose, pharynx, larynx, trachea, lungs, alveoli) provides exchange of oxygen and carbon dioxide.

4.4 Explain how the nervous system (brain, spinal cord, sensory neurons, motor neurons) mediates communication among different parts of the body and mediates the body's interactions with the environment. Identify the basic unit of the nervous system, the neuron, and explain generally how it works.

4.5 Explain how the muscular/skeletal system (skeletal, smooth and cardiac muscles, bones, cartilage, ligaments, tendons) works with other systems to support the body and allow for movement. Recognize that bones produce blood cells.

4.6 Recognize that the sexual reproductive system allows organisms to produce offspring that receive half of their genetic information from their mother and half from their father, and that sexually produced offspring resemble, but are not identical to, either of their parents.

4.7 Recognize that communication among cells is required for coordination of body functions. The nerves communicate with electrochemical signals, hormones circulate through the blood, and some cells produce signals to communicate only with nearby cells.

4.8 Recognize that the body's systems interact to maintain homeostasis. Describe the basic function of a physiological feedback loop.

5. Evolution & Biodiversity

Central Concepts: Evolution is the result of genetic changes that occur in constantly changing environments. Over many generations, changes in the genetic make-up of populations may affect biodiversity through speciation and extinction.

5.1 Explain how evolution is demonstrated by evidence from the fossil record, comparative anatomy, genetics, molecular biology, and examples of natural selection.

5.2 Describe species as reproductively distinct groups of organisms. Recognize that species are further classified into a hierarchical taxonomic system (kingdom, phylum, class, order, family, genus, species) based on morphological, behavioral, and molecular similarities. Describe the role that geographic isolation can play in speciation.

5.3 Explain how evolution through natural selection can result in changes in biodiversity through the increase or decrease of genetic diversity within a population.

6. Ecology

Central Concept: Ecology is the interaction among organisms and between organisms and their environment.

6.1 Explain how birth, death, immigration, and emigration influence population size.

6.2 Analyze changes in population size and biodiversity (speciation and extinction) that result from the following: natural causes, changes in climate, human activity, and the introduction of invasive, non-native species.

6.3 Use a food web to identify and distinguish producers, consumers, and decomposers, and explain the transfer of energy through trophic levels. Describe how relationships among organisms (predation, parasitism, competition,

commensalism, mutualism) add to the complexity of biological communities.

6.4 Explain how water, carbon, and nitrogen cycle between abiotic resources and organic matter in an ecosystem, and how oxygen cycles through photosynthesis and respiration.

Scientific Inquiry Skills Standards

SIS1. Make observations, raise questions, and formulate hypotheses.

- Observe the world from a scientific perspective.
- Pose questions and form hypotheses based on personal observations, scientific articles, experiments, and knowledge.
- Read, interpret, and examine the credibility and validity of scientific claims in different sources of information, such as scientific articles, advertisements, or media stories.

SIS2. Design and conduct scientific investigations.

- Articulate and explain the major concepts being investigated and the purpose of an investigation.
- Select required materials, equipment, and conditions for conducting an experiment.
- Identify independent and dependent variables.
- Write procedures that are clear and replicable.
- Employ appropriate methods for accurately and consistently
    - making observations
    - making and recording measurements at appropriate levels of precision
    - collecting data or evidence in an organized way
- Properly use instruments, equipment, and materials (e.g., scales, probeware, meter sticks, microscopes, computers) including set-up, calibration (if required), technique, maintenance, and storage.
- Follow safety guidelines.

SIS3. Analyze and interpret results of scientific investigations.

- Present relationships between and among variables in appropriate forms.
    - Represent data and relationships between and among variables in charts and graphs.
    - Use appropriate technology (e.g., graphing software) and other tools.
- Use mathematical operations to analyze and interpret data results.
- Assess the reliability of data and identify reasons for inconsistent results, such as sources of error or uncontrolled conditions.
- Use results of an experiment to develop a conclusion to an investigation that addresses the initial questions and supports or refutes the stated hypothesis.
- State questions raised by an experiment that may require further investigation.

SIS4. Communicate and apply the results of scientific investigations.

- Develop descriptions of and explanations for scientific concepts that were a focus of one or more investigations.
- Review information, explain statistical analysis, and summarize data collected and analyzed as the result of an investigation.
- Explain diagrams and charts that represent relationships of variables.
- Construct a reasoned argument and respond appropriately to critical comments and questions.
- Use language and vocabulary appropriately, speak clearly and logically, and use appropriate technology (e.g., presentation software) and other tools to present findings.
- Use and refine scientific models that simulate physical processes or phenomena.

Reading Standards for Literacy in Science

Key Ideas and Details

1. Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.

2. Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text.
3. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text.
Craft and Structure
4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 9–10 texts and topics*.
5. Analyze the structure of the relationships among concepts in a text, including relationships among key terms (e.g., *force, friction, reaction force, energy*).
6. Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, defining the question the author seeks to address.
Integration of Knowledge and Ideas
7. Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.
8. Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem.
9. Compare and contrast findings presented in a text to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts.
Range of Reading and Level of Text Complexity
10. By the end of grade 10, read and comprehend science/technical texts in the grades 9–10 text complexity band independently and proficiently.
Writing Standards
Text Types and Purposes
1. Write arguments focused on *discipline-specific content*. a. Introduce precise claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that establishes clear relationships among the claim(s), counterclaims, reasons, and evidence. b. Develop claim(s) and counterclaims fairly, supplying data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form and in a manner that anticipates the audience's knowledge level and concerns. c. Use words, phrases, and clauses to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims. d. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing. e. Provide a concluding statement or section that follows from or supports the argument presented.
2. Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. a. Introduce a topic and organize ideas, concepts, and information to make important connections and distinctions; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension. b. Develop the topic with well-chosen, relevant, and sufficient facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic. c. Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among ideas and concepts. d. Use precise language and domain-specific vocabulary to manage the complexity of the topic and convey a style appropriate to the discipline and context as well as to the expertise of likely readers. e. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing. f. Provide a concluding statement or section that follows from and supports the information or explanation presented (e.g., articulating implications or the significance of the topic).
3. Students' narrative skills continue to grow in these grades. The standards require that students be able to incorporate narrative elements effectively into arguments and informative/explanatory texts. In history/social studies, students must be able to incorporate narrative accounts into their analyses of individuals or events of historical import. In science and technical subjects, students must be able to write precise enough descriptions of the step-by-step procedures they use in their investigations or technical work that others can replicate them and (possibly) reach the same results.
Production and Distribution of Writing

4.	Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
5.	Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.
6.	Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically.
Research to Build and Present Knowledge	
7.	Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.
8.	Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation.
9.	Draw evidence from informational texts to support analysis, reflection, and research.
Range of Writing	
10.	Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

Essential Questions

- How is scientific inquiry used as a tool to understand the world?
- How are living things classified and organized?
- What do all living things have in common and how do they maintain homeostasis?
- How can knowledge of DNA help us understand the way that organisms are related to each other and how organisms change over time?
- Why do cells divide?
- How do living things accomplish life functions?
- How are structure and function related in living things?
- How are all living things interconnected within the biosphere?

Enduring Understandings

Students will learn how:

- Scientists use the process of the scientific method to solve problems.
- Living things are made of atoms bonded together to form organic molecules.
- All living things are composed of cells.
- Genes are a set of instructions encoded in the DNA sequence of each organism that specify the sequence of amino acids in proteins characteristic of that organism.
- There is a relationship between structure and function in organ systems of humans.
- Evolution and biodiversity are the result of genetic changes that occur in constantly changing environments.
- There is an interaction between living organisms and their environment.

Evidence of Understanding

The students will:

- Take formative and summative quizzes and tests on paper and online
- Complete homework and projects
- Conduct formal and informal labs
- Analyze data and share findings through presentations and written reports
- Conduct research and apply to technical writing
- Write critically and creatively
- Collaborate on group projects
- Present information to the class
- Participate in formal and informal class discussions
- Contribute to the class website
- Read actively and critically
- Communicate clearly in speech
- Write effectively

- Identify, access, and utilize a variety of resources for obtaining information
- Employ multiple strategies in reasoning and problem solving both independently and collaboratively
- Listen effectively and critically
- Demonstrate knowledge and skills in a variety of forms
- Demonstrate respect and tolerance
- Act responsibly and display good citizenship

Course Outline

Unit	Essential Questions	Skills and Understandings	Assessment
Scientific Inquiry	How is scientific inquiry used as a tool to understand the world?	• Listing and explaining each step of the scientific method on a written test. • Distinguishing between independent and dependent variables from a list of sample variables. • Applying the steps of the scientific method to a teacher generated laboratory situation. • Designing an experiment using the scientific method. • Writing lab reports including data and observations, analysis of results, answers to questions, and drawn conclusions.	• Quiz • Lab report
Chemistry of Life	What are living things made of? Why do cells need energy?	• Answering short answer and open response questions regarding the chemistry of life. • Diagramming and labeling a pH scale • Identifying acids and bases in the laboratory • Labeling organic molecules based on structure and function • Outlining the role of enzymes in an open response format. • Writing lab reports including data and observations, answers to questions, and drawn conclusions. • Using proper terminology in discussions, written assignments, evaluations, and lab reports.	• MCAS questions • Quiz • Test • Enzyme lab report
Cell Biology	How do cells carry out life functions? How do cell structures relate to	• Summarize the main ideas and development of the cell theory.	• MCAS questions • Quiz • Test

	their functions? How do photosynthesis and cellular respiration keep all organisms alive? Why do cells divide?	• Explain the contributions of Leeuwenhoek, Hooke, Schleidan, Schwann, Virchow, and Pasteur to the cell theory. • Differentiate between prokaryotic and eukaryotic cells. • Relate cell organelles to their functions. • Distinguish between plant and animal cells. • Describe the processes by which substances can enter and leave a cell (diffusion and osmosis) and differentiate between hypertonic, hypotonic, and isotonic environments. • Describe how changes in turgor pressure contribute to the health and strength of plants. • Explain the role of cell membranes as a selective barrier. • Describe other forms of transport such as facilitated diffusion, active transport, endocytosis (pinocytosis and phagocytosis), and exocytosis. • Distinguish between active and passive transport. • Collect data and observations, analysis of results, answers to questions, and draw conclusions on photosynthesis and cellular respiration labs • Kinesthetic drawings of pathways • Put scrambled steps of pathways in order • Label diagrams, answer short answers, and open response questions • Describe the processes and significance of mitosis and meiosis. • Discuss the cell cycle including interphase, mitosis (prophase,	• Cell models • Osmosis lab report • Photosynthesis and cellular respiration lab • Model mitosis and meiosis • Chromosomal Character writing assignment

		metaphase, anaphase, telophase), and cytokinesis. • Label the structure of a chromosome. • Discuss the surface area to volume ratio of cell size and relate it to cell division. • Classify cells by chromosome number (haploid and diploid). • Explain the difference between sexual and asexual reproduction. Explain how zygotes are produced in the fertilization process. • Explain why sexually reproducing organisms have a survival advantage over organisms that reproduce only by mitosis. • Define the formation of the egg and sperm. • Describe the process of crossing over and explain the significance of genetic recombination.	
Genetics	How can knowledge of DNA help us understand the way that organisms are related to each other and how organisms change over time? How can we apply probability to genetic understandings?	• Explain Mendel's Principles of Heredity including the laws of segregation, independent assortment, and dominance and recessiveness. • Relate the principles of probability to simple genetics. • Explain the relationship between DNA, genes, and chromosomes. • Predict and analyze the results of various monohybrid and dihybrid crosses. • Apply and utilize appropriate genetic terminology including homozygous, heterozygous, dominant, recessive, genotype, phenotype, allele, gene and chromosome, trait, and hybrid. • Define, explain, and solve	• MCAS questions • Quiz • Test • Punnett squares • Genetics lab report • Genetic disorder research and presentation

		examples of applied genetics which includes co-dominance, multiple alleles (blood typing), sex linked traits, sex-influenced traits, pedigree studies, test crosses, and polygenic traits. • Describe mutations both chromosomal and gene and explain their significance in heredity. Examples include nondisjunction, deletion, inversion, translocation, point and frameshift. • Describe the structure and function of DNA and RNA, and distinguish among replication, transcription and translation. • Identify complimentary base pairs. • Explain the roles of enzymes DNA helicase and DNA polymerase. • Summarize the making of a protein from a single strand of DNA to an amino acid chain. • Discuss genetic engineering including recombinant DNA, DNA fingerprinting, and polymerase chain reaction (PCR).	
Evolution	How is evolution evident in life? How are living organisms organized? How do living organisms change over time?	• Distinguish between the diversity and variation among living organisms. • Explain what the term unity of pattern represents in evolution. • Explain the presence of specific adaptations in a species using Darwin's theory of natural selection. • Apply Darwin's theory of Natural Selection to a concrete example. • Compare and contrast Darwin's theory of Natural Selection with Lamarck' hypothesis of acquired characteristics	• MCAS questions • Quiz • Test • Natural selection lab • Natural selection writing assignment

		through use and disuse. • Identify the evidence that supports Darwinian natural selection including: biochemistry, biogeography, embryology, comparative anatomy, and fossil record. • Identify sources of variability required for natural selection (mutation, genetic recombination, and crossing over). • Explain how genetic variation is preserved or eliminated from a population through Darwinian natural selection. • Define the term adaptation and list specific adaptations for individual organisms. • Identify the evolutionary mechanisms that can affect a population's gene pool (migration, mutation, natural selection, genetic drift, and sexual selection). • Discuss the Hardy Weinberg Principle, including factors that will allow a population to stay in equilibrium. • Explain how the process of adaptive radiation leads to speciation. • Distinguish between punctuated equilibrium and gradualism. • Differentiate between evolutionary patterns. (divergence, convergence, parallel, co-evolution). • Identify if a population is in equilibrium by applying $p^2 + 2pq + q^2=1$ • Calculate allelic frequencies of a simulated population and apply the Hardy Weinberg Principle.	
Anatomy and	Why is the body organized?	• Explain how the digestive	• MCAS questions

Physiology	How do the structures of organs relate to their functions? How do the major body systems interact with one another to maintain homeostasis?	system (mouth, pharynx, esophagus, stomach, small and large intestines, rectum) converts macromolecules from food into smaller molecules that can be used by cells for energy and for repair and growth. • Explain how the circulatory system (heart, arteries, veins, capillaries, red blood cells) transports nutrients and oxygen to cells and removes cell wastes. • Describe how the kidneys and the liver are closely associated with the circulatory system as they perform the excretory function of removing waste from the blood. Recognize that kidneys remove nitrogenous wastes, and the liver removes many toxic compounds from blood. • Explain how the respiratory system (nose, pharynx, larynx, trachea, lungs, alveoli) provides exchange of oxygen and carbon dioxide. • Explain how the nervous system (brain, spinal cord, sensory neurons, motor neurons) mediates communication between different parts of the body and the body's interactions with the environment. Identify the basic unit of the nervous system, the neuron, and explain how it works. • Explain how the muscular/skeletal system (skeletal, smooth and cardiac muscle, bones, cartilage, ligament, tendons) works with other systems to support and allow for movement. Recognize that bones produce both red and white blood cells. • Recognize that the sexual	• Quiz • Test • Homeostasis lab report • Digestive enzymes lab report

		reproductive system allows organisms to produce offspring that receive half of their genetic information from their mother and half from their father and that sexually produced offspring resemble, but are not identical to, either of their parents. • Recognize that communication between cells is required for coordination of body functions. The nerves communicate with electrochemical signals, hormones circulate through the blood, and some cells produce signals to communicate only with nearby cells. • Recognize that the body's systems interact to maintain homeostasis. Describe the basic function of a physiological feedback loop.	
Ecology	How do living organisms interact with each other and the nonliving parts of the world? Why are these interactions essential for survival? What causes populations to change?	• Explain that all living organisms are connected through the transfer of energy. • Identify the energy levels in a food web. • Distinguish between decomposers, producers, and consumers. • Distinguish between types of consumers ie. Herbivores, carnivores, and omnivores. • Define the terms heterotroph and autotroph. • Describe the flow of energy in a food chain. • Explain the 10 percent rule of energy flow in an energy pyramid. • Describe the movement of biocides through a food chain. • Distinguish between the levels of ecological	• MCAS questions • Quiz • Test • Food web project

		organization (species, populations, communities, ecosystems). • Distinguish between the four rates that determine population size (natality, mortality, immigration, emigration). • Identify abiotic and biotic limiting factors. • Determine carrying capacity and doubling time. • Explain mechanisms for the dispersal of populations. • Identify the niche of specific organisms. • Give examples of how symbiotic relationships produce both cooperation and competition within ecosystems. • Categorize examples of commensalisms, mutualism, and parasitism. • Discuss the carbon, water, nitrogen, and oxygen cycles. • Explain succession and describe changes in the ecosystem.	

Biology: Academic

Grade Level	9
Course Number	301
Subject Area	Science and Technology

Course Description

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Content Standards

1. The Chemistry of Life

Central Concept: Chemical elements form organic molecules that interact to perform the basic functions of life.

1.1 Recognize that biological organisms are composed primarily of very few elements. The six most common are C, H, N, O, P, and S.
1.2 Describe the basic molecular structures and primary functions of the four major categories of organic molecules (carbohydrates, lipids, proteins, nucleic acids).
1.3 Explain the role of enzymes as catalysts that lower the activation energy of biochemical reactions. Identify factors, such as pH and temperature, that have an effect on enzymes.

2. Cell Biology

Central Concepts: Cells have specific structures and functions that make them distinctive. Processes in a cell can be classified broadly as growth, maintenance, and reproduction.

2.1 Relate cell parts/organelles (plasma membrane, nuclear envelope, nucleus, nucleolus, cytoplasm, mitochondrion, endoplasmic reticulum, Golgi apparatus, lysosome, ribosome, vacuole, cell wall, chloroplast, cytoskeleton, centriole, cilium, flagellum, pseudopod) to their functions. Explain the role of cell membranes as a highly selective barrier (diffusion, osmosis, facilitated diffusion, active transport).
2.2 Compare and contrast, at the cellular level, the general structures and degrees of complexity of prokaryotes and eukaryotes.
2.3 Use cellular evidence (e.g., cell structure, cell number, cell reproduction) and modes of nutrition to describe the six kingdoms (Archaebacteria, Eubacteria, Protista, Fungi, Plantae, Animalia).
2.4 Identify the reactants, products, and basic purposes of photosynthesis and cellular respiration. Explain the interrelated nature of photosynthesis and cellular respiration in the cells of photosynthetic organisms.
2.5 Explain the important role that ATP serves in metabolism.
2.6 Describe the cell cycle and the process of mitosis. Explain the role of mitosis in the formation of new cells, and its importance in maintaining chromosome number during asexual reproduction.
2.7 Describe how the process of meiosis results in the formation of haploid cells. Explain the importance of this process in sexual reproduction, and how gametes form diploid zygotes in the process of fertilization.
2.8 Compare and contrast a virus and a cell in terms of genetic material and reproduction.

3. Genetics

Central Concepts: Genes allow for the storage and transmission of genetic information. They are a set of instructions encoded in the nucleotide sequence of each organism. Genes code for the specific sequences of amino acids that comprise the proteins characteristic to that organism.

3.1 Describe the basic structure (double helix, sugar/phosphate backbone, linked by complementary nucleotide pairs) of DNA, and describe its function in genetic inheritance.
3.2 Describe the basic process of DNA replication and how it relates to the transmission and conservation of the genetic code. Explain the basic processes of transcription and translation, and how they result in the expression of genes. Distinguish among the end products of replication, transcription, and translation.
3.3 Explain how mutations in the DNA sequence of a gene may or may not result in phenotypic change in an organism. Explain how mutations in gametes may result in phenotypic changes in offspring.
3.4 Distinguish among observed inheritance patterns caused by several types of genetic traits (dominant, recessive, codominant, sex-linked, polygenic, incomplete dominance, multiple alleles).
3.5 Describe how Mendel's laws of segregation and independent assortment can be observed through patterns of inheritance (e.g., dihybrid crosses).
3.6 Use a Punnett Square to determine the probabilities for genotype and phenotype combinations in monohybrid crosses.

4. Anatomy & Physiology

Central Concepts: There is a relationship between the organization of cells into tissues and the organization of tissues into organs. The structures and functions of organs determine their relationships within body systems of an organism. Homeostasis allows the body to perform its normal functions.

4.1 Explain generally how the digestive system (mouth, pharynx, esophagus, stomach, small and large intestines, rectum) converts macromolecules from food into smaller molecules that can be used by cells for energy and for repair and growth.
4.2 Explain how the circulatory system (heart, arteries, veins, capillaries, red blood cells) transports nutrients and oxygen to cells and removes cell wastes. Describe how the kidneys and the liver are closely associated with the circulatory system as they perform the excretory function of removing waste from the blood. Recognize that kidneys remove nitrogenous wastes, and the liver removes many toxic compounds from blood.

4.3 Explain how the respiratory system (nose, pharynx, larynx, trachea, lungs, alveoli) provides exchange of oxygen and carbon dioxide.

4.4 Explain how the nervous system (brain, spinal cord, sensory neurons, motor neurons) mediates communication among different parts of the body and mediates the body's interactions with the environment. Identify the basic unit of the nervous system, the neuron, and explain generally how it works.

4.5 Explain how the muscular/skeletal system (skeletal, smooth and cardiac muscles, bones, cartilage, ligaments, tendons) works with other systems to support the body and allow for movement. Recognize that bones produce blood cells.

4.6 Recognize that the sexual reproductive system allows organisms to produce offspring that receive half of their genetic information from their mother and half from their father, and that sexually produced offspring resemble, but are not identical to, either of their parents.

4.7 Recognize that communication among cells is required for coordination of body functions. The nerves communicate with electrochemical signals, hormones circulate through the blood, and some cells produce signals to communicate only with nearby cells.

4.8 Recognize that the body's systems interact to maintain homeostasis. Describe the basic function of a physiological feedback loop.

5. Evolution & Biodiversity

Central Concepts: Evolution is the result of genetic changes that occur in constantly changing environments. Over many generations, changes in the genetic make-up of populations may affect biodiversity through speciation and extinction.

5.1 Explain how evolution is demonstrated by evidence from the fossil record, comparative anatomy, genetics, molecular biology, and examples of natural selection.

5.2 Describe species as reproductively distinct groups of organisms. Recognize that species are further classified into a hierarchical taxonomic system (kingdom, phylum, class, order, family, genus, species) based on morphological, behavioral, and molecular similarities. Describe the role that geographic isolation can play in speciation.

5.3 Explain how evolution through natural selection can result in changes in biodiversity through the increase or decrease of genetic diversity within a population.

6. Ecology

Central Concept: Ecology is the interaction among organisms and between organisms and their environment.

6.1 Explain how birth, death, immigration, and emigration influence population size.

6.2 Analyze changes in population size and biodiversity (speciation and extinction) that result from the following: natural causes, changes in climate, human activity, and the introduction of invasive, non-native species.

6.3 Use a food web to identify and distinguish producers, consumers, and decomposers, and explain the transfer of energy through trophic levels. Describe how relationships among organisms (predation, parasitism, competition, commensalism, mutualism) add to the complexity of biological communities.

6.4 Explain how water, carbon, and nitrogen cycle between abiotic resources and organic matter in an ecosystem, and how oxygen cycles through photosynthesis and respiration.

Scientific Inquiry Skills Standards

SIS1. Make observations, raise questions, and formulate hypotheses.

- Observe the world from a scientific perspective.
- Pose questions and form hypotheses based on personal observations, scientific articles, experiments, and knowledge.
- Read, interpret, and examine the credibility and validity of scientific claims in different sources of information, such as scientific articles, advertisements, or media stories.

SIS2. Design and conduct scientific investigations.

- Articulate and explain the major concepts being investigated and the purpose of an investigation.
- Select required materials, equipment, and conditions for conducting an experiment.
- Identify independent and dependent variables.
- Write procedures that are clear and replicable.
- Employ appropriate methods for accurately and consistently

- making observations
- making and recording measurements at appropriate levels of precision
- collecting data or evidence in an organized way

- Properly use instruments, equipment, and materials (e.g., scales, probeware, meter sticks, microscopes, computers) including set-up, calibration (if required), technique, maintenance, and storage.
- Follow safety guidelines.

SIS3. Analyze and interpret results of scientific investigations.

- Present relationships between and among variables in appropriate forms.
  - Represent data and relationships between and among variables in charts and graphs.
  - Use appropriate technology (e.g., graphing software) and other tools.
- Use mathematical operations to analyze and interpret data results.
- Assess the reliability of data and identify reasons for inconsistent results, such as sources of error or uncontrolled conditions.
- Use results of an experiment to develop a conclusion to an investigation that addresses the initial questions and supports or refutes the stated hypothesis.
- State questions raised by an experiment that may require further investigation.

SIS4. Communicate and apply the results of scientific investigations.

- Develop descriptions of and explanations for scientific concepts that were a focus of one or more investigations.
- Review information, explain statistical analysis, and summarize data collected and analyzed as the result of an investigation.
- Explain diagrams and charts that represent relationships of variables.
- Construct a reasoned argument and respond appropriately to critical comments and questions.
- Use language and vocabulary appropriately, speak clearly and logically, and use appropriate technology (e.g., presentation software) and other tools to present findings.
- Use and refine scientific models that simulate physical processes or phenomena.

Reading Standards for Literacy in Science
Key Ideas and Details
1. Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.
2. Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text.
3. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text.
Craft and Structure
4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 9–10 texts and topics*.
5. Analyze the structure of the relationships among concepts in a text, including relationships among key terms (e.g., *force, friction, reaction force*, *energy*).
6. Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, defining the question the author seeks to address.
Integration of Knowledge and Ideas
7. Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.
8. Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem.
9. Compare and contrast findings presented in a text to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts.
Range of Reading and Level of Text Complexity

10. By the end of grade 10, read and comprehend science/technical texts in the grades 9–10 text complexity band independently and proficiently.

Writing Standards

Text Types and Purposes

1. Write arguments focused on *discipline-specific content*.
- a. Introduce precise claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that establishes clear relationships among the claim(s), counterclaims, reasons, and evidence.
- b. Develop claim(s) and counterclaims fairly, supplying data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form and in a manner that anticipates the audience's knowledge level and concerns.
- c. Use words, phrases, and clauses to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims.
- d. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.
- e. Provide a concluding statement or section that follows from or supports the argument presented.

2. Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.
- a. Introduce a topic and organize ideas, concepts, and information to make important connections and distinctions; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.
- b. Develop the topic with well-chosen, relevant, and sufficient facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic.
- c. Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among ideas and concepts.
- d. Use precise language and domain-specific vocabulary to manage the complexity of the topic and convey a style appropriate to the discipline and context as well as to the expertise of likely readers.
- e. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.
- f. Provide a concluding statement or section that follows from and supports the information or explanation presented (e.g., articulating implications or the significance of the topic).

3. Students' narrative skills continue to grow in these grades. The standards require that students be able to incorporate narrative elements effectively into arguments and informative/explanatory texts. In history/social studies, students must be able to incorporate narrative accounts into their analyses of individuals or events of historical import. In science and technical subjects, students must be able to write precise enough descriptions of the step-by-step procedures they use in their investigations or technical work that others can replicate them and (possibly) reach the same results.

Production and Distribution of Writing

4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

5. Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.

6. Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically.

Research to Build and Present Knowledge

7. Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

8. Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation.

9. Draw evidence from informational texts to support analysis, reflection, and research.

Range of Writing

10. Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

Essential Questions

- How is scientific inquiry used as a tool to understand the world?
- How are living things classified and organized?
- What do all living things have in common and how do they maintain homeostasis?
- How can knowledge of DNA help us understand the way that organisms are related to each other and how organisms change over time?
- Why do cells divide?
- How do living things accomplish life functions?
- How are structure and function related in living things?
- How are all living things interconnected within the biosphere?

Enduring Understandings

Students will learn how:

- Scientists use the process of the scientific method to solve problems.
- Living things are made of atoms bonded together to form organic molecules.
- All living things are composed of cells.
- Genes are a set of instructions encoded in the DNA sequence of each organism that specify the sequence of amino acids in proteins characteristic of that organism.
- There is a relationship between structure and function in organ systems of humans.
- Evolution and biodiversity are the result of genetic changes that occur in constantly changing environments.
- There is an interaction between living organisms and their environment.

Evidence of Understanding

The students will:

- Take formative and summative quizzes and tests on paper and online
- Complete homework and projects
- Conduct formal and informal labs
- Analyze data and share findings through presentations and written reports
- Conduct research and apply to technical writing
- Write critically and creatively
- Collaborate on group projects
- Present information to the class
- Participate in formal and informal class discussions
- Contribute to the class website
- Read actively and critically
- Communicate clearly in speech
- Write effectively
- Identify, access, and utilize a variety of resources for obtaining information
- Employ multiple strategies in reasoning and problem solving both independently and collaboratively
- Listen effectively and critically
- Demonstrate knowledge and skills in a variety of forms
- Demonstrate respect and tolerance
- Act responsibly and display good citizenship

Course Outline

Unit	Essential Questions	Skills and Understandings	Assessment
Scientific Inquiry	How is scientific inquiry used as a tool to understand the world?	• Listing and explaining each step of the scientific method on a written test. • Distinguishing between independent and dependent variables from a list of sample variables. • Applying the steps of the scientific method to a teacher generated laboratory situation.	• Quiz • Lab report

		• Designing an experiment using the scientific method. • Writing lab reports including data and observations, analysis of results, answers to questions, and drawn conclusions.	
Chemistry of Life	What are living things made of? Why do cells need energy?	• Answering short answer and open response questions regarding the chemistry of life. • Diagramming and labeling a pH scale • Labeling organic molecules based on structure and function • Outlining the role of enzymes in an open response format. • Writing lab reports including data and observations, answers to questions, and drawn conclusions. • Using proper terminology in discussions, written assignments, evaluations, and lab reports.	• MCAS questions • Quiz • Test • Enzyme lab report
Cell Biology	How do cells carry out life functions? How do cell structures relate to their functions? How do photosynthesis and cellular respiration keep all organisms alive? Why do cells divide?	• Summarize the main ideas and development of the cell theory. • Differentiate between prokaryotic and eukaryotic cells. • Relate cell organelles to their functions. • Distinguish between plant and animal cells. • Describe the processes by which substances can enter and leave a cell (diffusion and osmosis) and differentiate between hypertonic, hypotonic, and isotonic environments. • Describe how changes in turgor pressure contribute to the health and strength of plants. • Explain the role of cell membranes as a selective barrier.	• MCAS questions • Quiz • Test • Cell models • Osmosis lab report • Photosynthesis and cellular respiration lab • Model mitosis and meiosis • Chromosomal Character writing assignment

		• Describe other forms of transport such as facilitated diffusion, active transport, endocytosis (pinocytosis and phagocytosis), and exocytosis. • Distinguish between active and passive transport. • Collect data and observations, analysis of results, answers to questions, and draw conclusions on photosynthesis and cellular respiration labs • Kinesthetic drawings of pathways • Put scrambled steps of pathways in order • Label diagrams, answer short answers, and open response questions • Describe the processes and significance of mitosis and meiosis. • Discuss the cell cycle including interphase, mitosis (prophase, metaphase, anaphase, telophase), and cytokinesis. • Label the structure of a chromosome. • Discuss the surface area to volume ratio of cell size and relate it to cell division. • Classify cells by chromosome number (haploid and diploid). • Explain the difference between sexual and asexual reproduction. Explain how zygotes are produced in the fertilization process. • Explain why sexually reproducing organisms have a survival advantage over organisms that reproduce only by mitosis. • Define the formation of the egg and sperm. • Describe the process of	

		crossing over and explain the significance of genetic recombination.	
Genetics	How can knowledge of DNA help us understand the way that organisms are related to each other and how organisms change over time? How can we apply probability to genetic understandings?	• Explain Mendel's Principles of Heredity including the laws of segregation, independent assortment, and dominance and recessiveness. • Relate the principles of probability to simple genetics. • Explain the relationship between DNA, genes, and chromosomes. • Predict and analyze the results of various monohybrid and dihybrid crosses. • Apply and utilize appropriate genetic terminology including homozygous, heterozygous, dominant, recessive, genotype, phenotype, allele, gene and chromosome, trait, and hybrid. • Define, explain, and solve examples of applied genetics which includes co-dominance, multiple alleles (blood typing), sex linked traits, sex-influenced traits, pedigree studies, test crosses, and polygenic traits. • Describe mutations both chromosomal and gene and explain their significance in heredity. Examples include nondisjunction, deletion, inversion, translocation, point and frameshift. • Describe the structure and function of DNA and RNA, and distinguish among replication, transcription and translation. • Identify complimentary base pairs. • Explain the roles of enzymes DNA helicase and DNA polymerase.	• MCAS questions • Quiz • Test • Punnett squares • Genetics lab report • Genetic disorder research and presentation

		• Summarize the making of a protein from a single strand of DNA to an amino acid chain. • Discuss genetic engineering including recombinant DNA, DNA fingerprinting, and polymerase chain reaction (PCR).	
Evolution	How is evolution evident in life? How are living organisms organized? How do living organisms change over time?	• Distinguish between the diversity and variation among living organisms. • Explain what the term unity of pattern represents in evolution. • Explain the presence of specific adaptations in a species using Darwin's theory of natural selection. • Apply Darwin's theory of Natural Selection to a concrete example. • Compare and contrast Darwin's theory of Natural Selection with Lamarck' hypothesis of acquired characteristics through use and disuse. • Identify the evidence that supports Darwinian natural selection including: biochemistry, biogeography, embryology, comparative anatomy, and fossil record. • Identify sources of variability required for natural selection (mutation, genetic recombination, and crossing over). • Explain how genetic variation is preserved or eliminated from a population through Darwinian natural selection. • Define the term adaptation and list specific adaptations for individual organisms. • Identify the evolutionary mechanisms that can	• MCAS questions • Quiz • Test • Natural selection lab • Natural selection writing assignment

		affect a population's gene pool (migration, mutation, natural selection, genetic drift, and sexual selection). • Explain how the process of adaptive radiation leads to speciation. • Distinguish between punctuated equilibrium and gradualism. • Differentiate between evolutionary patterns. (divergence, convergence, parallel, co-evolution).	
Anatomy and Physiology	Why is the body organized? How do the structures of organs relate to their functions? How do the major body systems interact with one another to maintain homeostasis?	• Explain how the digestive system (mouth, pharynx, esophagus, stomach, small and large intestines, rectum) converts macromolecules from food into smaller molecules that can be used by cells for energy and for repair and growth. • Explain how the circulatory system (heart, arteries, veins, capillaries, red blood cells) transports nutrients and oxygen to cells and removes cell wastes. • Describe how the kidneys and the liver are closely associated with the circulatory system as they perform the excretory function of removing waste from the blood. Recognize that kidneys remove nitrogenous wastes, and the liver removes many toxic compounds from blood. • Explain how the respiratory system (nose, pharynx, larynx, trachea, lungs, alveoli) provides exchange of oxygen and carbon dioxide. • Explain how the nervous system (brain, spinal cord, sensory neurons, motor neurons) mediates communication between different parts of the body	• MCAS questions • Quiz • Test • Homeostasis lab report • Digestive enzymes lab report

		and the body's interactions with the environment. Identify the basic unit of the nervous system, the neuron, and explain how it works. • Explain how the muscular/skeletal system (skeletal, smooth and cardiac muscle, bones, cartilage, ligament, tendons) works with other systems to support and allow for movement. Recognize that bones produce both red and white blood cells. • Recognize that the sexual reproductive system allows organisms to produce offspring that receive half of their genetic information from their mother and half from their father and that sexually produced offspring resemble, but are not identical to, either of their parents. • Recognize that communication between cells is required for coordination of body functions. The nerves communicate with electrochemical signals, hormones circulate through the blood, and some cells produce signals to communicate only with nearby cells. • Recognize that the body's systems interact to maintain homeostasis. Describe the basic function of a physiological feedback loop.	
Ecology	How do living organisms interact with each other and the nonliving parts of the world? Why are these interactions essential for survival? What causes populations to change?	• Explain that all living organisms are connected through the transfer of energy. • Identify the energy levels in a food web. • Distinguish between decomposers, producers, and consumers.	• MCAS questions • Quiz • Test • Food web project

		• Distinguish between types of consumers ie. Herbivores, carnivores, and omnivores. • Define the terms heterotroph and autotroph. • Describe the flow of energy in a food chain. • Explain the 10 percent rule of energy flow in an energy pyramid. • Describe the movement of biocides through a food chain. • Distinguish between the levels of ecological organization (species, populations, communities, ecosystems). • Distinguish between the four rates that determine population size (natality, mortality, immigration, emigration). • Identify abiotic and biotic limiting factors. • Determine carrying capacity and doubling time. • Explain mechanisms for the dispersal of populations. • Identify the niche of specific organisms. • Give examples of how symbiotic relationships produce both cooperation and competition within ecosystems. • Categorize examples of commensalisms, mutualism, and parasitism. • Discuss the carbon, water, nitrogen, and oxygen cycles. • Explain succession and describe changes in the ecosystem.	

Anatomy & Physiology: Academic

Grade Level	11, 12
Course Number	310
Subject Area	Science and Technology

Course Description

This course is an in-depth study of the human body. The anatomy, physiology, and pathology of each human system will be investigated. The class will focus on hands-on activities and laboratories. This course will meet the needs of students preparing for higher education in an area of biological science or for those seeking to enter a health-related profession. A small mammal dissection may be required.

Content Standards

4. Anatomy and Physiology

Central Concepts: There is a relationship between the organization of cells into tissues and the organization of tissues into organs. The structures and functions of organs determine their relationships within body systems of an organism. Homeostasis allows the body to perform its normal functions.

4.1 Explain generally how the digestive system (mouth, pharynx, esophagus, stomach, small and large intestines, rectum) converts macromolecules from food into smaller molecules that can be used by cells for energy and for repair and growth.

4.2 Explain how the circulatory system (heart, arteries, veins, capillaries, red blood cells) transports nutrients and oxygen to cells and removes cell wastes. Describe how the kidneys and the liver are closely associated with the circulatory system as they perform the excretory function of removing waste from the blood. Recognize that kidneys remove nitrogenous wastes, and the liver removes many toxic compounds from blood.

4.3 Explain how the respiratory system (nose, pharynx, larynx, trachea, lungs, alveoli) provides exchange of oxygen and carbon dioxide.

4.4 Explain how the nervous system (brain, spinal cord, sensory neurons, motor neurons) mediates communication among different parts of the body and mediates the body's interactions with the environment. Identify the basic unit of the nervous system, the neuron, and explain generally how it works.

4.5 Explain how the muscular/skeletal system (skeletal, smooth and cardiac muscles, bones, cartilage, ligaments, tendons) works with other systems to support the body and allow for movement. Recognize that bones produce blood cells.

4.6 Recognize that the sexual reproductive system allows organisms to produce offspring that receive half of their genetic information from their mother and half from their father, and that sexually produced offspring resemble, but are not identical to, either of their parents.

4.7 Recognize that communication among cells is required for coordination of body functions. The nerves communicate with electrochemical signals, hormones circulate through the blood, and some cells produce signals to communicate only with nearby cells.

4.8 Recognize that the body's systems interact to maintain homeostasis. Describe the basic function of a physiological feedback loop.

Scientific Inquiry Skills Standards

SIS1. Make observations, raise questions, and formulate hypotheses.

- Observe the world from a scientific perspective.
- Pose questions and form hypotheses based on personal observations, scientific articles, experiments, and knowledge.
- Read, interpret, and examine the credibility and validity of scientific claims in different sources of information, such as scientific articles, advertisements, or media stories.

SIS2. Design and conduct scientific investigations.

- Articulate and explain the major concepts being investigated and the purpose of an investigation.

- Select required materials, equipment, and conditions for conducting an experiment.
- Identify independent and dependent variables.
- Write procedures that are clear and replicable.
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    - making observations
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- Properly use instruments, equipment, and materials (e.g., scales, probeware, meter sticks, microscopes, computers) including set-up, calibration (if required), technique, maintenance, and storage.
- Follow safety guidelines.

SIS3. Analyze and interpret results of scientific investigations.

- Present relationships between and among variables in appropriate forms.
    - Represent data and relationships between and among variables in charts and graphs.
    - Use appropriate technology (e.g., graphing software) and other tools.
- Use mathematical operations to analyze and interpret data results.
- Assess the reliability of data and identify reasons for inconsistent results, such as sources of error or uncontrolled conditions.
- Use results of an experiment to develop a conclusion to an investigation that addresses the initial questions and supports or refutes the stated hypothesis.
- State questions raised by an experiment that may require further investigation.

SIS4. Communicate and apply the results of scientific investigations.

- Develop descriptions of and explanations for scientific concepts that were a focus of one or more investigations.
- Review information, explain statistical analysis, and summarize data collected and analyzed as the result of an investigation.
- Explain diagrams and charts that represent relationships of variables.
- Construct a reasoned argument and respond appropriately to critical comments and questions.
- Use language and vocabulary appropriately, speak clearly and logically, and use appropriate technology (e.g., presentation software) and other tools to present findings.
- Use and refine scientific models that simulate physical processes or phenomena.

Reading Standards for Literacy in Science
Key Ideas and Details
1. Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.
2. Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text.
3. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text.
Craft and Structure
4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 9–10 texts and topics*.
5. Analyze the structure of the relationships among concepts in a text, including relationships among key terms (e.g., *force, friction, reaction force, energy*).
6. Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, defining the question the author seeks to address.
Integration of Knowledge and Ideas
7. Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.
8. Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem.

9. Compare and contrast findings presented in a text to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts.

Range of Reading and Level of Text Complexity

10. By the end of grade 10, read and comprehend science/technical texts in the grades 9–10 text complexity band independently and proficiently.

Writing Standards

Text Types and Purposes

1. Write arguments focused on *discipline-specific content*.
- a. Introduce precise claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that establishes clear relationships among the claim(s), counterclaims, reasons, and evidence.
- b. Develop claim(s) and counterclaims fairly, supplying data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form and in a manner that anticipates the audience's knowledge level and concerns.
- c. Use words, phrases, and clauses to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims.
- d. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.
- e. Provide a concluding statement or section that follows from or supports the argument presented.

2. Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.
- a. Introduce a topic and organize ideas, concepts, and information to make important connections and distinctions; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.
- b. Develop the topic with well-chosen, relevant, and sufficient facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic.
- c. Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among ideas and concepts.
- d. Use precise language and domain-specific vocabulary to manage the complexity of the topic and convey a style appropriate to the discipline and context as well as to the expertise of likely readers.
- e. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.
- f. Provide a concluding statement or section that follows from and supports the information or explanation presented (e.g., articulating implications or the significance of the topic).

3. Students' narrative skills continue to grow in these grades. The standards require that students be able to incorporate narrative elements effectively into arguments and informative/explanatory texts. In history/social studies, students must be able to incorporate narrative accounts into their analyses of individuals or events of historical import. In science and technical subjects, students must be able to write precise enough descriptions of the step-by-step procedures they use in their investigations or technical work that others can replicate them and (possibly) reach the same results.

Production and Distribution of Writing

4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

5. Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.

6. Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically.

Research to Build and Present Knowledge

7. Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

8. Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation.

9. Draw evidence from informational texts to support analysis, reflection, and research.

Range of Writing

10. Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a

day or two) for a range of discipline-specific tasks, purposes, and audiences.

Essential Questions

- How do the body systems interact with one another to maintain homeostasis?
- How does structure relate to function?

Enduring Understandings

Students will learn how:

- Explain generally how the digestive system converts macromolecules from food into smaller molecules that can be used by cells for energy and for repair and growth.
- Explain how the circulatory system transports nutrients and oxygen to cells and removes cell wastes. Describe how the kidneys and the liver are closely associated with the circulatory system as they perform excretory function of removing waste from the blood. Recognize that kidneys remove nitrogenous wastes, and the liver removes many toxic compounds from blood.
- Explain how the respiratory system provides exchange of oxygen and carbon dioxide.
- Explain how the nervous system mediates communication among different parts of the body and mediates the body's interactions with the environment. Identify the basic unit of the nervous system, the neuron, and explain generally how it works.
- Explain how the muscular/skeletal system works with other systems to support the body and allow for movement. Recognize that bones produce blood cells.
- Recognize the sexual reproductive system allows organisms to produce offspring that receive half of their genetic information from their mother and half from their father, and that sexually produced offspring resemble, but are not identical to, either of their parents.
- Recognize that communication among cells is required for coordination of body functions. The nerves communicate with electrochemical signals, hormones circulate through the blood, and some cells produce signals to communicate only with nearby cells.
- Recognize that the body's systems interact to maintain homeostasis. Describe the basic function of a physiological feedback loop.

Evidence of Understanding

The students will:

- Students will complete tests and quizzes, lab reports, projects – storyboard for endocrine system, career PowerPoint, pathology presentations, homework, and participation.

Course Outline

Unit	Essential Questions	Skills and Understandings	Assessment
Introduction to Anatomy	How is the body organized? Why is it organized that way? What makes something alive? What are the characteristics of life? What directional terms are used by scientists to effectively	Define anatomy and physiology, and explain how they are related to each other and other fields of science. • Discuss the characteristics of life and requirements for	Quiz Test Autopsy project

	communicate with one another?	survival. • Define homeostasis, explain its importance to survival, and provide examples of a homeostatic mechanism. • Explain the levels of organization of the human body. • Describe the locations of the major body cavities and list the organs located in each. • Name the major organ systems and list the organs associated with each. • Describe the general functions of each organ system. • Properly use the terms that describe relative position, body sections, and body regions.	
Basic Chemistry	How do chemical changes in the body affect physiological processes? Why?	• Distinguish between the processes of anabolism and catabolism. • Define pH and indicate how a change in the body's pH may upset homeostasis. • List the major groups of inorganic substances and elements that are common in living cells. • Compare and contrast the structures and functions of organic compounds (lipids, carbohydrates, proteins, and nucleic acids). • Relate organic compounds to the effects of diet and nutrition on body function. • Identify enzymes and their function. Describe and demonstrate lactose intolerance.	Quiz Test Lactose Lab
Cells	How does cellular function in the body affect physiological processes?	• Explain how cells differ from one another in structure and function. • Understand cell differentiation and that there are 200 different types of	Quiz Test Microscope Lab

		cells comprising organisms. • Describe the cell nucleus and each kind of cytoplasmic organelle and explain their functions. • Draw and label the structure of the cell membrane and discuss the functions of it. • Review how substances move into and out of cells and distinguish between the processes of diffusion, osmosis, facilitated diffusion, and active transport. • Review the cell cycle and how a cell reproduces. • Identify diseases that occur at the cellular level and compare healthy cells to cancer cells.	
Tissues	How do tissues make up organs and how do their functions contribute to the survival of the organism?	• Explain the general function and outstanding features of each of the primary types of tissues. • Illustrate the different types of epithelial tissue. Discuss where in the body each type is found and its function. • Compare and contrast the three types of muscle tissue. • Diagram and identify different types of connective tissue. Explain where each is found in the body and its function. • Discuss the function and structure of nervous tissue. • Identify various diseases that affect tissues and discuss possible treatments.	Quiz Test Microscope Lab
Skeletal System	How does the skeletal system function to support the human body and interact with other body systems? How does the skeletal system grow, repair itself, and maintain proper function? What bones comprise the skeletal system and how are they	• Describe the functions of the human skeleton. • Classify the four types of bone and provide examples of each. • Describe bone development (intramembraneous vs.	Quiz Test Lab Practical

	organized and articulated?	endochondral), composition, and maintenance. • Recognize the microscopic structure of bone. Compare compact and spongy. • Identify the parts of a long bone and their functions. • Distinguish between the axial and appendicular skeletons, and name the major parts of each. • Locate and identify the major bones of the skull, vertebral column, thoracic cage, pectoral girdle, upper limb, pelvic girdle, and lower limb. • Describe the effects of sunlight, nutrition, hormonal secretions, and exercise on bone development. • Distinguish between different types of joints and bone movements. • Assess different types of bone fractures and disorders. • Explain the bone repair process. • Recognize the connection between the skeletal system with other organ systems of the body.	
Muscular System	How does the functioning of the muscular system keep an organism alive? How does the muscular system work in conjunction with other body systems?	• Identify the general functions of the muscular system. • Name the major parts of a skeletal muscle fiber and describe the function of each part. • Explain the major events that occur during muscle fiber contraction • Diagram and describe the graph of a single muscle twitch. • Explain how energy is supplied to the muscle fiber contraction mechanism, how oxygen debt develops, and how a muscle may become fatigued. • Describe how exercise affects skeletal muscles.	Quiz Test Disorder of the Muscular System Project

		• Explain how various types of muscular contractions produce body movements and help maintain posture. • Compare the contraction mechanisms of skeletal, smooth, and cardiac muscle fibers. • Identify and locate the major skeletal muscles of each body region and describe the action of each muscle. • Recognize various muscular disorders, their causes, symptoms, and treatments. • Interconnect the structures and functions of the muscular system with other body systems.	
Nervous System	How does the functioning of the nervous system keep an organism alive?	Explain the general functions of the nervous system. • Describe the general structure of a neuron and classify the different types. • Name the four types of neuroglial cells and describe the functions of each. • Explain how a membrane becomes polarized and discuss the events that lead to the conduction of a nerve impulse. • Explain how a nerve impulse is transmitted from one neuron to another at a synapse. • Distinguish between excitatory and inhibitory postsynaptic potentials. • Compare and contrast the structures and functions of the central and peripheral nervous system. • Describe the structure of the spinal cord and its major functions. • Name the major parts of the brain and describe the functions of each. • Distinguish among motor, sensory, and association areas of the areas of the	Quiz Test Dissection of sheep brain

		cerebral cortex and explain hemisphere dominance. • Explain the stages in memory storage. • Describe the formation and function of cerebrospinal fluid. • List the major parts of the peripheral nervous system. • Name the cranial nerves and list their major functions. • Explain how spinal nerves are named and their functions. • Describe the general characteristics of the autonomic nervous system. • Compare and contrast the sympathetic and parasympathetic divisions of the autonomic nervous system. • Discuss various disorders of the nervous system. - Recognize the connection between the nervous system to the other body systems	
Cardiovascular System	How does the functioning of the cardiovascular system keep the human body alive? How does the cardiovascular system work in conjunction with other body systems? Why is it important to distinguish people's blood types? Why is it important to measure a person's blood pressure?	Compare and contrast the abundance, structure, and function of erythrocytes, leukocytes, and thrombocytes. • Discuss red blood cell production and life cycle. • Explain ABO and Rh blood classification and blood coagulation. • Describe the process of blood clotting. • Discuss the structure and function of the heart. • Trace the coronary pathway of blood through the heart chambers, valves, and major vessels attached to the heart, and identify where the blood is oxygenated and where it is deoxygenated. • Explain the electrical action of the heart's conduction system, and relate them to the waves in	Quiz Test Daphnia or Goldfish Respiration Lab Dissection of sheep heart

		an electrocardiogram. • Compare the pulmonary and systemic circuits, locating and identifying the major arteries and veins involved in each. • Compare and contrast the types of blood vessels including arteries, arterioles, capillaries, venules, and veins. • Discuss the process of gas exchange in the capillaries at the alveoli and body tissues. • Identify certain cardiovascular disorders including cause, symptoms, and treatments. • Understand how blood pressure is produced and controlled. • Describe how the cardiovascular system is connected with other body systems.	
Lymphatic System	Why is the functioning of the lymphatic system necessary for survival? Why does the body have specific and nonspecific defenses against invading pathogens?	Describe the general functions of the lymphatic system • Describe how tissue fluid and lymph form and explain the function of lymph. • Locate and describe the major chains of lymph nodes and their functions. • Discuss the functions of the thymus and spleen • Distinguish between specific and nonspecific defenses, and provide examples of each. • Explain how two major types of lymphocytes are formed, activated, and how they function in immune mechanisms. • Distinguish between primary and secondary immune responses. • Explain how allergic reactions, tissue rejection reactions, and autoimmunity arise from immune mechanisms. • Discuss various immune	Quiz Test

		system disorders, specifically AIDS. • Recognize the connection between the lymphatic system and the other body systems.	
Digestive System	How do the structures and functions of the digestive system keep the human body alive?	Name and describe the major organs and accessory structures of the digestive system. • Describe the general functions of each digestive organ. • Describe the structure of the wall of the alimentary canal. • Explain how the contents of the alimentary canal are mixed and moved. • List the enzymes that the digestive organs and glands secrete and describe the function of each. • Describe how digestive secretions are regulated. • Describe the mechanisms of swallowing, vomiting, and defecating. • Explain how the products of digestion are absorbed. • Identify the cause, symptoms, and treatments of various digestive disorders. • Recognize the connection between the digestive system and the other organ systems.	Quiz Test
Respiratory System	Why is the functioning of the respiratory system necessary for survival? Why do we breathe?	Locate and describe all the structures along the respiratory tract. • List the general function of the respiratory system. • Discuss the mechanics of breathing including both inspiration and expiration. • Explain how breathing is controlled and regulated by the respiratory center. • Trace the path of an oxygen molecule from the atmosphere to the alveoli	Quiz Test

		and then to the body tissues and the path of a carbon dioxide molecule from body tissues to the alveoli and finally to the atmosphere. • Describe how oxygen and carbon dioxide are transported and compare and contrast external and internal respiration. • Explain the driving force behind the gas exchange. • Analyze the effects of exercise on the utilization of oxygen for cellular respiration and the production of carbon dioxide. • Examine the cause, symptoms, and treatments for respiratory disorders. • Measure respiratory volumes such as breathing rate, tidal volume, and total lung capacity. • Interpret a graph of respiratory volumes taken from a spirometer. • Make connections between the respiratory system with the other organ systems.	
Urinary System	How do the structures and functions of the urinary system contribute to survival?	Explain the term homeostasis and relate it to the importance of the kidney. • Identify the four major organs of the urinary system and describe the functions of each. • Demonstrate the main function of the kidney as the body's filtering system. • Describe the location and structure of the kidney. • Discuss the structure of a nephron. • Trace the pathway of blood through the major vessels within the kidney. • Compare and contrast glomerular filtration, tubular reabsorption, and tubular secretion.	Quiz Test

		• Perform and analyze methods of urinalysis used to diagnose urinary disorders. • Describe the regulation of urine formation. • Identify the cause, symptoms, and treatments of different urinary disorders. • Discuss how dialysis can be used to treat renal failure. • Identify the connections between the urinary systems with the other systems of the body.	
Endocrine System	How does the endocrine system work in conjunction with other systems? How does the endocrine system maintain homeostasis and regulate metabolic processes?	Name and describe the locations of the major endocrine glands and list the hormones they secrete. • Describe the general functions of the various hormones. • Distinguish between endocrine and exocrine glands • Discuss how negative feedback mechanisms regulate hormonal secretion. • Explain how the nervous system controls hormonal secretion. • Describe the general stress response. • Identify various disorders of the endocrine system. • Recognize the connection between the endocrine system and the other organ systems of the body.	Quiz Test Endocrine Gland Dysfunction Project
Reproductive System	How do the structures and functions of the reproductive system assure for the continued success of a species?	State the general functions of the male and female reproductive systems. • Name the parts of the male and female reproductive systems and describe the general functions of each part. • Outline the processes of spermatogenesis and oogenesis. • Explain how hormones	Quiz Test Nine Month Miracle

		control the activities of the male and female reproductive organs and the development of secondary sex characteristics. • Describe the major events that occur during a menstrual cycle. • Describe the hormonal changes in the maternal body during pregnancy. • Identify disorders of the reproductive system. • Recognize the connection between the reproductive system and other body systems.	
Integumentary System	How do the structures and functions of the integumentary system contribute to an organism's survival?	Compare and contrast the structure of the two main skin layers. • List the general functions of each skin layer. • Describe the accessory organs associated with the skin, including hair, glands, and nails. • Explain the functions of each accessory organ. • Explain how the skin helps to regulate body temperature. • Summarize the factors that determine skin color. • Discuss various skin disorders, their causes, symptoms, and treatments. • Recognize the connection between the skin and the other body systems.	Quiz Test

Advanced Placement Biology	
Grade Level	11-12
Course Number	315
Subject Area	Science and Technology

Course Description

This course is designed to be equivalent of a college introductory biology course. It is composed of three general areas of study: molecules and cells, genetics and evolution, and organisms and populations. The major themes will include: Science as a process; Evolution; Energy Transfer; Continuity and Change; Relationship of Structure to Function; Regulation, Interdependence in Nature, and Science, Technology and Society. The course is designed to reflect the academic expectations and rigor of a college-level course as delineated by the College Board. Summer assignments are required to be completed. It is the responsibility of the student to obtain this summer work prior to leaving school in June.

Content Standards

1. The Chemistry of Life

Central Concept: Chemical elements form organic molecules that interact to perform the basic functions of life.

1.1 Recognize that biological organisms are composed primarily of very few elements. The six most common are C, H, N, O, P, and S.
1.2 Describe the basic molecular structures and primary functions of the four major categories of organic molecules (carbohydrates, lipids, proteins, nucleic acids).
1.3 Explain the role of enzymes as catalysts that lower the activation energy of biochemical reactions. Identify factors, such as pH and temperature, that have an effect on enzymes.

2. Cell Biology

Central Concepts: Cells have specific structures and functions that make them distinctive. Processes in a cell can be classified broadly as growth, maintenance, and reproduction.

2.1 Relate cell parts/organelles (plasma membrane, nuclear envelope, nucleus, nucleolus, cytoplasm, mitochondrion, endoplasmic reticulum, Golgi apparatus, lysosome, ribosome, vacuole, cell wall, chloroplast, cytoskeleton, centriole, cilium, flagellum, pseudopod) to their functions. Explain the role of cell membranes as a highly selective barrier (diffusion, osmosis, facilitated diffusion, active transport).
2.2 Compare and contrast, at the cellular level, the general structures and degrees of complexity of prokaryotes and eukaryotes.
2.3 Use cellular evidence (e.g., cell structure, cell number, cell reproduction) and modes of nutrition to describe the six kingdoms (Archaebacteria, Eubacteria, Protista, Fungi, Plantae, Animalia).
2.4 Identify the reactants, products, and basic purposes of photosynthesis and cellular respiration. Explain the interrelated nature of photosynthesis and cellular respiration in the cells of photosynthetic organisms.
2.5 Explain the important role that ATP serves in metabolism.
2.6 Describe the cell cycle and the process of mitosis. Explain the role of mitosis in the formation of new cells, and its importance in maintaining chromosome number during asexual reproduction.
2.7 Describe how the process of meiosis results in the formation of haploid cells. Explain the importance of this process in sexual reproduction, and how gametes form diploid zygotes in the process of fertilization.
2.8 Compare and contrast a virus and a cell in terms of genetic material and reproduction.

3. Genetics

Central Concepts: Genes allow for the storage and transmission of genetic information. They are a set of instructions encoded in the nucleotide sequence of each organism. Genes code for the specific sequences of amino acids that comprise the proteins characteristic to that organism.

3.1 Describe the basic structure (double helix, sugar/phosphate backbone, linked by complementary nucleotide pairs) of DNA, and describe its function in genetic inheritance.
3.2 Describe the basic process of DNA replication and how it relates to the transmission and conservation of the genetic code. Explain the basic processes of transcription and translation, and how they result in the expression of genes. Distinguish among the end products of replication, transcription, and translation.
3.3 Explain how mutations in the DNA sequence of a gene may or may not result in phenotypic change in an organism. Explain how mutations in gametes may result in phenotypic changes in offspring.
3.4 Distinguish among observed inheritance patterns caused by several types of genetic traits (dominant, recessive, codominant, sex-linked, polygenic, incomplete dominance, multiple alleles).
3.5 Describe how Mendel's laws of segregation and independent assortment can be observed through patterns of

inheritance (e.g., dihybrid crosses).

3.6 Use a Punnett Square to determine the probabilities for genotype and phenotype combinations in monohybrid crosses.

4. Anatomy & Physiology

Central Concepts: There is a relationship between the organization of cells into tissues and the organization of tissues into organs. The structures and functions of organs determine their relationships within body systems of an organism. Homeostasis allows the body to perform its normal functions.

4.1 Explain generally how the digestive system (mouth, pharynx, esophagus, stomach, small and large intestines, rectum) converts macromolecules from food into smaller molecules that can be used by cells for energy and for repair and growth.

4.2 Explain how the circulatory system (heart, arteries, veins, capillaries, red blood cells) transports nutrients and oxygen to cells and removes cell wastes. Describe how the kidneys and the liver are closely associated with the circulatory system as they perform the excretory function of removing waste from the blood. Recognize that kidneys remove nitrogenous wastes, and the liver removes many toxic compounds from blood.

4.3 Explain how the respiratory system (nose, pharynx, larynx, trachea, lungs, alveoli) provides exchange of oxygen and carbon dioxide.

4.4 Explain how the nervous system (brain, spinal cord, sensory neurons, motor neurons) mediates communication among different parts of the body and mediates the body's interactions with the environment. Identify the basic unit of the nervous system, the neuron, and explain generally how it works.

4.5 Explain how the muscular/skeletal system (skeletal, smooth and cardiac muscles, bones, cartilage, ligaments, tendons) works with other systems to support the body and allow for movement. Recognize that bones produce blood cells.

4.6 Recognize that the sexual reproductive system allows organisms to produce offspring that receive half of their genetic information from their mother and half from their father, and that sexually produced offspring resemble, but are not identical to, either of their parents.

4.7 Recognize that communication among cells is required for coordination of body functions. The nerves communicate with electrochemical signals, hormones circulate through the blood, and some cells produce signals to communicate only with nearby cells.

4.8 Recognize that the body's systems interact to maintain homeostasis. Describe the basic function of a physiological feedback loop.

5. Evolution & Biodiversity

Central Concepts: Evolution is the result of genetic changes that occur in constantly changing environments. Over many generations, changes in the genetic make-up of populations may affect biodiversity through speciation and extinction.

5.1 Explain how evolution is demonstrated by evidence from the fossil record, comparative anatomy, genetics, molecular biology, and examples of natural selection.

5.2 Describe species as reproductively distinct groups of organisms. Recognize that species are further classified into a hierarchical taxonomic system (kingdom, phylum, class, order, family, genus, species) based on morphological, behavioral, and molecular similarities. Describe the role that geographic isolation can play in speciation.

5.3 Explain how evolution through natural selection can result in changes in biodiversity through the increase or decrease of genetic diversity within a population.

6. Ecology

Central Concept: Ecology is the interaction among organisms and between organisms and their environment.

6.1 Explain how birth, death, immigration, and emigration influence population size.

6.2 Analyze changes in population size and biodiversity (speciation and extinction) that result from the following: natural causes, changes in climate, human activity, and the introduction of invasive, non-native species.

6.3 Use a food web to identify and distinguish producers, consumers, and decomposers, and explain the transfer of energy through trophic levels. Describe how relationships among organisms (predation, parasitism, competition, commensalism, mutualism) add to the complexity of biological communities.

6.4 Explain how water, carbon, and nitrogen cycle between abiotic resources and organic matter in an ecosystem, and how oxygen cycles through photosynthesis and respiration.

Scientific Inquiry Skills Standards

SIS1. Make observations, raise questions, and formulate hypotheses.

- Observe the world from a scientific perspective.
- Pose questions and form hypotheses based on personal observations, scientific articles, experiments, and knowledge.
- Read, interpret, and examine the credibility and validity of scientific claims in different sources of information, such as scientific articles, advertisements, or media stories.

SIS2. Design and conduct scientific investigations.

- Articulate and explain the major concepts being investigated and the purpose of an investigation.
- Select required materials, equipment, and conditions for conducting an experiment.
- Identify independent and dependent variables.
- Write procedures that are clear and replicable.
- Employ appropriate methods for accurately and consistently
    - making observations
    - making and recording measurements at appropriate levels of precision
    - collecting data or evidence in an organized way
- Properly use instruments, equipment, and materials (e.g., scales, probeware, meter sticks, microscopes, computers) including set-up, calibration (if required), technique, maintenance, and storage.
- Follow safety guidelines.

SIS3. Analyze and interpret results of scientific investigations.

- Present relationships between and among variables in appropriate forms.
    - Represent data and relationships between and among variables in charts and graphs.
    - Use appropriate technology (e.g., graphing software) and other tools.
- Use mathematical operations to analyze and interpret data results.
- Assess the reliability of data and identify reasons for inconsistent results, such as sources of error or uncontrolled conditions.
- Use results of an experiment to develop a conclusion to an investigation that addresses the initial questions and supports or refutes the stated hypothesis.
- State questions raised by an experiment that may require further investigation.

SIS4. Communicate and apply the results of scientific investigations.

- Develop descriptions of and explanations for scientific concepts that were a focus of one or more investigations.
- Review information, explain statistical analysis, and summarize data collected and analyzed as the result of an investigation.
- Explain diagrams and charts that represent relationships of variables.
- Construct a reasoned argument and respond appropriately to critical comments and questions.
- Use language and vocabulary appropriately, speak clearly and logically, and use appropriate technology (e.g., presentation software) and other tools to present findings.
- Use and refine scientific models that simulate physical processes or phenomena.

Reading Standards for Literacy in Science

Key Ideas and Details

1. Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.

2. Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text.

3. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text.

Craft and Structure

4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific

scientific or technical context relevant to *grades 9–10 texts and topics*.
5. Analyze the structure of the relationships among concepts in a text, including relationships among key terms (e.g., *force, friction, reaction force, energy*).
6. Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, defining the question the author seeks to address.
Integration of Knowledge and Ideas
7. Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.
8. Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem.
9. Compare and contrast findings presented in a text to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts.
Range of Reading and Level of Text Complexity
10. By the end of grade 10, read and comprehend science/technical texts in the grades 9–10 text complexity band independently and proficiently.
Writing Standards
Text Types and Purposes
1. Write arguments focused on *discipline-specific content*. a. Introduce precise claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that establishes clear relationships among the claim(s), counterclaims, reasons, and evidence. b. Develop claim(s) and counterclaims fairly, supplying data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form and in a manner that anticipates the audience's knowledge level and concerns. c. Use words, phrases, and clauses to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims. d. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing. e. Provide a concluding statement or section that follows from or supports the argument presented.
2. Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. a. Introduce a topic and organize ideas, concepts, and information to make important connections and distinctions; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension. b. Develop the topic with well-chosen, relevant, and sufficient facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic. c. Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among ideas and concepts. d. Use precise language and domain-specific vocabulary to manage the complexity of the topic and convey a style appropriate to the discipline and context as well as to the expertise of likely readers. e. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing. f. Provide a concluding statement or section that follows from and supports the information or explanation presented (e.g., articulating implications or the significance of the topic).
3. Students' narrative skills continue to grow in these grades. The standards require that students be able to incorporate narrative elements effectively into arguments and informative/explanatory texts. In history/social studies, students must be able to incorporate narrative accounts into their analyses of individuals or events of historical import. In science and technical subjects, students must be able to write precise enough descriptions of the step-by-step procedures they use in their investigations or technical work that others can replicate them and (possibly) reach the same results.
Production and Distribution of Writing
4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
5. Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.
6. Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking

advantage of technology's capacity to link to other information and to display information flexibly and dynamically.
Research to Build and Present Knowledge
7. Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.
8. Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation.
9. Draw evidence from informational texts to support analysis, reflection, and research.
Range of Writing
10. Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

Essential Questions

What is the basis of molecules and cells?
What is the basis of Heredity and Evolution?
What is the basis of Organisms and Populations?

Enduring Understandings

Students will learn how:
Students will learn how to:

- Discuss how behavior has proximate and ultimate causes.
- Support, with examples, the premise that behavior has a genetic basis.
- Give examples to show that behaviors sometimes undergo development after birth.
- Discuss different types of learning and how learning affects behavior.
- Discuss sexual selection in relation to female selectivity and male competition for mates.
- List and give examples of the different types of communication between animals.
- Explain how altruism might evolve under certain circumstances
- Discuss several scientists who have contributed to the field of ethology and the experiments that they performed.
- Explain how behavioral ethology emphasizes evolutionary hypotheses.
- Calculate the rate of natural increase for a population when provided with the number of individuals in the population, the birthrate, and the death rate.
- Contrast a J-shaped growth curve with an S-shaped growth curve. Discuss how density-independent and density dependent limiting factors maintain homeostasis in an ecosystem.
- Indicate which parts of an S-shaped growth curve represent biotic potential, environmental resistance, and carrying capacity.
- Give examples of density-independent and density-dependent effects of environmental resistance.
- Contrast three likely types of survivorship curves for a population.
- Contrast three common age structure diagrams for a population.
- Contrast an r-strategist population with a K-strategist population in regard to growth curves, survivorship curves, and age structure diagrams.
- Describe the growth curve for the world's human population. Indicate the environmental and social issues that have emerged with our growing population.
- Discuss the effect that interspecific competition can have on population size.
- State the competitive exclusion principle, and relate this principle to the diversity of organisms.
- Distinguish between the niche and the habitat of an organism.
- Discuss the effect that predation can have on the size of the prey population and on the diversity of the community.
- Explain the principle of mimicry, and give examples of the two kinds of mimicry.
- Give examples of the three types of symbiotic relationships, and explain what effect they can have on population size.
- Give examples of biotic components within an ecosystem.
- Describe the process of primary and secondary succession on land; contrast the properties of the early stages of succession with the climax stage of succession
- Give examples of food chains and food webs, and define trophic level.
- Give examples to show how environmental disturbances can affect a food web.
- Construct a pyramid of energy and use it as a basis to explain why energy flows through an ecosystem.
- Describe the carbon, nitrogen, phosphorus, and water cycles.

- Distinguish between freshwater and marine communities. Describe the life zones of a lake and an ocean.
- Describe the characteristics of the terrestrial biomes.
- Discuss how human activity damages the biosphere. Explain how exponential population growth, destruction of habitats, pollution, and other activities all contribute to the damage of the environment.
- Describe the relationships between matter, atoms, and molecules.
- Discuss how atomic structure determines how atoms interact.
- Explain how molecular and structural formulas are used to symbolize the composition of compounds.
- Compare and contrast different chemical bonds.
- Illustrate a molecule of water and discuss its unique properties.
- Write and balance different types of chemical reactions.
- Note which atom has been reduced and which has been oxidized in a particular reaction.
- Define pH and indicate how a change in the body's pH may upset homeostasis.
- List the major groups of inorganic substances and elements that are common in living cells.
- Compare and contrast the structures and functions of organic compounds (lipids, carbohydrates, proteins, and nucleic acids).
- Distinguish between condensation of monomers and hydrolysis of polymers.
- Identify enzymes and their function.
- State the cell theory.
- Explain, on the basis of cell-volume-to-cell-surface relationships, why cells are so very small.
- Contrast the structures of prokaryotic cells, eukaryotic animal cells, and eukaryotic plant cells.
- Explain the relationship between chloroplasts and mitochondria, and describe the structure and function of each.
- Name the components of the cytoskeleton, and describe the structure and the functions of each component.
- Draw and label the structure of the cell membrane and discuss the functions of it.
- Explain how substances move into and out of cells and distinguish between the processes of diffusion, osmosis, facilitated diffusion, and active transport.
- Describe the appearance of a plant cell and an animal cell in isotonic, hypotonic, and hypertonic solutions.
- Name two types of carrier proteins, and give an example for each.
- Contrast endocytosis and exocytosis. Name three types of endocytosis and differentiate among them.
- Describe the composition of the plant cell wall.
- List and describe three types of junctions that occur between animal cells. Name and describe one type of junction between plant cells.
- Describe energy transfer and the reciprocal reactions of photosynthesis and cellular respiration.
- Describe the electromagnetic spectrum and the absorption spectra for chlorophylls a and b.
- Describe the structure of chloroplasts, and give the function of the two main parts.
- Explain the terms light-dependent reactions and light-independent reactions, and describe how the light-dependent reactions drive the light-independent reactions.
- Trace and compare the cyclic and noncyclic electron pathway in chloroplasts.
- Describe the process of chemiosmotic ATP synthesis in chloroplasts.
- Describe the three stages of the Calvin cycle.
- Contrast C3 and C4 plants, and relate the phenomenon of photorespiration to the success of C4 plants in hot, dry climates.
- Contrast the routes of photosynthesis in CAM and C4 plants.
- Describe the general function of cellular respiration.
- Diagram a molecule of ATP and describe where energy is stored and how it is released.
- Describe both the anaerobic and aerobic fate of pyruvate.
- Discuss glycolysis and note the inputs and outputs of the pathway.
- Describe lactate fermentation and alcoholic fermentation and the evolutionary significance of the fermentation process.
- Relate lactate fermentation to the contraction of a muscle fiber and discuss the sliding filament theory.
- Relate the structure of the mitochondria to the location of the Krebs cycle and the electron transport system.
- Discuss the transition reaction and the Krebs cycle and give the inputs and outputs of each.
- Discuss the electron transport system and its contribution to the formation of ATP.
- Describe the arrangement of protein complexes in the inner membrane of the mitochondria and explain the process of chemiosmotic ATP synthesis.
- Calculate the yield of ATP molecules per glucose molecule for glycolysis and aerobic respiration.
- Identify why cells divide.
- Discuss the importance of an appropriate surface area to cell size.
- Explain the steps of the cell cycle including Interphase, Mitosis, and Cytokinesis.
- Compare cytokinesis in plant and animal cells.
- Discuss stem cells and cell differentiation. Discuss how modern technology has created ethical issues concerning the use

of embryonic and adult stem cells.
- State possible causes for abnormal cell division.
- Compare and contrast the goals and phases of mitosis and meiosis.
- Identify the steps of meiosis.
- Explain how crossing over, independent assortment, and random fertilization contribute to genetic recombination.
- Compare and contrast oogenesis and spermatogenesis.
- Discuss asexual and sexual reproduction and explain how sexual reproduction and genetic variation is the basis for evolution.
- Discuss the ideas about heredity that were prevalent when Mendel began his experiments. • Outline the general methodology that Mendel used for his experiments,
- Diagram monohybrid and dihybrid crosses, using words to indicate the phenotype and letters to indicate the genotype.
- State Mendel's laws of segregation and independent assortment, and describe the reasoning he used to arrive at these laws.
- Solve two-trait genetics problems utilizing the laws of probability.
- Recognize and solve genetics problems involving degrees of dominance, multiple alleles, sex-linked traits, and polygenes.
- Distinguish the difference between sex-linked and sex-influenced traits.
- Explain why linked genes do not obey Mendel's laws and solve genetic linkage problems. Use results to determine the order of genes on a chromosome.
- Give examples of chromosomal mutations caused by a change in chromosomal number or chromosomal structure, and explain how such mutations occur.
- Recognize the autosomal dominant versus the autosomal recessive pattern of inheritance in a human pedigree chart.
- Give examples of and describe the most common autosomal genetic disorders in humans.
- Discuss the role of Barr bodies and genomic imprinting.
- Describe the experiments of Griffith, Avery, Hershey and Chase, Chargaff, Franklin, and Watson and Crick.
- Discuss why each of the experiments was significant.
- Describe the structure of DNA and explain the semiconservative manner in which DNA replicates.
- Contrast the process of DNA replication in prokaryotes and eukaryotes.
- List the biochemical differences between RNA and DNA.
- Explain how transcription and translation occurs.
- Discuss the roles of ribosomes, mRNA, tRNA, and amino acids during protein synthesis.
- Determine the mRNA codons, possible tRNA anticodons, and the sequence of amino acids in the resulting protein when given a DNA coding strand and a table of codons.
- Discuss the different types of gene mutations, the rate of mutation, and the manner in which DNA is protected from mutation. Apply this to the idea of continuity and change.
- List and define the components of an operon. Explain why the lac operon is an inducible operon and trp operon is a repressible operon.
- Describe the process by which recombinant DNA is prepared and a gene is cloned.
- Describe the polymerase chain reaction; note how and for what purpose DNA segments are analyzed.
- Discuss the process of gel electrophoresis and how it can be used for DNA fingerprinting.
- Describe the services performed by transgenic bacteria.
- Outline current methods employed for gene therapy and list illnesses that may be corrected by using it.
- Show that scientific world views were beginning to change during the eighteenth century.
- Contrast the prevalent pre-Darwinian views with post-Darwinian views.
- Describe Lamarck's hypotheses of evolution, and explain which aspects of his theory were incorrect.
- Describe Charles Darwin's background and the path of the voyage of the HMS Beagle.
- Describe natural selection as a process that results in adaptation to the environment.
- Explain how the fossil record, biogeography, comparative anatomy, embryology, and comparative biochemistry support a hypothesis of common descent.
- State the sources of variation in a population of sexually reproducing diploid organisms.
- Explain the Hardy-Weinberg law, along with its conditions.
- List and discuss the agents of evolutionary change.
- Distinguish among directional, stabilizing, and disruptive selection by giving examples.
- Explain the biological definition of a species and discuss reproductive isolating mechanisms.
- Contrast allopatric and sympatric speciation.
- Explain the process of adaptive radiation and give examples.
- Describe and explain an organism's scientific name.
- Discuss taxonomy and what structures and functions place organisms into their classification categories.
- Name and give examples of the five kingdoms.
- Analyze and discuss a phylogenetic tree.

- Contrast the characteristics of viruses and bacteria to show that viruses are nonliving and bacteria are living organisms.
- Describe the structures of viruses and how they replicate
- Describe the structure of a prokaryotic cell, how they reproduce, how they acquire nutrition, and how they are classified.
- Discuss how the eukaryotic cell may have arisen.
- List and describe the phyla for different types of algae, protozoa, and slime molds.
- List and discuss the characteristics of fungi, stressing their ecological importance.
- List the characteristics shared by all plants.
- Compare and contrast bryophytes and vascular plants (both seed and seedless).
- Discuss the nutrition, transport, development, and reproduction of plants.
- List the characteristics of animals and draw a phylogenetic tree that shows the nine major animal phyla.
- Compare and contrast the anatomical features of invertebrates.
- List and discuss several advantages of having a coelom.
- List the embryological differences between protostomes and deuterostomes, and tell which animal phyla belong to each group.
- Discuss the evolution of the three-part body plan, segmentation, and jointed appendages.
- Discuss the evolution of chordate characteristics, vertebrates, jaws, limbs, the amniote egg, wings and feathers, and finally homeothermy.
- Describe the appearances of jawless fish, cartilaginous fish, bony fish, amphibians, reptiles, birds, and mammals. Discuss their adaptations for survival.

Evidence of Understanding

The students will:
Students will complete tests and quizzes, lab reports, projects, complete previous AP exams, homework, and participation.

Course Outline

Unit	Essential Questions	Skills and Understandings	Assessment
Unit 1: Animal Behavior	What is ethology? How does behavior increase individual fitness?	▪ Discuss how behavior has proximate and ultimate causes. ▪ Support, with examples, the premise that behavior has a genetic basis. ▪ Give examples to show that behaviors sometimes undergo development after birth. ▪ Discuss different types of learning and how learning affects behavior. ▪ Discuss sexual selection in relation to female selectivity and male competition for mates. ▪ List and give examples of the different types of communication between animals. ▪ Explain how altruism	Students will complete tests and quizzes, lab report, complete previous AP exams questions, homework (free response and multiple choice)

		might evolve under certain circumstances ▪ Discuss several scientists who have contributed to the field of ethology and the experiments that they performed. ▪ Explain how behavioral ethology emphasizes evolutionary hypotheses.	
Unit 2: Ecology	How do living organisms interact with each other and the nonliving parts of the world? Why are these interactions essential for survival? What causes populations to change?	▪ Calculate the rate of natural increase for a population when provided with the number of individuals in the population, the birthrate, and the death rate. ▪ Contrast a J-shaped growth curve with an S-shaped growth curve. Discuss how density-independent and density dependent limiting factors maintain homeostasis in an ecosystem. ▪ Indicate which parts of an S-shaped growth curve represent biotic potential, environmental resistance, and carrying capacity. ▪ Give examples of density-independent and density-dependent effects of environmental resistance. ▪ Contrast three likely types of survivorship curves for a population. ▪ Contrast three common age structure diagrams for a population. ▪ Contrast an r-strategist population with a K-strategist population in regard to growth curves, survivorship curves, and age structure diagrams. ▪ Describe the growth curve for the world's human population. Indicate the environmental and	Students will complete tests and quizzes, lab report, complete previous AP exams questions, homework (free response and multiple choice)

		social issues that have emerged with our growing population. ▪ Discuss the effect that interspecific competition can have on population size. ▪ State the competitive exclusion principle, and relate this principle to the diversity of organisms. ▪ Distinguish between the niche and the habitat of an organism. ▪ Discuss the effect that predation can have on the size of the prey population and on the diversity of the community. ▪ Explain the principle of mimicry, and give examples of the two kinds of mimicry. ▪ Give examples of the three types of symbiotic relationships, and explain what effect they can have on population size. ▪ Give examples of biotic components within an ecosystem. ▪ Describe the process of primary and secondary succession on land; contrast the properties of the early stages of succession with the climax stage of succession. ▪ Give examples of food chains and food webs, and define trophic level. ▪ Give examples to show how environmental disturbances can affect a food web. ▪ Construct a pyramid of energy and use it as a basis to explain why energy flows through an ecosystem. ▪ Describe the carbon, nitrogen, phosphorus, and water cycles. ▪ Distinguish between	

		freshwater and marine communities. Describe the life zones of a lake and an ocean. ▪ Describe the characteristics of the terrestrial biomes. ▪ Discuss how human activity damages the biosphere. Explain how exponential population growth, destruction of habitats, pollution, and other activities all contribute to the damage of the environment.	
Unit 3: Basic Chemistry	How does the structure of an organic molecule affect the function? What are living things made of? Why do cells need energy?	▪ Describe the relationships between matter, atoms, and molecules. ▪ Discuss how atomic structure determines how atoms interact. ▪ Explain how molecular and structural formulas are used to symbolize the composition of compounds. ▪ Compare and contrast different chemical bonds. ▪ Illustrate a molecule of water and discuss its unique properties. ▪ Write and balance different types of chemical reactions. ▪ Note which atom has been reduced and which has been oxidized in a particular reaction. ▪ Define pH and indicate how a change in the body's pH may upset homeostasis. ▪ List the major groups of inorganic substances and elements that are common in living cells. ▪ Compare and contrast the structures and functions of organic compounds (lipids, carbohydrates, proteins, and nucleic acids). ▪ Distinguish between condensation of	Students will complete tests and quizzes, lab report, complete previous AP exams questions, homework (free response and multiple choice)

		monomers and hydrolysis of polymers. ▪ Identify enzymes and their function.	
Unit 4: The Cell	How do cells carry out life functions? How do cell structures relate to their functions? Why do cells divide?	▪ State the cell theory. ▪ Explain, on the basis of cell-volume-to-cell-surface relationships, why cells are so very small. ▪ Contrast the structures of prokaryotic cells, eukaryotic animal cells, and eukaryotic plant cells. ▪ Explain the relationship between chloroplasts and mitochondria, and describe the structure and function of each. ▪ Name the components of the cytoskeleton, and describe the structure and the functions of each component. ▪ Draw and label the structure of the cell membrane and discuss the functions of it. ▪ Explain how substances move into and out of cells and distinguish between the processes of diffusion, osmosis, facilitated diffusion, and active transport. ▪ Describe the appearance of a plant cell and an animal cell in isotonic, hypotonic, and hypertonic solutions. ▪ Name two types of carrier proteins, and give an example for each. ▪ Contrast endocytosis and exocytosis. Name three types of endocytosis and differentiate among them. ▪ Describe the composition of the plant cell wall. ▪ List and describe three types of junctions that occur between animal	Students will complete tests and quizzes, lab report, complete previous AP exams questions, homework (free response and multiple choice)

		cells. Name and describe one type of junction between plant cells.	
Unit 5: Photosynthesis and Cellular Respiration	How do photosynthesis and cellular respiration keep all organisms alive?	▪ Describe energy transfer and the reciprocal reactions of photosynthesis and cellular respiration. ▪ Describe the electromagnetic spectrum and the absorption spectra for chlorophylls a and b. ▪ Describe the structure of chloroplasts, and give the function of the two main parts. ▪ Explain the terms light-dependent reactions and light-independent reactions, and describe how the light-dependent reactions drive the light-independent reactions. ▪ Trace and compare the cyclic and noncyclic electron pathway in chloroplasts. ▪ Describe the process of chemiosmotic ATP synthesis in chloroplasts. ▪ Describe the three stages of the Calvin cycle. ▪ Contrast C3 and C4 plants, and relate the phenomenon of photorespiration to the success of C4 plants in hot, dry climates. ▪ Contrast the routes of photosynthesis in CAM and C4 plants. ▪ Describe the general function of cellular respiration. ▪ Diagram a molecule of ATP and describe where energy is stored and how it is released. ▪ Describe both the anaerobic and aerobic fate of pyruvate. ▪ Discuss glycolysis and note the inputs and outputs of the pathway.	Students will complete tests and quizzes, lab report, complete previous AP exams questions, homework (free response and multiple choice)

		▪ Describe lactate fermentation and alcoholic fermentation and the evolutionary significance of the fermentation process. ▪ Relate lactate fermentation to the contraction of a muscle fiber and discuss the sliding filament theory. ▪ Relate the structure of the mitochondria to the location of the Krebs cycle and the electron transport system. ▪ Discuss the transition reaction and the Krebs cycle and give the inputs and outputs of each. ▪ Discuss the electron transport system and its contribution to the formation of ATP. ▪ Describe the arrangement of protein complexes in the inner membrane of the mitochondria and explain the process of chemiosmotic ATP synthesis. ▪ Calculate the yield of ATP molecules per glucose molecule for glycolysis and aerobic respiration.	
Unit 6: Mitosis and Meiosis	Why do cells divide? How is genetic variability attained?	▪ Identify why cells divide. ▪ Discuss the importance of an appropriate surface area to cell size. ▪ Explain the steps of the cell cycle including Interphase, Mitosis, and Cytokinesis. ▪ Compare cytokinesis in plant and animal cells. ▪ Discuss stem cells and cell differentiation. Discuss how modern technology has created ethical issues concerning the use of embryonic and adult stem cells. ▪ State possible causes for	Students will complete tests and quizzes, lab report, complete previous AP exams questions, homework (free response and multiple choice)

		abnormal cell division. ▪ Compare and contrast the goals and phases of mitosis and meiosis. ▪ Identify the steps of meiosis. ▪ Explain how crossing over, independent assortment, and random fertilization contribute to genetic recombination. ▪ Compare and contrast oogenesis and spermatogenesis. ▪ Discuss asexual and sexual reproduction and explain how sexual reproduction and genetic variation is the basis for evolution.	
Unit 7: Genetics and Heredity	How can knowledge of DNA help us understand the way that organisms are related to each other and how organisms change over time? How can we apply probability to genetic understandings?	▪ Discuss the ideas about heredity that were prevalent when Mendel began his experiments. • Outline the general methodology that Mendel used for his experiments, ▪ Diagram monohybrid and dihybrid crosses, using words to indicate the phenotype and letters to indicate the genotype. ▪ State Mendel's laws of segregation and independent assortment, and describe the reasoning he used to arrive at these laws. ▪ Solve two-trait genetics problems utilizing the laws of probability. ▪ Recognize and solve genetics problems involving degrees of dominance, multiple alleles, sex-linked traits, and polygenes. ▪ Distinguish the difference between sex-linked and sex-influenced traits. ▪ Explain why linked genes do not obey Mendel's laws and solve	Students will complete tests and quizzes, lab report, complete previous AP exams questions, homework (free response and multiple choice), and genetics problems

		genetic linkage problems. Use results to determine the order of genes on a chromosome. ▪ Give examples of chromosomal mutations caused by a change in chromosomal number or chromosomal structure, and explain how such mutations occur. ▪ Recognize the autosomal dominant versus the autosomal recessive pattern of inheritance in a human pedigree chart. ▪ Give examples of and describe the most common autosomal genetic disorders in humans. ▪ Discuss the role of Barr bodies and genomic imprinting.	
Unit 8: DNA to Protein	How are proteins expressed? What is the central dogma?	▪ Describe the experiments of Griffith, Avery, Hershey and Chase, Chargaff, Franklin, and Watson and Crick. ▪ Discuss why each of the experiments was significant. ▪ Describe the structure of DNA and explain the semiconservative manner in which DNA replicates. ▪ Contrast the process of DNA replication in prokaryotes and eukaryotes. ▪ List the biochemical differences between RNA and DNA. ▪ Explain how transcription and translation occurs. ▪ Discuss the roles of ribosomes, mRNA, tRNA, and amino acids during protein synthesis. ▪ Determine the mRNA codons, possible tRNA anticodons, and the sequence of amino acids	Students will complete tests and quizzes, lab report, complete previous AP exams questions, homework (free response and multiple choice)

		in the resulting protein when given a DNA coding strand and a table of codons. ▪ Discuss the different types of gene mutations, the rate of mutation, and the manner in which DNA is protected from mutation. Apply this to the idea of continuity and change. ▪ List and define the components of an operon. Explain why the lac operon is an inducible operon and trp operon is a repressible operon. ▪ Describe the process by which recombinant DNA is prepared and a gene is cloned. ▪ Describe the polymerase chain reaction; note how and for what purpose DNA segments are analyzed. ▪ Discuss the process of gel electrophoresis and how it can be used for DNA fingerprinting. ▪ Describe the services performed by transgenic bacteria. ▪ Outline current methods employed for gene therapy and list illnesses that may be corrected by using it.	
Unit 9: Natural Selection and Classification	How are living things organized? What makes something living? How is evolution evident in life? How are living organisms organized? How do living organisms change over time?	▪ Show that scientific world views were beginning to change during the eighteenth century. ▪ Contrast the prevalent pre-Darwinian views with post-Darwinian views. ▪ Describe Lamarck's hypotheses of evolution, and explain which aspects of his theory were incorrect. ▪ Describe Charles Darwin's background and the path of the	Students will complete tests and quizzes, lab report, complete previous AP exams questions, homework (free response and multiple choice)

		voyage of the HMS Beagle. ▪ Describe natural selection as a process that results in adaptation to the environment. ▪ Explain how the fossil record, biogeography, comparative anatomy, embryology, and comparative biochemistry support a hypothesis of common descent. ▪ State the sources of variation in a population of sexually reproducing diploid organisms. ▪ Explain the Hardy-Weinberg law, along with its conditions. ▪ List and discuss the agents of evolutionary change. ▪ Distinguish among directional, stabilizing, and disruptive selection by giving examples. ▪ Explain the biological definition of a species and discuss reproductive isolating mechanisms. ▪ Contrast allopatric and sympatric speciation. ▪ Explain the process of adaptive radiation and give examples. ▪ Describe and explain an organism's scientific name. ▪ Discuss taxonomy and what structures and functions place organisms into their classification categories. ▪ Name and give examples of the five kingdoms. ▪ Analyze and discuss a phylogenetic tree.	
Unit 10: Diversity of Life	How are living things organized? What makes something living? How do the major body systems interact with one another to maintain homeostasis?	▪ Contrast the characteristics of viruses and bacteria to show that viruses are nonliving and bacteria are living organisms. ▪ Describe the structures	Students will complete tests and quizzes, lab report, complete previous AP exams questions, homework (free response and multiple choice)

		of viruses and how they replicate ▪ Describe the structure of a prokaryotic cell, how they reproduce, how they acquire nutrition, and how they are classified. ▪ Discuss how the eukaryotic cell may have arisen. ▪ List and describe the phyla for different types of algae, protozoa, and slime molds. ▪ List and discuss the characteristics of fungi, stressing their ecological importance. ▪ List the characteristics shared by all plants. ▪ Compare and contrast bryophytes and vascular plants (both seed and seedless). ▪ Discuss the nutrition, transport, development, and reproduction of plants. ▪ List the characteristics of animals and draw a phylogenetic tree that shows the nine major animal phyla. ▪ Compare and contrast the anatomical features of invertebrates. ▪ List and discuss several advantages of having a coelom. ▪ List the embryological differences between protostomes and deuterostomes, and tell which animal phyla belong to each group. ▪ Discuss the evolution of the three-part body plan, segmentation, and jointed appendages. ▪ Discuss the evolution of chordate characteristics, vertebrates, jaws, limbs, the amniote egg, wings and feathers, and finally homeothermy. ▪ Describe the appearances of jawless	

		fish, cartilaginous fish, bony fish, amphibians, reptiles, birds, and mammals. Discuss their adaptations for survival.	

Biochemistry: Honors

Grade Level	11, 12
Course Number	317
Subject Area	Science and Technology

Course Description

This course, an alternative to Advanced Placement Science courses, is the study of fundamental concepts of chemistry as well as topics of chemistry as they relate to living systems. This course is similar to a course found at a college level entering the health sciences and related fields. An in-depth study of medical applications of the topics is a common theme of the course. Topics covered include: chemistry of foods and their effects on the body, hormone interactions and their behavior, health and medical applications such as drug and alcohol use, environmental and societal issues such as poisons and pollution due to organic compounds and products emitted into our atmosphere. This course is very useful for students interested in majoring in medicine, nursing, pharmacology, chemistry, pharmacy, biology, physical therapy, and any other of the health-related areas.

Content Standards

CHEMISTRY

2. Atomic Structure and Nuclear Chemistry

Central Concepts: Atomic models are used to explain atoms and help us understand the interaction of elements and compounds observed on a macroscopic scale. Nuclear chemistry deals with radioactivity, nuclear processes, and nuclear properties. Nuclear reactions produce tremendous amounts of energy and lead to the formation of elements.

2.4 Write the electron configurations for the first twenty elements of the periodic table.
2.5 Identify the three main types of radioactive decay (alpha, beta, and gamma) and compare their properties (composition, mass, charge, and penetrating power).
2.6 Describe the process of radioactive decay by using nuclear equations, and explain the concept of half-life for an isotope (for example, C-14 is a powerful tool in determining the age of objects).
2.7 Compare and contrast nuclear fission and nuclear fusion.

3. Periodicity

Central Concepts: Repeating (periodic) patterns of physical and chemical properties occur among elements that define families with similar properties. The periodic table displays the repeating patterns, which are related to the atoms' outermost electrons.

3.3 Relate the position of an element on the periodic table to its electron configuration and compare its reactivity to the reactivity of other elements in the table.

4. Chemical Bonding

Central Concept: Atoms bond with each other by transferring or sharing valence electrons to form compounds.

4.1 Explain how atoms combine to form compounds through both ionic and covalent bonding. Predict chemical formulas based on the number of valence electrons.
4.2 Draw Lewis dot structures for simple molecules and ionic compounds.
4.3 Use electronegativity to explain the difference between polar and nonpolar covalent bonds.

4.5 Identify how hydrogen bonding in water affects a variety of physical, chemical, and biological phenomena (e.g., surface tension, capillary action, density, boiling point).
4.6 Name and write the chemical formulas for simple ionic and molecular compounds, including those that contain the polyatomic ions: ammonium, carbonate, hydroxide, nitrate, phosphate, and sulfate.

8. Acids and Bases and Oxidation-Reduction Reactions

Central Concepts: Acids and bases are important in numerous chemical processes that occur around us, from industrial procedures to biological ones, from the laboratory to the environment. Oxidation-reduction reactions occur when one substance transfers electrons to another substance, and constitute a major class of chemical reactions.

8.2 Relate hydrogen ion concentrations to the pH scale and to acidic, basic, and neutral solutions. Compare and contrast the strengths of various common acids and bases (e.g., vinegar, baking soda, soap, citrus juice).
8.3 Explain how a buffer works.

Scientific Inquiry Skills Standards

SIS1. Make observations, raise questions, and formulate hypotheses.

- Observe the world from a scientific perspective.
- Pose questions and form hypotheses based on personal observations, scientific articles, experiments, and knowledge.
- Read, interpret, and examine the credibility and validity of scientific claims in different sources of information, such as scientific articles, advertisements, or media stories.

SIS2. Design and conduct scientific investigations.

- Articulate and explain the major concepts being investigated and the purpose of an investigation.
- Select required materials, equipment, and conditions for conducting an experiment.
- Identify independent and dependent variables.
- Write procedures that are clear and replicable.
- Employ appropriate methods for accurately and consistently
    - making observations
    - making and recording measurements at appropriate levels of precision
    - collecting data or evidence in an organized way
- Properly use instruments, equipment, and materials (e.g., scales, probeware, meter sticks, microscopes, computers) including set-up, calibration (if required), technique, maintenance, and storage.
- Follow safety guidelines.

SIS3. Analyze and interpret results of scientific investigations.

- Present relationships between and among variables in appropriate forms.
    - Represent data and relationships between and among variables in charts and graphs.
    - Use appropriate technology (e.g., graphing software) and other tools.
- Use mathematical operations to analyze and interpret data results.
- Assess the reliability of data and identify reasons for inconsistent results, such as sources of error or uncontrolled conditions.
- Use results of an experiment to develop a conclusion to an investigation that addresses the initial questions and supports or refutes the stated hypothesis.
- State questions raised by an experiment that may require further investigation.

SIS4. Communicate and apply the results of scientific investigations.

- Develop descriptions of and explanations for scientific concepts that were a focus of one or more investigations.
- Review information, explain statistical analysis, and summarize data collected and analyzed as the result of an investigation.
- Explain diagrams and charts that represent relationships of variables.

- Construct a reasoned argument and respond appropriately to critical comments and questions.
- Use language and vocabulary appropriately, speak clearly and logically, and use appropriate technology (e.g., presentation software) and other tools to present findings.
- Use and refine scientific models that simulate physical processes or phenomena.

BIOLOGY

I. Content Standards

1. The Chemistry of Life

Broad Concept: Chemical elements form organic molecules that interact to perform the basic functions of life.

1.1 Recognize that biological organisms are composed primarily of very few elements. The six most common are C, H, N, O, P, S.

1.2 Describe the basic molecular structures and primary functions of the four major categories of organic molecules (carbohydrates, lipids, proteins, and nucleic acids).

1.3 Explain the role of enzymes as catalysts that lower the activation energy of biochemical reactions. Identify factors, such as pH and temperature, which have an effect on enzymes.

2. Cell Biology

Broad Concept: Cells have specific structures and functions that make them distinctive. Processes in a cell can be classified broadly as growth, maintenance, and reproduction.

2.1 Relate cell parts/organelles (plasma membrane, nuclear envelope, nucleus, nucleolus, cytoplasm, mitochondrion, endoplasmic reticulum, Golgi apparatus, lysosome, ribosome, vacuole, cell wall, chloroplast, cytoskeleton, centriole, cilium, flagellum, pseudopod) to their functions. Explain the role of cell membranes as a highly selective barrier (diffusion, osmosis, facilitated diffusion, and active transport).

2.4 Identify the reactants, products, and basic purposes of photosynthesis and cellular respiration. Explain the interrelated nature of photosynthesis and cellular respiration in the cells of photosynthetic organisms.

2.5 Explain the important role that ATP serves in metabolism.

2.6 Describe the cell cycle and the process of mitosis. Explain the role of mitosis in the formation of new cells, and its importance in maintaining chromosome number during asexual reproduction.

2.7 Describe how the process of meiosis results in the formation of haploid cells. Explain the importance of this process in sexual reproduction, and how gametes form diploid zygotes in the process of fertilization.

2.8 Compare and contrast a virus and a cell in terms of genetic material and reproduction.

3. Genetics

Broad Concept: Genes allow for the storage and transmission of genetic information. They are a set of instructions encoded in the nucleotide sequence of each organism. Genes code for the specific sequences of amino acids that comprise the proteins that are characteristic of that organism.

3.1 Describe the basic structure (double helix, sugar/phosphate backbone, linked by complementary nucleotide pairs) of DNA, and describe its function in genetic inheritance.

3.2 Describe the basic process of DNA replication and how it relates to the transmission and conservation of the genetic code. Explain the basic processes of transcription and translation, and how they result in the expression of genes. Distinguish among the end products of replication, transcription, and translation.

3.3 Explain how mutations in the DNA sequence of a gene may or may not result in phenotypic change in an organism. Explain how mutations in gametes may result in phenotypic changes in offspring.

4. Anatomy and Physiology

Broad Concept: There is a relationship between the organization of cells into tissues, and tissues into organs. The structure and function of organs determine their relationships within body systems of an organism. Homeostasis allows the body to perform its normal functions.

4.1 Explain generally how the digestive system (mouth, pharynx, esophagus, stomach, small and large intestines, rectum) converts macromolecules from food into smaller molecules that can be used by cells for energy and for repair and growth.

4.2 Explain how the circulatory system (heart, arteries, veins, capillaries, red blood cells) transports nutrients and oxygen to cells and removes cell wastes. Describe how the kidneys and the liver are closely associated with the circulatory system as they perform the excretory function of removing waste from the blood. Recognize that kidneys remove nitrogenous wastes, and the liver removes many toxic compounds from blood.

4.3 Explain how the respiratory system (nose, pharynx, larynx, trachea, lungs, alveoli) provides exchange of oxygen and carbon dioxide.

4.1 Explain how the nervous system (brain, spinal cord, sensory neurons, motor neurons) mediates communication between different parts of the body and the body's interactions with the environment. Identify the basic unit of the nervous system, the neuron, and explain generally how it works.

4.2 Explain how the muscular/skeletal system (skeletal, smooth and cardiac muscle, bones, cartilage, ligaments, tendons) works with other systems to support and allow for movement. Recognize that bones produce both red and white blood cells.

4.3 Recognize that communication between cells is required for coordination of body functions. The nerves communicate with electrochemical signals, hormones circulate through the blood, and some cells produce signals to communicate only with nearby cells.

4.4 Recognize that the body's systems interact to maintain homeostasis. Describe the basic function of a physiological feedback loop.

Reading Standards for Literacy in Science
Key Ideas and Details
1. Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.
2. Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text.
3. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text.
Craft and Structure
4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 9–10 texts and topics*.
5. Analyze the structure of the relationships among concepts in a text, including relationships among key terms (e.g., *force, friction, reaction force, energy*).
6. Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, defining the question the author seeks to address.
Integration of Knowledge and Ideas
7. Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.
8. Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem.
9. Compare and contrast findings presented in a text to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts.
Range of Reading and Level of Text Complexity
10. By the end of grade 10, read and comprehend science/technical texts in the grades 9–10 text complexity band independently and proficiently.

Writing Standards
Text Types and Purposes
1. Write arguments focused on *discipline-specific content*. a. Introduce precise claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that establishes clear relationships among the claim(s), counterclaims, reasons, and evidence. b. Develop claim(s) and counterclaims fairly, supplying data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form and in a manner that anticipates the audience's knowledge level and concerns. c. Use words, phrases, and clauses to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims. d. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing. e. Provide a concluding statement or section that follows from or supports the argument presented.
2. Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. a. Introduce a topic and organize ideas, concepts, and information to make important connections and distinctions;

include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.

b. Develop the topic with well-chosen, relevant, and sufficient facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic.

c. Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among ideas and concepts.

d. Use precise language and domain-specific vocabulary to manage the complexity of the topic and convey a style appropriate to the discipline and context as well as to the expertise of likely readers.

e. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.

f. Provide a concluding statement or section that follows from and supports the information or explanation presented (e.g., articulating implications or the significance of the topic).

3. Students' narrative skills continue to grow in these grades. The standards require that students be able to incorporate narrative elements effectively into arguments and informative/explanatory texts. In history/social studies, students must be able to incorporate narrative accounts into their analyses of individuals or events of historical import. In science and technical subjects, students must be able to write precise enough descriptions of the step-by-step procedures they use in their investigations or technical work that others can replicate them and (possibly) reach the same results.

Production and Distribution of Writing

4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

5. Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.

6. Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically.

Research to Build and Present Knowledge

7. Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

8. Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation.

9. Draw evidence from informational texts to support analysis, reflection, and research.

Range of Writing

10. Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

Essential Questions

- How are radioisotopes beneficial in medicine?
- What is the difference between an alkene an alkyne?
- What is an aromatic compound?
- What functional group is needed for an organic compound to be an alcohol?
- Why are alcohols important?
- Why are organic acids weaker than inorganic acids?
- What is the function of an ester?
- How do carboxylic acids reduce bacterial growth and enhance the flavors of foods?
- What is an organic compound?
- Why are amines and amides important to our survival?
- Why are some organic compounds biologically active while others are not?
- How do we taste and smell at the molecular level?
- Why is organic chemistry important to the study of biochemistry?
- What are the families of organic compounds, and why are they important?
- Why are carbohydrates important to life?
- Can all carbohydrates be digested by humans?
- Why are lipids important in our diet?
- How are lipids used as energy?

- Are all lipids dietary lipids?
- Why are proteins important?
- What happens when a protein no longer functions?
- What is the difference between DNA and RNA?
- What new research is being done in genetic engineering?

Enduring Understandings

Students will learn how:

- To describe the major types of radioactive emissions.
- To detect and measure radiation.
- To identify the characteristics of radioisotopes used in diagnosis and in therapy.
- To describe the bonding in alkanes, alkenes, and alkynes.
- To draw and name alcohols, ethers, aldehydes, ketones, carboxylic acids, esters, amines, and amides
- To draw Lewis structures.
- To classify organic compounds.
- To draw and name molecular and structural formulas.
- To use the IUPAC system to draw and name organic compounds.
- To describe the biological role of carbohydrates.
- To outline the structure and function of monosaccharides, oligosaccharides, and polysaccharides.
- To describe the groups of biomolecules.
- To expand on the reactants and products in the photosynthesis equation.
- To draw the structures, and describe the physical properties of saturated and unsaturated fatty acids.
- To draw and describe the structure of biological membranes.
- To describe the process by which molecules and ions are transported across membranes.
- To describe the forces that stabilize proteins.
- To outline the differences between fibrous and globular proteins.
- To define mutations, and their influence on living organisms.
- To outline the categories of mutations.
- To draw diagrams of replication, transcription, and translation.
- To describe the three-dimensional structures of DNA and RNA.
- To outline the replication process of DNA.
- To describe the formation and function of rRNA, tRNA, and mRNA.
- To summarize the role of mutations.
- To summarize recombinant DNA research.

Evidence of Understanding

Twenty-first Century Learning Expectations

Academic Expectations:

1: The student reads actively and critically.

2: The student communicates clearly in speech.

3: The student writes effectively.

4: The student identifies, accesses, and utilizes a variety of resources for obtaining information.

5: The student employs multiple strategies in reasoning and problem solving both independently and collaboratively.

6: The student listens effectively and critically.

7: The student demonstrates knowledge and skills in a variety of forms.

Civic and Social Expectations:

8: The student demonstrates respect and tolerance.

9: The student acts responsibly and displays good citizenship.

The students will:

- participate in discussions
- complete poster presentations
- prepare PowerPoint presentations
- complete homework assignments
- complete formal laboratory reports
- create oral presentation on a research project
- take tests and quizzes
- participate in group laboratory investigations

Course Outline

Unit	Essential Questions	Skills and Understandings	Assessment
Chapter 10: Chemical and Biological Effects of Radiation	• What is radioactivity?	Describe the major types of radioactive emissions.	Nuclear Chemistry Test Nuclear Applications Research Quizzes Radioactive Decay Lab Homework
Chapter 11 & 12: Saturated and Unsaturated Hydrocarbons	• Why is organic chemistry important to the study of biochemistry?	Distinguish between a saturated and unsaturated hydrocarbon.	Chapter Tests (11-12) Quizzes Homework Formula Activity Biochemical Elements Organic Research Food Analysis Lab
Chapter 13 & 14: Alcohols, Phenols, Ethers, Aldehydes, & Ketones	• What are the families of organic compounds, and why are they important?	Draw and name organic functional groups.	Chapter Tests (13-14) Quizzes Flavor Lab Fragrance Lab Homework
Chapter 15 & 16: Carboxylic Acids, Esters, Amines, & Amides	• What are the families of organic compounds, and why are they important?	Draw and name organic functional groups.	Chapter Tests (15-16) Quizzes Carboxylic Acid Lab Soap Lab Amine Research Homework
Chapter 17& 18: Stereoisomerism & Carbohydrates	• Why are carbohydrates important to life?	Describe the biological role of carbohydrates.	Chapter Tests (17-18) Quizzes My Sweet Tooth Lab Research Sweeteners Carbohydrate Lab Analysis of Juice Homework
Chapter 19: Lipids	• How are lipids used as energy?	Draw the structures, and describe the physical properties of saturated and unsaturated fatty acids.	Lipid Test Quizzes Lipid Food Lab

			Steroid Activity Research Membranes Homework
Chapter 20: Proteins	How are proteins classified?	Draw and categorize amino acids.	Protein Test Quizzes Milk Lab Chemical Reactions of Peptides Activity Research Mad Cow Disease Enzyme Lab Cheese Lab Homework
Chapter 21: Nucleic Acids	• What new research is being done in genetic engineering?	Describe the synthesis of polypeptides.	Nucleic Acid Test Quizzes Antibiotic Research Nucleic Acid Models Homework

Physical Science: Academic

Grade Level	10
Course Number	320
Subject Area	Science and Technology

Course Description

This course is designed to afford students with the opportunity to improve their scientific intuition and to develop confidence in dealing with science-related topics. Students will be provided an opportunity to develop and hone their skills in scientific principles to prepare them for the study of higher level sciences such as chemistry and physics. The course will survey the principles of physical science with some integration of life science concepts. Students will explore several traditional divisions of classical physics, including motion and force and also gain an appreciation of the nature and properties of matter, energy transformations, matter cycles, and astronomy. The course will provide an inquiry-based approach which focuses on hands-on laboratory investigations, individual studies, and group activities.

Content Standards

Chemistry

1. Properties of Matter

Central Concept: Physical and chemical properties reflect the nature of the interactions between molecules or atoms, and can be used to classify and describe matter.

1.1 Identify and explain physical properties (e.g., density, melting point, boiling point, conductivity, malleability) and chemical properties (e.g., the ability to form new substances). Distinguish between chemical and physical changes.
1.2 Explain the difference between pure substances (elements and compounds) and mixtures. Differentiate between heterogeneous and homogeneous mixtures.
1.3 Describe the three normal states of matter (solid, liquid, gas) in terms of energy, particle motion, and phase transitions.

2. Atomic Structure and Nuclear Chemistry

Central Concepts: Atomic models are used to explain atoms and help us understand the interaction of elements and

compounds observed on a macroscopic scale. Nuclear chemistry deals with radioactivity, nuclear processes, and nuclear properties. Nuclear reactions produce tremendous amounts of energy and lead to the formation of elements.

2.1 Recognize discoveries from Dalton (atomic theory), Thomson (the electron), Rutherford (the nucleus), and Bohr (planetary model of atom), and understand how each discovery leads to modern theory.
2.2 Describe Rutherford's "gold foil" experiment that led to the discovery of the nuclear atom. Identify the major components (protons, neutrons, and electrons) of the nuclear atom and explain how they interact.
2.3 Interpret and apply the laws of conservation of mass, constant composition (definite proportions), and multiple proportions.
2.4 Write the electron configurations for the first twenty elements of the periodic table.

3. Periodicity

Central Concepts: Repeating (periodic) patterns of physical and chemical properties occur among elements that define families with similar properties. The periodic table displays the repeating patterns, which are related to the atoms' outermost electrons.

3.1 Explain the relationship of an element's position on the periodic table to its atomic number. Identify families (groups) and periods on the periodic table.
3.2 Use the periodic table to identify the three classes of elements: metals, nonmetals, and metalloids.

6. States of Matter, Kinetic Molecular Theory, and Thermochemistry

Central Concepts: Gas particles move independently of each other and are far apart. The behavior of gas particles can be modeled by the kinetic molecular theory. In liquids and solids, unlike gases, particles are close to each other. The driving forces of chemical reactions are energy and entropy. The reorganization of atoms in chemical reactions results in the release or absorption of heat energy.

6.1 Using the kinetic molecular theory, explain the behavior of gases and the relationship between pressure and volume (Boyle's law), volume and temperature (Charles's law), pressure and temperature (Gay-Lussac's law), and the number of particles in a gas sample (Avogadro's hypothesis). Use the combined gas law to determine changes in pressure, volume, and temperature.
6.3 Using the kinetic molecular theory, describe and contrast the properties of gases, liquids, and solids. Explain, at the molecular level, the behavior of matter as it undergoes phase transitions.

Physics

1. Motion and Forces

Central Concept: Newton's laws of motion and gravitation describe and predict the motion of most objects.

1.2 Distinguish between displacement, distance, velocity, speed, and acceleration. Solve problems involving displacement, distance, velocity, speed, and constant acceleration.
1.3 Create and interpret graphs of 1-dimensional motion, such as position vs. time, distance vs. time, speed vs. time, velocity vs. time, and acceleration vs. time where acceleration is constant.
1.4 Interpret and apply Newton's three laws of motion.
1.5 Use a free-body force diagram to show forces acting on a system consisting of a pair of interacting objects. For a diagram with only co-linear forces, determine the net force acting on a system and between the objects.

2. Conservation of Energy and Momentum

Central Concept: The laws of conservation of energy and momentum provide alternate approaches to predict and describe the movement of objects.

2.1 Interpret and provide examples that illustrate the law of conservation of energy.
2.2 Interpret and provide examples of how energy can be converted from gravitational potential energy to kinetic energy and vice versa.
2.3 Describe both qualitatively and quantitatively how work can be expressed as a change in mechanical energy.
2.4 Describe both qualitatively and quantitatively the concept of power as work done per unit time.

2.5 Provide and interpret examples showing that linear momentum is the product of mass and velocity, and is always conserved (law of conservation of momentum). Calculate the momentum of an object.

3. Heat and Heat Transfer

Central Concept: Heat is energy that is transferred by the processes of convection, conduction, and radiation between objects or regions that are at different temperatures.

3.1 Explain how heat energy is transferred by convection, conduction, and radiation.
3.2 Explain how heat energy will move from a higher temperature to a lower temperature until equilibrium is reached.
3.3 Describe the relationship between average molecular kinetic energy and temperature. Recognize that energy is absorbed when a substance changes from a solid to a liquid to a gas, and that energy is released when a substance changes from a gas to a liquid to a solid. Explain the relationships among evaporation, condensation, cooling, and warming.

Scientific Inquiry Skills Standards

SIS1. Make observations, raise questions, and formulate hypotheses.

- Observe the world from a scientific perspective.
- Pose questions and form hypotheses based on personal observations, scientific articles, experiments, and knowledge.
- Read, interpret, and examine the credibility and validity of scientific claims in different sources of information, such as scientific articles, advertisements, or media stories.

SIS2. Design and conduct scientific investigations.

- Articulate and explain the major concepts being investigated and the purpose of an investigation.
- Select required materials, equipment, and conditions for conducting an experiment.
- Identify independent and dependent variables.
- Write procedures that are clear and replicable.
- Employ appropriate methods for accurately and consistently
    - making observations
    - making and recording measurements at appropriate levels of precision
    - collecting data or evidence in an organized way
- Properly use instruments, equipment, and materials (e.g., scales, probeware, meter sticks, microscopes, computers) including set-up, calibration (if required), technique, maintenance, and storage.
- Follow safety guidelines.

SIS3. Analyze and interpret results of scientific investigations.

- Present relationships between and among variables in appropriate forms.
    - Represent data and relationships between and among variables in charts and graphs.
    - Use appropriate technology (e.g., graphing software) and other tools.
- Use mathematical operations to analyze and interpret data results.
- Assess the reliability of data and identify reasons for inconsistent results, such as sources of error or uncontrolled conditions.
- Use results of an experiment to develop a conclusion to an investigation that addresses the initial questions and supports or refutes the stated hypothesis.
- State questions raised by an experiment that may require further investigation.

SIS4. Communicate and apply the results of scientific investigations.

- Develop descriptions of and explanations for scientific concepts that were a focus of one or more investigations.
- Review information, explain statistical analysis, and summarize data collected and analyzed as the result of an investigation.
- Explain diagrams and charts that represent relationships of variables.

- Construct a reasoned argument and respond appropriately to critical comments and questions.
- Use language and vocabulary appropriately, speak clearly and logically, and use appropriate technology (e.g., presentation software) and other tools to present findings.
- Use and refine scientific models that simulate physical processes or phenomena.

Reading Standards for Literacy in Science

Key Ideas and Details

1. Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.

2. Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text.

3. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text.

Craft and Structure

4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 9–10 texts and topics*.

5. Analyze the structure of the relationships among concepts in a text, including relationships among key terms (e.g., *force*, *friction*, *reaction force*, *energy*).

6. Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, defining the question the author seeks to address.

Integration of Knowledge and Ideas

7. Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.

8. Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem.

9. Compare and contrast findings presented in a text to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts.

Range of Reading and Level of Text Complexity

10. By the end of grade 10, read and comprehend science/technical texts in the grades 9–10 text complexity band independently and proficiently.

Writing Standards

Text Types and Purposes

1. Write arguments focused on *discipline-specific content*.

a. Introduce precise claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that establishes clear relationships among the claim(s), counterclaims, reasons, and evidence.

b. Develop claim(s) and counterclaims fairly, supplying data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form and in a manner that anticipates the audience's knowledge level and concerns.

c. Use words, phrases, and clauses to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims.

d. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.

e. Provide a concluding statement or section that follows from or supports the argument presented.

2. Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.

a. Introduce a topic and organize ideas, concepts, and information to make important connections and distinctions; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.

b. Develop the topic with well-chosen, relevant, and sufficient facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic.

c. Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among ideas and concepts.

d. Use precise language and domain-specific vocabulary to manage the complexity of the topic and convey a style appropriate to the discipline and context as well as to the expertise of likely readers.

e. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.
f. Provide a concluding statement or section that follows from and supports the information or explanation presented (e.g., articulating implications or the significance of the topic).

3. Students' narrative skills continue to grow in these grades. The standards require that students be able to incorporate narrative elements effectively into arguments and informative/explanatory texts. In history/social studies, students must be able to incorporate narrative accounts into their analyses of individuals or events of historical import. In science and technical subjects, students must be able to write precise enough descriptions of the step-by-step procedures they use in their investigations or technical work that others can replicate them and (possibly) reach the same results.

Production and Distribution of Writing

4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

5. Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.

6. Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically.

Research to Build and Present Knowledge

7. Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

8. Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation.

9. Draw evidence from informational texts to support analysis, reflection, and research.

Range of Writing

10. Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

Essential Questions

- How does Science happen?
- What scientific skills can be utilized in every day life?
- How do you present Scientific Data?
- What is matter?
- What's in an atom?
- How are elements classified?
- What are compounds?
- How are compounds organized and named?
- What are chemical reactions and how are they classified?
- What is motion and how do Newton's Laws of Motion apply?
- What is work and energy?
- What is the difference between heat and temperature?

Enduring Understandings

Students will learn how:

- The scientific method can be applied to all aspects of science and helps in gathering accurate data. A good background in mathematics will help students excel in science.
- Physical and chemical properties reflect the nature of the interactions between molecules or atoms, and can be used to classify and describe matter.
- Atomic models are used to explain atoms and help us understand the interaction of elements and compounds observed on a macroscopic scale.
- Repeating (periodic) patterns of physical and chemical properties occur among elements that define families with similar properties.
- Gas particles move independently of each other and are far apart. The behavior of gas particles can be modeled by the kinetic molecular theory. In liquids and solids, unlike gases, particles are close to each other. The driving forces of

chemical reactions are energy and entropy. The reorganization of atoms in chemical reactions results in the release or absorption of heat energy.

- Newton's laws of motion and gravitation describe and predict the motion of most objects.
- The laws of conservation of energy and momentum provide alternate approaches to predict and describe the movement of objects.
- Heat is energy that is transferred by the processes of convection, conduction, and radiation between objects or regions that are at different temperatures.

Evidence of Understanding

The students will:

- Take formative and summative quizzes and
- Complete homework and projects
- Conduct formal and informal labs
- Analyze data and share findings through presentations and written reports
- Conduct research and apply to technical writing
- Write critically and creatively
- Collaborate on group projects
- Present information to the class
- Participate in formal and informal class discussions
- Read actively and critically
- Communicate clearly in speech
- Write effectively
- Identify, access, and utilize a variety of resources for obtaining information
- Employ multiple strategies in reasoning and problem solving both independently and collaboratively
- Listen effectively and critically
- Demonstrate knowledge and skills in a variety of forms
- Demonstrate respect and tolerance
- Act responsibly and display good citizenship

Course Outline

Unit	Essential Questions	Skills and Understandings	Assessment
Methods of Science	• How does Science happen? • What skills can be utilized? • How do you present Scientific Data?	• Describe the main branches of natural science and relate them to each other • Explain the roles of models and mathematics in scientific theories and laws • Understand how to use critical thinking skills to solve problems • Describe the steps of the scientific method • Explain the objective of a consistent system of units • Identify SI prefixes and convert	• Concept mapping of the scientific method • Worksheets that help them to identify between scientific theory and laws • Practicing mathematics through homeworks and worksheets on measurements, significant figures, graphing, and conversions • Lab that will help to focus students in on the scientific method and how it can be used for accurate and precise data collection

		measurements • Interpret graphs • Identify significant figures • Use scientific notation • Understand the difference between precision and accuracy	
Nature of Matter	• What is matter? • What's in an atom? • How are elements classified? • What are compounds? • How are compounds organized and named?	• Explain the relationship between matter, atoms, and elements • Distinguish between elements and compounds • Interpret and write some common chemical formulas • Categorize materials as pure substances or mixtures • Perform calculations involving density • Distinguish between chemical and physical changes • Apply the laws of conservation of mass and energy • Explain Dalton's atomic theory • State the charge, mass and location of each part of an atom • Relate the organization of the periodic table to the arrangement of electrons within an atom • Locate the different families of elements on the periodic table	• Worksheets on element families and chemical bonding • Activities on periodicity, mixtures, and chemical bonding • Presentation on elements and element families • Element webquest • Quiz and test
Changes in Matter	• What are chemical reactions and how are they classified? • How does matter change by physical means?	• Use kinetic theory to describe different states of matter • Describe energy transfers involved in changes of state • Describe the laws of conservation of mass and energy • Distinguish between	• Lab on chemical reactions and phase changes • Worksheets on chemical reactions and phase changes • Quiz and test

		chemical and physical properties of matter • Distinguish between compounds and mixtures • Use models to visualize a compounds chemical structure • Describe how the chemical structure of a compound affects its properties • Recognize some signs that a chemical reaction is taking place • Explain chemical changes in terms of the structure and motion of atoms and molecules • Identify situations involving chemical energy • Distinguish between homogeneous and heterogeneous mixtures • Compare and contrast the properties of solutions, colloids, and suspensions • Identify ways to separate different kinds of mixtures • Identify several factors that affect the rate at which a substance dissolves • Relate the structure of water to its ability to dissolve many different substances	
Motion and Energy	• What is motion and how do Newton's Laws of Motion apply? • What is work and energy? • What is the difference between heat and temperature?	• Relate speed to distance and time • Distinguish between speed and velocity • Recognize that all moving objects have momentum • Solve problems involving time, distance, velocity	• Roller coaster lab on conservation of energy • Balloon car project on velocity, acceleration and Newton's Laws • Home heating project to investigate heat transfer • Bookwork • Quiz and test

		and momentum • Calculate acceleration of an object • Describe how force affects the motion of an object • Distinguish between balanced and unbalanced forces • Explain how friction affects the motion of an object • State Newton's 3 laws of motion, and apply them to physical situations • Calculate force, mass, and acceleration with Newton's 2nd law • Recognize that free-fall acceleration near earth's surface is independent of the mass of the falling object • Explain the difference between mass and weight • Identify paired forces on interacting objects • Define work and power • Calculate the work done on an object and the rate at which work is done • Use the concept of mechanical advantage to explain how machines make doing work easier • Calculate the mechanical advantage of various machines • Name and describe the 6 types of simple machines • Discuss the mechanical advantage of simple machines • Recognize simple machines within	

		compound machines • Explain the relationship between energy and work • Define potential energy and kinetic energy • Calculate kinetic energy and gravitational potential energy • Distinguish between mechanical and nonmechanical energy • Identify transformation of energy • Explain the law of conservation of energy • Discuss where energy goes when it seems to disappear • Analyze the efficiency of machines • Define temperature in terms of average kinetic energy • Convert temp readings between F, C, and K • Describe heat as a form of heat transfer • Investigate how energy is transferred by conduction, convection, and radiation • Identify and distinguish between conductors and insulators	

Environmental Science: Academic	
Grade Level	11, 12
Course Number	322
Subject Area	Science and Technology

Course Description

This course will introduce students to current environmental topics through experimentation, case studies and text. The Earth and biological science blend to show how humankind has changed the world. Students will connect science with other subjects, such as sociology and politics. Topics include: ecosystems, energy flow, human requirements, energy resources, pollution, population and global trends. Solutions and ongoing strategies will be discussed.

Content Standards

5. Evolution (Biology)

Central Concepts: Evolution is the result of genetic changes that occur in constantly changing environments. Over many generations, changes in the genetic make-up of populations may affect biodiversity through speciation and extinction.

5.3 Explain how evolution through natural selection can result in changes in biodiversity through the increase or decrease of genetic diversity within a population.

6. Ecology (Biology)

Central Concept: Ecology is the interaction among organisms and between organisms and their environment.

6.1 Explain how birth, death, immigration, and emigration influence population size.
6.2 Analyze changes in population size and biodiversity (speciation and extinction) that result from the following: natural causes, changes in climate, human activity, and the introduction of invasive, non-native species.
6.3 Use a food web to identify and distinguish producers, consumers, and decomposers, and explain the transfer of energy through trophic levels. Describe how relationships among organisms (predation, parasitism, competition, commensalism, mutualism) add to the complexity of biological communities.
6.4 Explain how water, carbon, and nitrogen cycle between abiotic resources and organic matter in an ecosystem, and how oxygen cycles through photosynthesis and respiration.

2. Energy Resources in the Earth System (Earth and Space Science)

Central Concepts: Energy resources are used to sustain human civilization. The amount and accessibility of these resources influence their use and their impact on the environment.

2.1 Recognize, describe, and compare renewable energy resources (e.g., solar, wind, water, biomass) and nonrenewable energy resources (e.g., fossil fuels, nuclear energy).
2.2 Describe the effects on the environment and on the carbon cycle of using both renewable and nonrenewable sources of energy.

3. Earth Processes and Cycles (Earth and Space Science)

Central Concepts: Earth is a dynamic interconnected system. The evolution of Earth has been driven by interactions between the lithosphere, hydrosphere, atmosphere, and biosphere. Over geologic time, the internal motions of Earth have continuously altered the topography and geography of the continents and ocean basins by both constructive and destructive processes.

3.1 Explain how physical and chemical weathering leads to erosion and the formation of soils and sediments, and creates various types of landscapes. Give examples that show the effects of physical and chemical weathering on the environment.
3.2 Describe the carbon cycle.
3.3 Describe the nitrogen cycle.
3.4 Explain how water flows into and through a watershed. Explain the roles of aquifers, wells, porosity, permeability, water table, and runoff.
3.5 Describe the processes of the hydrologic cycle, including evaporation, condensation, precipitation, surface runoff and groundwater percolation, infiltration, and transpiration.

Scientific Inquiry Skills Standards

SIS1. Make observations, raise questions, and formulate hypotheses.

- Observe the world from a scientific perspective.

- Pose questions and form hypotheses based on personal observations, scientific articles, experiments, and knowledge.
- Read, interpret, and examine the credibility and validity of scientific claims in different sources of information, such as scientific articles, advertisements, or media stories.

SIS2. Design and conduct scientific investigations.

- Articulate and explain the major concepts being investigated and the purpose of an investigation.
- Select required materials, equipment, and conditions for conducting an experiment.
- Identify independent and dependent variables.
- Write procedures that are clear and replicable.
- Employ appropriate methods for accurately and consistently
    - making observations
    - making and recording measurements at appropriate levels of precision
    - collecting data or evidence in an organized way
- Properly use instruments, equipment, and materials (e.g., scales, probeware, meter sticks, microscopes, computers) including set-up, calibration (if required), technique, maintenance, and storage.
- Follow safety guidelines.

SIS3. Analyze and interpret results of scientific investigations.

- Present relationships between and among variables in appropriate forms.
    - Represent data and relationships between and among variables in charts and graphs.
    - Use appropriate technology (e.g., graphing software) and other tools.
- Use mathematical operations to analyze and interpret data results.
- Assess the reliability of data and identify reasons for inconsistent results, such as sources of error or uncontrolled conditions.
- Use results of an experiment to develop a conclusion to an investigation that addresses the initial questions and supports or refutes the stated hypothesis.
- State questions raised by an experiment that may require further investigation.

SIS4. Communicate and apply the results of scientific investigations.

- Develop descriptions of and explanations for scientific concepts that were a focus of one or more investigations.
- Review information, explain statistical analysis, and summarize data collected and analyzed as the result of an investigation.
- Explain diagrams and charts that represent relationships of variables.
- Construct a reasoned argument and respond appropriately to critical comments and questions.
- Use language and vocabulary appropriately, speak clearly and logically, and use appropriate technology (e.g., presentation software) and other tools to present findings.
- Use and refine scientific models that simulate physical processes or phenomena.

Reading Standards for Literacy in Science

Key Ideas and Details

1. Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.

2. Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text.

3. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text.

Craft and Structure

4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 9–10 texts and topics*.

5. Analyze the structure of the relationships among concepts in a text, including relationships among key terms (e.g., *force, friction, reaction force, energy*).

6. Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, defining the question the author seeks to address.
Integration of Knowledge and Ideas
7. Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.
8. Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem.
9. Compare and contrast findings presented in a text to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts.
Range of Reading and Level of Text Complexity
10. By the end of grade 10, read and comprehend science/technical texts in the grades 9–10 text complexity band independently and proficiently.
Writing Standards
Text Types and Purposes
1. Write arguments focused on *discipline-specific content*. a. Introduce precise claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that establishes clear relationships among the claim(s), counterclaims, reasons, and evidence. b. Develop claim(s) and counterclaims fairly, supplying data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form and in a manner that anticipates the audience's knowledge level and concerns. c. Use words, phrases, and clauses to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims. d. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing. e. Provide a concluding statement or section that follows from or supports the argument presented.
2. Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. a. Introduce a topic and organize ideas, concepts, and information to make important connections and distinctions; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension. b. Develop the topic with well-chosen, relevant, and sufficient facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic. c. Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among ideas and concepts. d. Use precise language and domain-specific vocabulary to manage the complexity of the topic and convey a style appropriate to the discipline and context as well as to the expertise of likely readers. e. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing. f. Provide a concluding statement or section that follows from and supports the information or explanation presented (e.g., articulating implications or the significance of the topic).
3. Students' narrative skills continue to grow in these grades. The standards require that students be able to incorporate narrative elements effectively into arguments and informative/explanatory texts. In history/social studies, students must be able to incorporate narrative accounts into their analyses of individuals or events of historical import. In science and technical subjects, students must be able to write precise enough descriptions of the step-by-step procedures they use in their investigations or technical work that others can replicate them and (possibly) reach the same results.
Production and Distribution of Writing
4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
5. Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.
6. Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically.
Research to Build and Present Knowledge
7. Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject,

demonstrating understanding of the subject under investigation.

8. Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation.

9. Draw evidence from informational texts to support analysis, reflection, and research.

Range of Writing

10. Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

Essential Questions

- How do Earth systems work together to maintain equilibrium on the planet?
- How do anthropogenic actions affect Earth systems?
- How can environmental problems be resolved or prevented?
- How can we live more sustainably?

Enduring Understandings

Students will learn how:

- To explain that the conditions on Earth are unique within the solar system to support life; the Earth as a living system that supports life will lay the foundation for the course work.
- To understand that each organism has a role within the environment and that no living thing is isolated from others. Students will also be able to explain why matter can be cycled throughout an ecosystem but a constant input of energy is required.
- To explain how climate determines what organisms will live in an environment and how adaptations of these organisms allow them to survive. Students will also understand the impact of humans on both terrestrial and aquatic ecosystems and the effects of human involvement on other living things.
- To see that the size of a population depends on many factors and that the human population is not exempt from all of these factors. Students will focus on the changes within the human population and be able to make predictions of what the human population will look like in the future given different scenarios.
- To understand how human societies have changed over the course of human history and how these changes affect Earth. Students will also investigate agriculture and land use and analyze which techniques are more beneficial to humans.
- To compare and contrast the major types of fossil fuels and their uses and impact throughout the world; students will also examine the advantages and disadvantages of nuclear energy and other alternative energy sources, including renewable energy. A focus on energy in the future will be maintained throughout the unit.
- To explain how humans have adapted to and modified the land, water, and air that support life on Earth. A problem-solving approach will be used to focus on reducing pollution and negative human impact, and students will try to implement their own plans in the local area.
- To explain how policies and laws shape the way that humans interact with the environment. Local, national, and international policies and laws will be investigated to assess their impact and effectiveness.
- To employ various laboratory techniques to collect and analyze data and then interpret the results in the context of classroom learning. These techniques will include traditional labs, field work, and mathematical analysis of results.

Evidence of Understanding

The students will:

- Take formative and summative quizzes and tests on paper and online
- Complete homework and projects
- Conduct formal and informal labs
- Analyze data and share findings through presentations and written reports
- Conduct research and apply to technical writing
- Write critically and creatively
- Collaborate on group projects
- Present information to the class
- Participate in formal and informal class discussions
- Contribute to the class website
- Read actively and critically
- Communicate clearly in speech

- Write effectively
- Identify, access, and utilize a variety of resources for obtaining information
- Employ multiple strategies in reasoning and problem solving both independently and collaboratively
- Listen effectively and critically
- Demonstrate knowledge and skills in a variety of forms
- Demonstrate respect and tolerance
- Act responsibly and display good citizenship

Course Outline

Unit	Essential Questions	Skills and Understandings	Assessment
Studying Earth	What makes Earth unique? Are humans responsible for the changes of Earth, or is it all part of a natural cycle?	• Identify and describe the regions of Earth in which living things are found • Explain why fresh water is a valuable resource for organisms • Diagram and describe the layers of the atmosphere • Explain how organisms interact with the biosphere • Describe ways in which the three layers of the biosphere change over time • List factors that affect an area's ability to support life • Predict how changes in the environment might affect organisms • Describe the structure of an ecosystem • Relate the concept of habitat destruction to the loss of biodiversity	• Illustration of biosphere
Ecological Interactions	Can one change in an ecosystem have a large effect on the rest of the ecosystem?	• Identify the roles of producers, consumers, and decomposers • Explain the concept of the trophic level • Describe food chains and food webs • Examine how ecosystem structure is related to population changes and the transfer of pollutants • Investigate the movement of energy through an ecosystem • Define ecological pyramid and explain its relationship to energy in an ecosystem • Explain how Earth is closed with respect to matter and open with respect to energy • Describe the chemical composition of the human body	• Online quiz • Test • Persuasive essay • Biogeochemical cycle story • Succession comic strip

		• Explain the water cycle, the carbon cycle, the nitrogen cycle, and the phosphorus cycle • Describe the concept of the niche • Examine how interactions between a species and its environment define the species' niche • Explain how a species adapts to its niche • Describe convergent evolution and coevolution, and relate each to the concept of niche • Describe the effect of invasive species on an environment • Define symbiosis and describe several symbiotic relationships • Contrast primary and secondary succession • Describe the sequence of ecological succession in a lake and on an island • Explain the concept of ecosystem stability • Characterize the effects of disturbances on ecosystems	
Populations	Why can't populations continue to increase in size forever? Is the human population too large?	• Explain how populations of organisms grow • Describe the factors that limit the growth of a population • Identify the shapes of growth curves that represent populations of different organisms • Explain the relationship between the population sizes of predator and prey • Describe the major events that have affected the rate of human population growth throughout history • Identify factors that affect the size of a population • Compare and contrast population growth trends in developing and industrialized nations • Relate overpopulation to the use of natural resources, energy demands, and biodiversity	• Online quiz • Test • Analysis of population sampling methods • Population projections • Fishbowl discussion

		• Hypothesize about the effect of availability of resources on future population growth	
Biomes	Why are regions of Earth different? How do organisms survive in different biomes?	• Explain the concept of biome and name the eight major land biomes • Identify and explain different factors that affect the climate of a region • Illustrate where each of the eight major land biomes occurs • Describe the characteristics of a desert • Explain how desert organisms are adapted to live in their environment • Illustrate the processes that cause deserts to form • Describe why the characteristics of the tundra make it a fragile ecosystem • Compare the characteristics of tundra organisms with those of their relatives in warmer climates • Describe the characteristics of grasslands • Identify where grasslands are located • Describe the importance of temperate grasslands in agriculture • Explain how organisms have adapted to survive on the savanna • Describe the characteristics of the coniferous forest • Explain adaptations that enable organisms to survive in coniferous forests • Identify the characteristics of the deciduous forest • Describe the organisms that inhabit deciduous forests • Describe the characteristics of the tropical rain forest • Illustrate the complexity and diversity of the	• Online quiz • Test • Biomes research and presentation

		rainforest ecosystem • Describe the factors that characterize the various types of aquatic biomes • Identify the characteristics of different types of standing-water ecosystems • Explain the value of wetlands and the reasons for their decline • Describe how abiotic factors of gravity, erosion, and sedimentation affect stream ecosystems • Locate the major ocean zones based on their relationship to the shore • Describe the flow of water through the world ocean and the characteristics of ocean water in different parts of the world • Describe the factors that define a neritic zone • Compare and contrast biodiversity in coral reefs and other aquatic ecosystems • List several human activities that damage intertidal habitats	
People in the Global Ecosystem	Why is the Earth more polluted now than it was before? Do we have enough food to feed over seven billion people?	• Describe Earth as a network of systems and connections • Identify hunter-gatherer, agricultural, and industrial societies • Describe how the impact of humans on the environment has increased over time • Define the frontier ethic and the sustainable development ethic • Contrast renewable and nonrenewable resources • List the major groups of nutrients and the amount of energy provided by each type • Explain the effects of economics on the production of food • Describe how farming techniques have changed during the past fifty years • Describe the basic	• Online quiz • Human society skit

		components of sustainable agriculture and explain why they are desirable	
Energy Resources	Why is gas so expensive? Why can't we use fossil fuels forever? Is renewable energy in our future?	• Explain how changes in human societies have changed the demand for energy • Describe the structure of organic fuels • List the stages of coal formation and describe the characteristics of each stage • Locate the major coal deposits in the world • Describe the process of petroleum formation and extraction • List several uses for petroleum and natural gas • Describe some of the problems associated with the use of fossil fuels • Compare biomass fuels to fossil fuels, and give an example of a bioconversion technique • Describe the structure of the atom and the atomic nucleus • Explain how unstable nuclei become stable by releasing radiation • Illustrate the fission chain reactions that power nuclear reactors and breeder reactors • Diagram the structure and function of a nuclear reactor • Define radioactive waste and explain the dangers that arise from it • State the problems involved in the safe disposal of radioactive waste • Identify the need and importance of alternative energy sources • Explain the importance of the sun in supplying energy to Earth • Describe how solar energy can be used to heat buildings and generate electricity	• Online quiz • Test • Renewable energy research and video • Townsville energy proposal • Energy efficient home design and presentation

		• Describe two ways that moving water can be used to produce electricity • Discuss the benefits and drawbacks of producing electricity through the use of hydroelectric power • Explain how the energy in wind can be used to produce electricity • Describe some advantages and disadvantages of using wind energy • Describe how geothermal energy is used	
Resources in the Biosphere	Are we messing up Earth…permanently? How can we reduce our impact on Earth?	• Describe minerals and identify some of their characteristics • List several ways that minerals are used • Describe methods for extracting minerals • Identify and explain ways in which extraction methods may affect the environment • Identify different soil types and how they influence soil characteristics • Describe the relationship between climate and soil formation • Identify causes of soil mismanagement and predict possible outcomes from such mismanagement • Identify ways in which soil is lost • Describe methods used in agriculture to prevent soil erosion • List examples of solid wastes and identify their sources • Describe past and present methods used to dispose of solid wastes • Identify problems associated with hazardous wastes • Classify hazardous wastes according to their characteristics • Identify and explain methods for reducing the volume of wastes	• Online quiz • Test • Analysis of soil and lab report • Analysis of water pollution • *A Civil Action* paper

		• Discuss the benefits and drawbacks of various forms of waste disposal • Describe the ways in which people use water • Relate how water use affects ecosystems • Explain ways in which fresh water is naturally stored as a resource • Predict the effects of the depletion of an aquifer • Explain why fresh water in many parts of the world is not potable • Trace the sequence of events involved in the purification of water • Explain the link between water pollution and human disease • Identify the major types of water pollutants and their sources • Examine the sources and effects of inorganic and organic toxic chemicals • Describe the process of eutrophication and its effects on lake ecosystems • Explain the problems of radioactive and thermal water pollution • Identify government attempts to control water pollution • Describe the problems involved in enforcing laws regarding water pollution • Describe air pollution • Identify common outdoor and indoor air pollutants • Identify the effects of air pollution on human health • Describe the effects of air pollution on plants and animals • Identify the cause and effects of acid precipitation and ozone depletion • Explain the greenhouse effect and global warming • Describe natural processes that help control air pollution • Explain human efforts to	

		control air pollution • Identify federal legislation for curbing air pollution	

Forensic Science: Academic

Grade Level	11, 12
Course Number	327
Subject Area	Science, Technology, and Engineering

Course Description

Forensic science is the application of basic biological, chemical, and physical science principles and technological practices to the purposes of justice in the study of criminal and civil issues. Major themes of study in this course are microscopy of hair and fibers, voice and facial recognition, pathology, ballistics, arson investigations, anthropology, odontology, trace evidence, biological fluids, DNA, fingerprints, impression evidence, questioned documents and forensic psychiatry/psychology. The class is student, and inquiry centered. Emphasis will be placed on lab investigations and writing.

Scientific Inquiry Skills Standards

SIS1. Make observations, raise questions, and formulate hypotheses.

- Observe the world from a scientific perspective.
- Pose questions and form hypotheses based on personal observations, scientific articles, experiments, and knowledge.
- Read, interpret, and examine the credibility and validity of scientific claims in different sources of information, such as scientific articles, advertisements, or media stories.

SIS2. Design and conduct scientific investigations.

- Articulate and explain the major concepts being investigated and the purpose of an investigation.
- Select required materials, equipment, and conditions for conducting an experiment.
- Identify independent and dependent variables.
- Write procedures that are clear and replicable.
- Employ appropriate methods for accurately and consistently
    - making observations
    - making and recording measurements at appropriate levels of precision
    - collecting data or evidence in an organized way
- Properly use instruments, equipment, and materials (e.g., scales, probeware, meter sticks, microscopes, and computers) including set-up, calibration (if required), technique, maintenance, and storage.
- Follow safety guidelines.

SIS3. Analyze and interpret results of scientific investigations.

- Present relationships between and among variables in appropriate forms.
- Represent data and relationships between and among variables in charts and graphs.
- Use appropriate technology (e.g., graphing software) and other tools.
- Use mathematical operations to analyze and interpret data results.
- Assess the reliability of data and identify reasons for inconsistent results, such as sources of error or uncontrolled conditions.
- Use results of an experiment to develop a conclusion to an investigation that addresses the initial questions and

supports or refutes the stated hypothesis.
- State questions raised by an experiment that may require further investigation.

SIS4. Communicate and apply the results of scientific investigations.
- Develop descriptions of and explanations for scientific concepts that were a focus of one or more investigations.
- Review information, explain statistical analysis, and summarize data collected and analyzed as the result of an investigation.
- Explain diagrams and charts that represent relationships of variables.
- Construct a reasoned argument and respond appropriately to critical comments and questions.
- Use language and vocabulary appropriately, speak clearly and logically, and use appropriate technology (e.g., presentation software) and other tools to present findings.
- Use and refine scientific models that simulate physical processes or phenomena.

Reading Standards for Literacy in Science
Key Ideas and Details
1. Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.
2. Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.
3. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.
Craft and Structure
4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 11–12 texts and topics*.
5. Analyze how the text structures information or ideas into categories or hierarchies, demonstrating understanding of the information or ideas.
6. Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, identifying important issues that remain unresolved.
Integration of Knowledge and Ideas
7. Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.
8. Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information.
9. Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.
Range of Reading and Level of Text Complexity
10. By the end of grade 12, read and comprehend science/technical texts in the grades 11–CCR text complexity band independently and proficiently.

Writing Standards
Text Types and Purposes
1. Write arguments focused on *discipline-specific content*. a. Introduce precise, knowledgeable claim(s), establish the significance of the claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that logically sequences the claim(s), counterclaims, reasons, and evidence. b. Develop claim(s) and counterclaims fairly and thoroughly, supplying the most relevant data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form that anticipates the audience's knowledge level, concerns, values, and possible biases. c. Use words, phrases, and clauses as well as varied syntax to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims. d. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing. e. Provide a concluding statement or section that follows from or supports the argument presented.

2. Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. a. Introduce a topic and organize complex ideas, concepts, and information so that each new element builds on that which precedes it to create a unified whole; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension. b. Develop the topic thoroughly by selecting the most significant and relevant facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic. c. Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among complex ideas and concepts. d. Use precise language, domain-specific vocabulary and techniques such as metaphor, simile, and analogy to manage the complexity of the topic; convey a knowledgeable stance in a style that responds to the discipline and context as well as to the expertise of likely readers. e. Provide a concluding statement or section that follows from and supports the information or explanation provided (e.g., articulating implications or the significance of the topic).
3. Students' narrative skills continue to grow in these grades. The standards require that students be able to incorporate narrative elements effectively into arguments and informative/explanatory texts. In history/social studies, students must be able to incorporate narrative accounts into their analyses of individuals or events of historical import. In science and technical subjects, students must be able to write precise enough descriptions of the step-by-step procedures they use in their investigations or technical work that others can replicate them and (possibly) reach the same results.
Production and Distribution of Writing
4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
5. Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.
6. Use technology, including the Internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments or information.
Research to Build and Present Knowledge
7. Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.
8. Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation.
9. Draw evidence from informational texts to support analysis, reflection, and research.
Range of Writing
10. Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

Essential Questions

In what ways is forensic science interdisciplinary?
How has forensic science developed over the course of history?
What skills are necessary to process a crime scene?
Is forensic evidence "better" than eyewitnesses and confessions?
How has technology aided the solving of crimes?
When did forensic science begin and how did it develop into an important component of criminal investigation?
How have forensic science advancements affected the rights of individuals?
What is involved in a thorough crime scene investigation?
What methods are useful when searching, isolating, collecting, and recording physical and trace evidence?
What are the procedures for preserving crime scenes and gathering evidence, and why?
How does a forensic scientist detect trace evidence at a crime scene?
As the accused, can I be sure that my trial is based on accurate, precise, complete, scientific evidence?
What skills does an investigator need to solve a crime?
What types of physical evidence are found at a crime scene?
How can you ID a victim from a skeleton? From bite marks?

How can a bone be used to determine an individual's age, height, race, and gender?
How can forensic scientists use trace evidence to explain what happened at a crime scene?
How can documents and currency be analyzed to determine their legitimacy?
What information about the crime and weapon can be found when examining bullets?
How do form and line quality relate to handwriting?
How do perps attempt to avoid fingerprint experts?
How are bite marks useful in investigations?
How does the tool mark from one instrument differ from another one?
What methods and techniques are sued for evaluating handwriting and document evidence?
How can a forensic scientist use hair and fiber to help them solve a crime?
How do scientists know that the shoe that made a footwear impression was my shoe, not one like mine?
How can scientists tell that a specific tool created a mark, not one like it?
How can ransom notes or suicide letters be helpful to forensic scientists?
How do we know that all fingerprints are unique?
Do identical twins have identical fingerprints?
What can blood from a crime scene tell forensic scientists?
How can you ID a victim from a skeleton? From bite marks?
What can DNA tell scientists?
What clues from a body or its surroundings pertain to time of death, cause and mechanism of death, and manner of death?
What is DNA Profiling and how is it useful in criminal investigations and civil cases?
How post mortem changes, such as rigor mortis and lividity, useful in determining probable time and cause of death?
How can knowing the insect larval development stages assist investigators in determining when an individual died?
How can the presence of insect larvae be used to determine if a body has been relocated?
How can plant DNA be used to convict criminals?
How does knowledge of plants being native to an area influence a criminal investigation?
How can alcohol, drugs, and poisons be detected in the human body?
How does spectrometry and chromatography link with toxicology?
How post mortem changes, such as rigor mortis and lividity, useful in determining probable time and cause of death?
How do forensic scientists know that substances are actually drugs?
Are the results of all forensic tests admissible in court?
What are the motives for arson?
What is the historical development of interrogation practices?
How do ethics play a role in interrogation proceedings?
What is the difference between an interview and an interrogation?
What are some of the interrogation methods and when would each be used?
How does objectivity play a role in interrogation and reporting?
What information is necessary to have when profiling a serial killer?
What defines a serial killer?
What motives have been established for serial killers historically?
What is a copycat killer?
How has technology impacted the success of serial killers?

Enduring Understandings

Forensic Science is the application of various sciences to those criminal and civil laws that are enforced by police agencies in a criminal justice system.
Forensic science is an interdisciplinary study, incorporating science topics from biology, chemistry, earth science, and physics, in addition to other disciplines such as mathematics, history, law, and law enforcement.
Forensic investigation requires strict protocols from trained professionals for securing crime scenes and gathering, processing and analyzing evidence of a crime.
Inquiry is the integration of process skills, the application of scientific content and critical thinking to solve problems.
Scientists use evidence gained through scientific processes to explain the natural world.
There is historical significance of scientific forensic techniques used in collecting and submitting evidence for admissibility in

court (ex. Locard's Principle, Frye Standard, and Daubert Ruling)
Historically, forensic science is a relatively new science.
Forensic Science is a relatively new science and is constantly evolving.
Science, with new discoveries and developments in technology, impacts everyday life, including solving crimes.
The ability to make GOOD observations is the foundation of all forensic science.
The ability to supply to the criminal justice system, accurate and objective information that reflects the events that occurred at a crime is an essential skill for the forensic scientist.
Forensic investigation requires strict protocols from trained professionals for securing crime scenes and gathering, processing and analyzing evidence of a crime.
Forensic Science is not based upon assumptions and instinct; rather, it is substantiated by valid, reproducible evidence leading to logical conclusions.
Different crime scenes require different methods of searching for evidence.
There have been several significant cases that have impacted forensic science.
Observations can be biased and impacted by many factors.
There are several factors that influence eyewitness accounts of events.
Technology has revolutionized forensic science by developing tools to improve forensic science techniques.
Forensic scientists use trace evidence to explain what happened at a crime scene.
Physical evidence includes hair, fibers, pollen, paint, glass, soil, fingerprints, and impressions (from shoes, tires, teeth, or tools).
Analysis of documents and currency, including examining the materials, inks, or designs incorporated into the piece, can detect forgeries and counterfeiting.
Bones can be interpreted to determine gender, age, race, and identity of the individual, as well as any previous injuries or disease they may have incurred.
Staged crime scenes pose unique problems for investigators.
Ballistics is the study of bullets and firearms, including examining unique rifling patterns on bullets, identifying firearms, and determining bullet trajectories.
Fingerprint evidence is unique and individual evidence.
Documents, when analyzed can often lead investigators to a single person.
Impressions can lead forensic scientists to a specific individual.
Hair samples and fiber samples are common pieces of trace evidence and can be of assistance in criminal investigations.
There is a difference between latent, patent, and plastic impressions.
Tire tracks provide information that can be used to narrow down the vehicle used in a criminal offense.
A person's handwriting is a window into their personality.
There are several important types of evidence that can be collected at a cyber-crime scene and each has forensic value.
DNA fingerprinting is a tool to help solve cases because, except for identical twins, no two people on Earth share the same nucleotide sequence in their DNA. Similarities in DNA fingerprints indicate relatedness between individuals, including paternity.
Blood types and blood spatter patterns can be used as physical and biological evidence to determine what happened at the crime scene.
Toxicologists detect and identify drugs and poisons in body fluids, tissues and organs.
Forensic examiners can determine cause and mechanism of death, manner of death, and time of death by examining specific characteristics of the body (eg. livor, algor, and rigor mortis; stomach contents and stage of digestion; and stages of decomposition) and insects associated with the body at the time it is discovered.
Blood can be useful to reconstruct a crime scene.
Insect larval stages are useful when determining the time of death of a victim.
Insect larval presence can be used to determine if a body has been moved.
Insects affect human remains.
Plant DNA can be used to convict criminals.
Drugs, even those legally obtained can be involved with crimes and crime scenes and forensic scientists are able to identify these.
Toxicologists detect and identify drugs and poisons in body fluids, tissues and organs.
The forensic aspects of investigating suspicious fires include a consideration of motive as well as investigating and physically

processing the crime scene.
Interviewing a suspect is different than interrogating a suspect.
Using a cognitive approach during interviewing suspects enhances their recollection of information.
Ethics is at the heart of all interrogation methods.
Interrogation methods differ depending on the criminal's accused offense, intellectual capacity, age, and other factors.
Serial Killers range in age, IQ, and academic and economic status.
There are more than 100 active serial killers in America at any one time.
Female serial killers are far more successful than male serial killers.
Understanding a serial killers motive and Modus Operandi can help investigators get a step ahead of them.

Evidence of Understanding

The students will:

- take unit tests
- take quarterly assessments
- take quizzes
- perform formal labs
- perform informal labs
- work collaboratively and independently on class work
- give oral presentations using Power Point
- solve crimes and write-up police reports
- analyze evidence at crime scenes using various techniques and prosecute suspects as if in a court of law
- read scientific literature
- plan the "perfect crime"

Course Outline

Unit	Essential Questions	Skills and Understandings	Assessment
Unit 1 Introduction to Forensic Science	• In what ways is forensic science interdisciplinary? • How has forensic science developed over the course of history? • What skills are necessary to process a crime scene? • Is forensic evidence "better" than eyewitnesses and confessions? • How has technology aided the solving of crimes? • When did forensic science begin and how did it develop into an important component of criminal investigation? • How have forensic science advancements affected the rights of individuals?	• Explain how technological advances have revolutionized the field of forensic science and its practices • Use deductive reasoning to effectively analyze evidence and come to logical conclusions • Explain how the legal system and forensic science coincide and affect one another • Sketch and explain which crime scene search technique is most useful for a variety of situations • Explain the process of forensic science from the time the crime has been committed to the acquittal or conviction of the criminal	• Newspaper Activity • Observation Activity • Deadly Picnic Activity • Activity Stinky Feet • White Powders Lab • Alien Invasion Activity • Search for Bones Lab • Sketch a Crime Scene Lab • Don't Touch the evidence Activity • Quizzes • Unit Test • Common Assessment #1

	• What is involved in a thorough crime scene investigation? • What methods are useful when searching, isolating, collecting, and recording physical and trace evidence? • What are the procedures for preserving crime scenes and gathering evidence, and why? • How does a forensic scientist detect trace evidence at a crime scene? • As the accused, can I be sure that my trial is based on accurate, precise, complete, scientific evidence? • What skills does an investigator need to solve a crime?		
Unit II. Physical Evidence	• What types of physical evidence are found at a crime scene? • How can you ID a victim from a skeleton? From bite marks? • How can a bone be used to determine an individual's age, height, race, and gender? • How can forensic scientists use trace evidence to explain what happened at a crime scene? • How can documents and currency be analyzed to determine their legitimacy? • What information about the crime and weapon can be found when examining bullets? • How do form and line quality relate to handwriting? • How do perps attempt to avoid fingerprint	• Identify various forms of physical evidence that might be at a crime scene • Use mathematical equations to determine the height of an individual if a single bone is discovered • Identify an individual's age, height, race, and gender from skeletal remains • Process physical evidence at a crime scene effectively-including lifting fingerprints, tagging and bagging evidence, making impressions, and analyzing tool marks • Analyzing personality traits from handwriting samples • Authenticating the originality of documents and ransom notes • Examine evidence to corroborate or dispute a witness's testimony • Measure stance and	• What Bones Can Tell You Lab • Stations Practical Exam • Bones: Male or Female • Missing Persons I Activity • Missing Persons II Activity • Skeletal System Forensics • Who Wrote This • Tattle Tale Lab • Write on-Forged Check • U.S. Currency Activity • Web Adventures • Quantum Enterprises Activity • Analyze Serial Killer Diaries-handwriting Activity • Crime Scene-Virtual Museum • Did Pete Cheat Lab • Bleeding Mixtures

	experts? • How are bite marks useful in investigations? • How does the tool mark from one instrument differ from another one? • What methods and techniques are sued for evaluating handwriting and document evidence? • How can a forensic scientist use hair and fiber to help them solve a crime? • How do scientists know that the shoe that made a footwear impression was my shoe, not one like mine? • How can scientists tell that a specific tool created a mark, not one like it? • How can ransom notes or suicide letters be helpful to forensic scientists? • How do we know that all fingerprints are unique? • Do identical twins have identical fingerprints? • How are Tire Treads useful in recreating crimes?	wheelbase of vehicles as well as use their tread pattern to determine if they were present at the crime scene. • Determine the caliber of a weapon measuring bullets and looking at striation patterns	Lab • Tire Treads I and II • Ballistics I and II Lab • Quizzes • Unit Test • Common Assessment #2
Unit III. Biological Evidence	• What can blood from a crime scene tell forensic scientists? • How can you ID a victim from a skeleton? From bite marks? • What can DNA tell scientists? • What clues from a body or its surroundings pertain to time of death, cause and mechanism of death, and manner of death? • What is DNA Profiling	• Determine the nature and cause of death when examining a body • Determine the time of death based on stage of rigor mortis and entomology • Discuss how to determine if a body has been moved or "dumped" after the individual has been killed • Explain the importance of DNA as a means of evidence	• Calculating Time of Death Using Rigor Mortis Lab • Reveal the Truth Activity • Rigor Mortis Manual TOD • Crime Scene Recreation • Blood Drop Lab • Blood Type Lab • Blood Spatter Activity • DNA Murder Lab • Quizzes

	and how is it useful in criminal investigations and civil cases? • How post mortem changes, such as rigor mortis and lividity, useful in determining probable time and cause of death? • Insect larval development stages assist investigators in determining when an individual died? • How can the presence of insect larvae be used to determine if a body has been relocated? • How can plant DNA be used to convict criminals? • How does knowledge of plants being native to an area influence a criminal investigation?	• Establish the relationship between dropping height and blood drop diameter • Recognize patterns around the drop, such as satellite spatter or spines • Reconstruct the events of a crime based on blood spatter patterns	• Crime Scene I McArthur • Crime Scene II- Alice • Unit Test • Common Assessment #3
Unit IV. Chemical and Materials Evidence	• How can alcohol, drugs, and poisons be detected in the human body? • How does spectrometry and chromatography link with toxicology? • How do forensic scientists know that substances are actually drugs? • Are the results of all forensic tests admissible in court? • What are the motives for arson?	• Determine whether poisons have been utilized by a criminal by examining bodily fluids and comparing them with a standard norm • Using chromatography to determine if a substance is a "narcotic" • Profile an arsonist and predict their next target	• Murdered Mayor Lab • Crime Scene III • Toxicology Lab • Drug Bust 3 • Dead and Breakfast • Terror in Paradise Lab • Quiz • Unit Test
Unit V. Interrogation	• What is the historical development of interrogation practices? • How do ethics play a role in interrogation proceedings? • What is the difference between an interview and an interrogation?	• Use appropriate and effective interrogation techniques when interrogating criminals being sure to adapt techniques to take into account the criminal's accused offense, intellectual capacity, age,	• Interrogation Essay I-techniques and personalities • Analysis of 48 Hours Episode • Interrogation Essay II- Interrogating Terrorists • Lie to Me Activity • Quizzes

	• What are some of the interrogation methods and when would each be used? • How does objectivity play a role in interrogation and reporting?	and other factors. • Identify body language which indicates a criminal is lying to you • Effectively interview witnesses to optimize their recall of information	• Unit Test
Unit VI. Serial Killers	• What information is necessary to have when profiling a serial killer? • What defines a serial killer? • What motives have been established for serial killers historically? • What is a copycat killer? • How has technology impacted the success of serial killers?	• Effectively profile a serial killer • Predict a serial killer's next move based on prior offenses • Effectively predict whether crimes are being committed by a male/female, individual/partners • Discuss how technology has enhanced law enforcement's ability to apprehend serial killers	• Serial Killer Profile Lab • Serial Killer Computer Activity • Serial Killer Baseball Cards • Serial Killer Research and Presentation • Quiz • Unit Test

Chemistry: Honors

Grade Level	10
Course Number	330
Subject Area	Science and Technology

Course Description

This course is a year-long study of the quantitative and descriptive principles of chemistry. Topics include: structure of matter, physical and chemical changes, atomic structure, periodic law, chemical bonding, chemical equations, acid-base theory, oxidation-reduction, electrochemistry, and gas laws.

Content Standards

1. Properties of Matter

Central Concept: Physical and chemical properties reflect the nature of the interactions between molecules or atoms, and can be used to classify and describe matter.

1.1 Identify and explain physical properties (e.g., density, melting point, boiling point, conductivity, malleability) and chemical properties (e.g., the ability to form new substances). Distinguish between chemical and physical changes.

1.2 Explain the difference between pure substances (elements and compounds) and mixtures. Differentiate between heterogeneous and homogeneous mixtures.

1.3 Describe the three normal states of matter (solid, liquid, gas) in terms of energy, particle motion, and phase transitions.

2. Atomic Structure and Nuclear Chemistry

Central Concepts: Atomic models are used to explain atoms and help us understand the interaction of elements and compounds observed on a macroscopic scale. Nuclear chemistry deals with radioactivity, nuclear processes, and nuclear properties. Nuclear reactions produce tremendous amounts of energy and lead to the formation of elements.

2.1 Recognize discoveries from Dalton (atomic theory), Thomson (the electron), Rutherford (the nucleus), and Bohr (planetary model of atom), and understand how each discovery leads to modern theory.
2.2 Describe Rutherford's "gold foil" experiment that led to the discovery of the nuclear atom. Identify the major components (protons, neutrons, and electrons) of the nuclear atom and explain how they interact.
2.3 Interpret and apply the laws of conservation of mass, constant composition (definite proportions), and multiple proportions.
2.4 Write the electron configurations for the first twenty elements of the periodic table.
2.5 Identify the three main types of radioactive decay (alpha, beta, and gamma) and compare their properties (composition, mass, charge, and penetrating power).
2.6 Describe the process of radioactive decay by using nuclear equations, and explain the concept of half-life for an isotope (for example, C-14 is a powerful tool in determining the age of objects).
2.7 Compare and contrast nuclear fission and nuclear fusion.

3. Periodicity

Central Concepts: Repeating (periodic) patterns of physical and chemical properties occur among elements that define families with similar properties. The periodic table displays the repeating patterns, which are related to the atoms' outermost electrons.

3.1 Explain the relationship of an element's position on the periodic table to its atomic number. Identify families (groups) and periods on the periodic table.
3.2 Use the periodic table to identify the three classes of elements: metals, nonmetals, and metalloids.
3.3 Relate the position of an element on the periodic table to its electron configuration and compare its reactivity to the reactivity of other elements in the table.
3.4 Identify trends on the periodic table (ionization energy, electronegativity, and relative sizes of atoms and ions).

4. Chemical Bonding

Central Concept: Atoms bond with each other by transferring or sharing valence electrons to form compounds.

4.1 Explain how atoms combine to form compounds through both ionic and covalent bonding. Predict chemical formulas based on the number of valence electrons.
4.2 Draw Lewis dot structures for simple molecules and ionic compounds.
4.3 Use electronegativity to explain the difference between polar and nonpolar covalent bonds.
4.4 Use valence-shell electron-pair repulsion theory (VSEPR) to predict the molecular geometry (linear, trigonal planar, and tetrahedral) of simple molecules.
4.5 Identify how hydrogen bonding in water affects a variety of physical, chemical, and biological phenomena (e.g., surface tension, capillary action, density, boiling point).
4.6 Name and write the chemical formulas for simple ionic and molecular compounds, including those that contain the polyatomic ions: ammonium, carbonate, hydroxide, nitrate, phosphate, and sulfate.

5. Chemical Reactions and Stoichiometry

Central Concepts: In a chemical reaction, one or more reactants are transformed into one or more new products. Chemical equations represent the reaction and must be balanced. The conservation of atoms in a chemical reaction leads to the ability to calculate the amount of products formed and reactants used (stoichiometry).

5.1 Balance chemical equations by applying the laws of conservation of mass and constant composition (definite proportions).
5.2 Classify chemical reactions as synthesis (combination), decomposition, single displacement (replacement), double displacement, and combustion.
5.3 Use the mole concept to determine number of particles and molar mass for elements and compounds.
5.4 Determine percent compositions, empirical formulas, and molecular formulas.
5.5 Calculate the mass-to-mass stoichiometry for a chemical reaction.
5.6 Calculate percent yield in a chemical reaction.

6. States of Matter, Kinetic Molecular Theory, and Thermochemistry

Central Concepts: Gas particles move independently of each other and are far apart. The behavior of gas particles can be modeled by the kinetic molecular theory. In liquids and solids, unlike gases, particles are close to each other. The driving forces of chemical reactions are energy and entropy. The reorganization of atoms in chemical reactions results in the release or absorption of heat energy.

6.1 Using the kinetic molecular theory, explain the behavior of gases and the relationship between pressure and volume (Boyle's law), volume and temperature (Charles's law), pressure and temperature (Gay-Lussac's law), and the number of particles in a gas sample (Avogadro's hypothesis). Use the combined gas law to determine changes in pressure, volume, and temperature.
6.2 Perform calculations using the ideal gas law. Understand the molar volume at 273 K and 1 atmosphere (STP).
6.3 Using the kinetic molecular theory, describe and contrast the properties of gases, liquids, and solids. Explain, at the molecular level, the behavior of matter as it undergoes phase transitions.
6.4 Describe the law of conservation of energy. Explain the difference between an endothermic process and an exothermic process.
6.5 Recognize that there is a natural tendency for systems to move in a direction of disorder or randomness (entropy).

7. Solutions, Rates of Reaction, and Equilibrium

Central Concepts: Solids, liquids, and gases dissolve to form solutions. Rates of reaction and chemical equilibrium are dynamic processes that are significant in many systems (e.g., biological, ecological, geological).

7.1 Describe the process by which solutes dissolve in solvents.
7.2 Calculate concentration in terms of molarity. Use molarity to perform solution dilution and solution stoichiometry.
7.3 Identify and explain the factors that affect the rate of dissolving (e.g., temperature, concentration, surface area, pressure, mixing).
7.4 Compare and contrast qualitatively the properties of solutions and pure solvents (colligative properties such as boiling point and freezing point).
7.5 Identify the factors that affect the rate of a chemical reaction (temperature, mixing, concentration, particle size, surface area, catalyst).
7.6 Predict the shift in equilibrium when a system is subjected to a stress (LeChatelier's principle) and identify the factors that can cause a shift in equilibrium (concentration, pressure, volume, temperature).

8. Acids and Bases and Oxidation-Reduction Reactions

Central Concepts: Acids and bases are important in numerous chemical processes that occur around us, from industrial procedures to biological ones, from the laboratory to the environment. Oxidation-reduction reactions occur when one substance transfers electrons to another substance, and constitute a major class of chemical reactions.

8.1 Define the Arrhenius theory of acids and bases in terms of the presence of hydronium and hydroxide ions in water and the Bronsted-Lowry theory of acids and bases in terms of proton donors and acceptors.
8.2 Relate hydrogen ion concentrations to the pH scale and to acidic, basic, and neutral solutions. Compare and contrast the strengths of various common acids and bases (e.g., vinegar, baking soda, soap, citrus juice).
8.3 Explain how a buffer works.
8.4 Describe oxidation and reduction reactions and give some everyday examples, such as fuel burning and corrosion. Assign oxidation numbers in a reaction.

Scientific Inquiry Skills Standards

SIS1. Make observations, raise questions, and formulate hypotheses.

- Observe the world from a scientific perspective.
- Pose questions and form hypotheses based on personal observations, scientific articles, experiments, and knowledge.
- Read, interpret, and examine the credibility and validity of scientific claims in different sources of information, such as scientific articles, advertisements, or media stories.

SIS2. Design and conduct scientific investigations.

- Articulate and explain the major concepts being investigated and the purpose of an investigation.
- Select required materials, equipment, and conditions for conducting an experiment.
- Identify independent and dependent variables.
- Write procedures that are clear and replicable.
- Employ appropriate methods for accurately and consistently
    - making observations
    - making and recording measurements at appropriate levels of precision
    - collecting data or evidence in an organized way

- Properly use instruments, equipment, and materials (e.g., scales, probeware, meter sticks, microscopes, computers) including set-up, calibration (if required), technique, maintenance, and storage.
- Follow safety guidelines.

SIS3. Analyze and interpret results of scientific investigations.

- Present relationships between and among variables in appropriate forms.
  - Represent data and relationships between and among variables in charts and graphs.
  - Use appropriate technology (e.g., graphing software) and other tools.
- Use mathematical operations to analyze and interpret data results.
- Assess the reliability of data and identify reasons for inconsistent results, such as sources of error or uncontrolled conditions.
- Use results of an experiment to develop a conclusion to an investigation that addresses the initial questions and supports or refutes the stated hypothesis.
- State questions raised by an experiment that may require further investigation.

SIS4. Communicate and apply the results of scientific investigations.

- Develop descriptions of and explanations for scientific concepts that were a focus of one or more investigations.
- Review information, explain statistical analysis, and summarize data collected and analyzed as the result of an investigation.
- Explain diagrams and charts that represent relationships of variables.
- Construct a reasoned argument and respond appropriately to critical comments and questions.
- Use language and vocabulary appropriately, speak clearly and logically, and use appropriate technology (e.g., presentation software) and other tools to present findings.
- Use and refine scientific models that simulate physical processes or phenomena.

Reading Standards for Literacy in Science

Key Ideas and Details

1. Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.

2. Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text.

3. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text.

Craft and Structure

4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 9–10 texts and topics*.

5. Analyze the structure of the relationships among concepts in a text, including relationships among key terms (e.g., *force*, *friction*, *reaction force*, *energy*).

6. Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, defining the question the author seeks to address.

Integration of Knowledge and Ideas

7. Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.

8. Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem.

9. Compare and contrast findings presented in a text to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts.

Range of Reading and Level of Text Complexity

10. By the end of grade 10, read and comprehend science/technical texts in the grades 9–10 text complexity band independently and proficiently.

Writing Standards

Text Types and Purposes

1. Write arguments focused on *discipline-specific content*.

a. Introduce precise claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that establishes clear relationships among the claim(s), counterclaims, reasons, and evidence.

b. Develop claim(s) and counterclaims fairly, supplying data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form and in a manner that anticipates the audience's knowledge level and concerns.
c. Use words, phrases, and clauses to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims.
d. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.
e. Provide a concluding statement or section that follows from or supports the argument presented.

2. Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.
a. Introduce a topic and organize ideas, concepts, and information to make important connections and distinctions; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.
b. Develop the topic with well-chosen, relevant, and sufficient facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic.
c. Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among ideas and concepts.
d. Use precise language and domain-specific vocabulary to manage the complexity of the topic and convey a style appropriate to the discipline and context as well as to the expertise of likely readers.
e. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.
f. Provide a concluding statement or section that follows from and supports the information or explanation presented (e.g., articulating implications or the significance of the topic).

3. Students' narrative skills continue to grow in these grades. The standards require that students be able to incorporate narrative elements effectively into arguments and informative/explanatory texts. In history/social studies, students must be able to incorporate narrative accounts into their analyses of individuals or events of historical import. In science and technical subjects, students must be able to write precise enough descriptions of the step-by-step procedures they use in their investigations or technical work that others can replicate them and (possibly) reach the same results.

Production and Distribution of Writing

4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

5. Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.

6. Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically.

Research to Build and Present Knowledge

7. Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

8. Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation.

9. Draw evidence from informational texts to support analysis, reflection, and research.

Range of Writing

10. Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

Essential Questions

- What constitutes matter?
- How do you differentiate between physical and chemical properties and changes?
- Why do scientists use SI units when making measurements?
- What are the relationships between SI units and our current method of measuring objects?
- How do we know that the atom is not the smallest particle?
- What is the currently accepted model of the atom?
- How is the periodic table arranged?

- Why and how do atoms bond?
- How are formulas written for a compound?
- What is the English translation of that chemical formula?
- Why are products formed and what possible products can be formed?
- How does the amount of starting material relate to the amount of product formed?
- Why does a real gas behave differently than an ideal gas?
- How can the pressure, volume, temperature or number of moles of a gas be determined?
- Why do gases diffuse at different rates?
- Why are solutions made precisely in known concentrations?
- How does temperature, pressure and molecule size affect the solubility of a compound?
- How is something classified as an acid or base? What do the pH values mean?
- What happens to the equilibrium of a reaction after it is disturbed by adjusting reactants or products?
- Why some nuclei are unstable and what do they decay into?
- How long does a sample take to decay?
- Where does fusion happen?
- How is energy created at a nuclear power plant?
- How can we protect ourselves from radiation?

Enduring Understandings

Students will learn how:

- To identify all types of matter and changes it undergoes
- To use the scientific method and SI units of measurement
- To use dimensional analysis to make unit conversions
- To identify the parts of an atom and how they were discovered
- To model the atom using the Bohr and Quantum models
- To use the periodic table to predict properties of elements
- To form covalent and ionic bonds between elements
- To name and write formulas for ionic and covalent compounds.
- To predict the products of chemical reactions
- To predict the amount of product that can be formed from a reaction.
- To explain the behavior of gases using the Kinetic Molecular Theory (KMT)
- To identify real and ideal gases using the KMT
- To solve for any of the variables in Boyles, Charles, Gay-Lussac, Combined or Ideal gas laws.
- To use Graham's Law of Diffusion
- To make a solution with a given concentration
- To modify the rate of dissolution
- To identify a molecule as an acid or base using various theories
- To predict the product of an acid base reaction
- To calculate pH and pOH of a solution
- To predict the shift in a reaction at equilibrium
- To identify unstable nuclei and decay rate (half-life)
- To predict the products of alpha, beta and gamma decay.
- To differentiate between fission and fusion
- To identify the parts of a nuclear reactor and explain how energy is produced
- To understand radiation safety

Evidence of Understanding

The students will:

- take chapter tests
- take quarterly Assessments
- take quizzes
- perform formal labs
- perform informal labs
- work collaboratively and independently on class work
- give oral presentations using Power Point

- give poster presentations
- read scientific literature

Course Outline			
Unit	Essential Questions	Skills and Understandings	Assessment
Unit 1 **Introduction to Chemistry and Matter**	• What constitutes matter? • How do you differentiate between physical and chemical properties and changes? • Why are units essential when making measurements? • What types of data is collected in science?	• Identify all types of matter and changes it undergoes • use the scientific method and SI units of measurement • Use dimensional analysis to make unit conversions	• Chromatography Lab • Electrolysis of Water Lab • Density Lab • Separation of a Mixture Lab • Chapter Tests (1-2) • Quizzes • Homework
Unit 2 **Organization of Matter**	• How do we know the atom is not the smallest particle? • What is the significance of Avogadro's number? • How do we represent what we cannot see? • How did the periodic table evolve into the one we use today? • Why is this the best order of the elements? • How does the Periodic Table determine the type of bond formed? • How is the state of matter intermolecular interactions?	• Identify the parts of an atom and how they were discovered • Model the atom using the Bohr and Quantum models • Use the periodic table to predict properties of elements • Form covalent and ionic bonds between elements	• Subatomic Particle timeline • Atomic Target Practice activity • Determination of an element by Molar Mass Lab • Molecular Geometry Lab • Chapter Tests (3-6) • Quizzes • Homework
Unit 3 **Language of Chemistry**	• What is the value of having a standardized system for chemical notation? • Why are products formed and what possible products can be formed? • How does the amount of starting material relate to the amount of product formed?	• Name and write formulas for ionic and covalent compounds. • Predict the products of chemical reactions • Predict the amount of product that can be formed from a reaction.	• Formula of a Hydrate Lab • Activity Series Lab • Chapter Tests (7-9) • Quizzes • Homework
Unit 4 **Phases of Matter**	• Why does a real gas behave differently than an ideal gas? • How can the pressure, volume, temperature or number of moles of a gas be determined? • Why do gases diffuse at different rates?	• Explain the behavior of gases using the Kinetic Molecular Theory (KMT) • Identify real and ideal gases using the KMT • Solve for any of the variables in Boyles, Charles, Gay-Lussac, Combined or Ideal gas laws. • Use Graham's Law of Diffusion	• Charles Law Lab • Ideal Gas Law Lab • Chapter 10/11 Test • Quiz • Homework
	• Why are solutions made precisely in known	• Make a solution with a given concentration	• Make molar solutions • pH Lab

Unit 5/6 **Solutions and Their Behavior**	concentrations? • How does temperature, pressure and molecule size affect the solubility of a compound? • How is something classified as an acid or base? What do the pH values mean? • What happens to the equilibrium of a reaction after it is disturbed by adjusting reactants or products?	• Modify the rate of dissolution • Identify a molecule as an acid or base using various theories • Predict the product of an acid base reaction • Calculate pH and pOH of a solution • Predict the shift in a reaction at equilibrium	• Indicator Lab • Acid-Base Test • Quiz • Homework
Unit 7 **Unit 7 (cont.)** **Organic and Nuclear Chemistry**	• Why are some nuclei unstable and what do they decay into? • How long does a sample take to decay? • Where does fusion happen? • How is energy created at a nuclear power plant? • How can we protect ourselves from radiation?	• Identify unstable nuclei and decay rate (half-life) • Predict the products of alpha, beta and gamma decay. • Differentiate between fission and fusion • Identify the parts of a nuclear reactor and explain how energy is produced • Understand radiation safety	• Half-life Lab • Nuclear Chemistry Test • Power Plant Diagram

Chemistry: Academic

Grade Level	10
Course Number	331
Subject Area	Science and Technology

Course Description

This course is a year-long study of the quantitative and descriptive principles of chemistry. Topics include: structure of matter, physical and chemical changes, atomic structure, periodic law, chemical bonding, chemical equations, acid-base theory, and gas laws.

Content Standards

1. Properties of Matter

Central Concept: Physical and chemical properties reflect the nature of the interactions between molecules or atoms, and can be used to classify and describe matter.

1.1 Identify and explain physical properties (e.g., density, melting point, boiling point, conductivity, malleability) and chemical properties (e.g., the ability to form new substances). Distinguish between chemical and physical changes.

1.2 Explain the difference between pure substances (elements and compounds) and mixtures. Differentiate between heterogeneous and homogeneous mixtures.

1.3 Describe the three normal states of matter (solid, liquid, gas) in terms of energy, particle motion, and phase transitions.

2. Atomic Structure and Nuclear Chemistry

Central Concepts: Atomic models are used to explain atoms and help us understand the interaction of elements and compounds observed on a macroscopic scale. Nuclear chemistry deals with radioactivity, nuclear processes, and nuclear properties. Nuclear reactions produce tremendous amounts of energy and lead to the formation of elements.

2.1 Recognize discoveries from Dalton (atomic theory), Thomson (the electron), Rutherford (the nucleus), and Bohr (planetary model of atom), and understand how each discovery leads to modern theory.
2.2 Describe Rutherford's "gold foil" experiment that led to the discovery of the nuclear atom. Identify the major components (protons, neutrons, and electrons) of the nuclear atom and explain how they interact.
2.3 Interpret and apply the laws of conservation of mass, constant composition (definite proportions), and multiple proportions.
2.4 Write the electron configurations for the first twenty elements of the periodic table.
2.5 Identify the three main types of radioactive decay (alpha, beta, and gamma) and compare their properties (composition, mass, charge, and penetrating power).
2.6 Describe the process of radioactive decay by using nuclear equations, and explain the concept of half-life for an isotope (for example, C-14 is a powerful tool in determining the age of objects).
2.7 Compare and contrast nuclear fission and nuclear fusion.

3. Periodicity

Central Concepts: Repeating (periodic) patterns of physical and chemical properties occur among elements that define families with similar properties. The periodic table displays the repeating patterns, which are related to the atoms' outermost electrons.

3.1 Explain the relationship of an element's position on the periodic table to its atomic number. Identify families (groups) and periods on the periodic table.
3.2 Use the periodic table to identify the three classes of elements: metals, nonmetals, and metalloids.
3.3 Relate the position of an element on the periodic table to its electron configuration and compare its reactivity to the reactivity of other elements in the table.
3.4 Identify trends on the periodic table (ionization energy, electronegativity, and relative sizes of atoms and ions).

4. Chemical Bonding

Central Concept: Atoms bond with each other by transferring or sharing valence electrons to form compounds.

4.1 Explain how atoms combine to form compounds through both ionic and covalent bonding. Predict chemical formulas based on the number of valence electrons.
4.2 Draw Lewis dot structures for simple molecules and ionic compounds.
4.3 Use electronegativity to explain the difference between polar and nonpolar covalent bonds.
4.4 Use valence-shell electron-pair repulsion theory (VSEPR) to predict the molecular geometry (linear, trigonal planar, and tetrahedral) of simple molecules.
4.5 Identify how hydrogen bonding in water affects a variety of physical, chemical, and biological phenomena (e.g., surface tension, capillary action, density, boiling point).
4.6 Name and write the chemical formulas for simple ionic and molecular compounds, including those that contain the polyatomic ions: ammonium, carbonate, hydroxide, nitrate, phosphate, and sulfate.

5. Chemical Reactions and Stoichiometry

Central Concepts: In a chemical reaction, one or more reactants are transformed into one or more new products. Chemical equations represent the reaction and must be balanced. The conservation of atoms in a chemical reaction leads to the ability to calculate the amount of products formed and reactants used (stoichiometry).

5.1 Balance chemical equations by applying the laws of conservation of mass and constant composition (definite proportions).
5.2 Classify chemical reactions as synthesis (combination), decomposition, single displacement (replacement), double displacement, and combustion.
5.3 Use the mole concept to determine number of particles and molar mass for elements and compounds.
5.4 Determine percent compositions, empirical formulas, and molecular formulas.
5.5 Calculate the mass-to-mass stoichiometry for a chemical reaction.
5.6 Calculate percent yield in a chemical reaction.

6. States of Matter, Kinetic Molecular Theory, and Thermochemistry

Central Concepts: Gas particles move independently of each other and are far apart. The behavior of gas particles can be

modeled by the kinetic molecular theory. In liquids and solids, unlike gases, particles are close to each other. The driving forces of chemical reactions are energy and entropy. The reorganization of atoms in chemical reactions results in the release or absorption of heat energy.

6.1 Using the kinetic molecular theory, explain the behavior of gases and the relationship between pressure and volume (Boyle's law), volume and temperature (Charles's law), pressure and temperature (Gay-Lussac's law), and the number of particles in a gas sample (Avogadro's hypothesis). Use the combined gas law to determine changes in pressure, volume, and temperature.
6.2 Perform calculations using the ideal gas law. Understand the molar volume at 273 K and 1 atmosphere (STP).
6.3 Using the kinetic molecular theory, describe and contrast the properties of gases, liquids, and solids. Explain, at the molecular level, the behavior of matter as it undergoes phase transitions.
6.4 Describe the law of conservation of energy. Explain the difference between an endothermic process and an exothermic process.
6.5 Recognize that there is a natural tendency for systems to move in a direction of disorder or randomness (entropy).

7. Solutions, Rates of Reaction, and Equilibrium

Central Concepts: Solids, liquids, and gases dissolve to form solutions. Rates of reaction and chemical equilibrium are dynamic processes that are significant in many systems (e.g., biological, ecological, geological).

7.1 Describe the process by which solutes dissolve in solvents.
7.2 Calculate concentration in terms of molarity. Use molarity to perform solution dilution and solution stoichiometry.
7.3 Identify and explain the factors that affect the rate of dissolving (e.g., temperature, concentration, surface area, pressure, mixing).
7.4 Compare and contrast qualitatively the properties of solutions and pure solvents (colligative properties such as boiling point and freezing point).
7.5 Identify the factors that affect the rate of a chemical reaction (temperature, mixing, concentration, particle size, surface area, catalyst).
7.6 Predict the shift in equilibrium when a system is subjected to a stress (LeChatelier's principle) and identify the factors that can cause a shift in equilibrium (concentration, pressure, volume, temperature).

8. Acids and Bases and Oxidation-Reduction Reactions

Central Concepts: Acids and bases are important in numerous chemical processes that occur around us, from industrial procedures to biological ones, from the laboratory to the environment. Oxidation-reduction reactions occur when one substance transfers electrons to another substance, and constitute a major class of chemical reactions.

8.1 Define the Arrhenius theory of acids and bases in terms of the presence of hydronium and hydroxide ions in water and the Bronsted-Lowry theory of acids and bases in terms of proton donors and acceptors.
8.2 Relate hydrogen ion concentrations to the pH scale and to acidic, basic, and neutral solutions. Compare and contrast the strengths of various common acids and bases (e.g., vinegar, baking soda, soap, citrus juice).
8.3 Explain how a buffer works.
8.4 Describe oxidation and reduction reactions and give some everyday examples, such as fuel burning and corrosion. Assign oxidation numbers in a reaction.

Scientific Inquiry Skills Standards

SIS1. Make observations, raise questions, and formulate hypotheses.

- Observe the world from a scientific perspective.
- Pose questions and form hypotheses based on personal observations, scientific articles, experiments, and knowledge.
- Read, interpret, and examine the credibility and validity of scientific claims in different sources of information, such as scientific articles, advertisements, or media stories.

SIS2. Design and conduct scientific investigations.

- Articulate and explain the major concepts being investigated and the purpose of an investigation.
- Select required materials, equipment, and conditions for conducting an experiment.
- Identify independent and dependent variables.
- Write procedures that are clear and replicable.
- Employ appropriate methods for accurately and consistently
    - making observations
    - making and recording measurements at appropriate levels of precision
    - collecting data or evidence in an organized way

- Properly use instruments, equipment, and materials (e.g., scales, probeware, meter sticks, microscopes, computers) including set-up, calibration (if required), technique, maintenance, and storage.
- Follow safety guidelines.

SIS3. Analyze and interpret results of scientific investigations.

- Present relationships between and among variables in appropriate forms.
  - Represent data and relationships between and among variables in charts and graphs.
  - Use appropriate technology (e.g., graphing software) and other tools.
- Use mathematical operations to analyze and interpret data results.
- Assess the reliability of data and identify reasons for inconsistent results, such as sources of error or uncontrolled conditions.
- Use results of an experiment to develop a conclusion to an investigation that addresses the initial questions and supports or refutes the stated hypothesis.
- State questions raised by an experiment that may require further investigation.

SIS4. Communicate and apply the results of scientific investigations.

- Develop descriptions of and explanations for scientific concepts that were a focus of one or more investigations.
- Review information, explain statistical analysis, and summarize data collected and analyzed as the result of an investigation.
- Explain diagrams and charts that represent relationships of variables.
- Construct a reasoned argument and respond appropriately to critical comments and questions.
- Use language and vocabulary appropriately, speak clearly and logically, and use appropriate technology (e.g., presentation software) and other tools to present findings.
- Use and refine scientific models that simulate physical processes or phenomena.

Reading Standards for Literacy in Science

Key Ideas and Details

1. Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.

2. Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text.

3. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text.

Craft and Structure

4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 9–10 texts and topics*.

5. Analyze the structure of the relationships among concepts in a text, including relationships among key terms (e.g., *force*, *friction*, *reaction force*, *energy*).

6. Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, defining the question the author seeks to address.

Integration of Knowledge and Ideas

7. Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.

8. Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem.

9. Compare and contrast findings presented in a text to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts.

Range of Reading and Level of Text Complexity

10. By the end of grade 10, read and comprehend science/technical texts in the grades 9–10 text complexity band independently and proficiently.

Writing Standards

Text Types and Purposes

1. Write arguments focused on *discipline-specific content*.

a. Introduce precise claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that establishes clear relationships among the claim(s), counterclaims, reasons, and evidence.

b. Develop claim(s) and counterclaims fairly, supplying data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form and in a manner that anticipates the audience's knowledge level and concerns. c. Use words, phrases, and clauses to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims. d. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing. e. Provide a concluding statement or section that follows from or supports the argument presented.
2. Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. a. Introduce a topic and organize ideas, concepts, and information to make important connections and distinctions; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension. b. Develop the topic with well-chosen, relevant, and sufficient facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic. c. Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among ideas and concepts. d. Use precise language and domain-specific vocabulary to manage the complexity of the topic and convey a style appropriate to the discipline and context as well as to the expertise of likely readers. e. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing. f. Provide a concluding statement or section that follows from and supports the information or explanation presented (e.g., articulating implications or the significance of the topic).
3. Students' narrative skills continue to grow in these grades. The standards require that students be able to incorporate narrative elements effectively into arguments and informative/explanatory texts. In history/social studies, students must be able to incorporate narrative accounts into their analyses of individuals or events of historical import. In science and technical subjects, students must be able to write precise enough descriptions of the step-by-step procedures they use in their investigations or technical work that others can replicate them and (possibly) reach the same results.
Production and Distribution of Writing
4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
5. Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.
6. Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically.
Research to Build and Present Knowledge
7. Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.
8. Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation.
9. Draw evidence from informational texts to support analysis, reflection, and research.
Range of Writing
10. Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

Essential Questions

- What constitutes matter?
- How do you differentiate between physical and chemical properties and changes?
- Why do scientists use SI units when making measurements?
- What are the relationships between SI units and our current method of measuring objects?
- How do we know that the atom is not the smallest particle?
- What is the currently accepted model of the atom?
- How is the periodic table arranged?

- Why and how do atoms bond?
- How are formulas written for a compound?
- What is the English translation of that chemical formula?
- Why are products formed and what possible products can be formed?
- How does the amount of starting material relate to the amount of product formed?
- Why does a real gas behave differently than an ideal gas?
- How can the pressure, volume, temperature or number of moles of a gas be determined?
- Why do gases diffuse at different rates?
- Why are solutions made precisely in known concentrations?
- How does temperature, pressure and molecule size affect the solubility of a compound?
- How is something classified as an acid or base? What do the pH values mean?
- What happens to the equilibrium of a reaction after it is disturbed by adjusting reactants or products?
- Why some nuclei are unstable and what do they decay into?
- How long does a sample take to decay?
- Where does fusion happen?
- How is energy created at a nuclear power plant?
- How can we protect ourselves from radiation?

Enduring Understandings

Students will learn how:

- To identify all types of matter and changes it undergoes
- To use the scientific method and SI units of measurement
- To use dimensional analysis to make unit conversions
- To identify the parts of an atom and how they were discovered
- To model the atom using the Bohr and Quantum models
- To use the periodic table to predict properties of elements
- To form covalent and ionic bonds between elements
- To name and write formulas for ionic and covalent compounds.
- To predict the products of chemical reactions
- To predict the amount of product that can be formed from a reaction.
- To explain the behavior of gases using the Kinetic Molecular Theory (KMT)
- To identify real and ideal gases using the KMT
- To solve for any of the variables in Boyles, Charles, Gay-Lussac, Combined or Ideal gas laws.
- To use Graham's Law of Diffusion
- To make a solution with a given concentration
- To modify the rate of dissolution
- To identify a molecule as an acid or base using various theories
- To predict the product of an acid base reaction
- To calculate pH and pOH of a solution
- To predict the shift in a reaction at equilibrium
- To identify unstable nuclei and decay rate (half-life)
- To predict the products of alpha, beta and gamma decay.
- To differentiate between fission and fusion
- To identify the parts of a nuclear reactor and explain how energy is produced
- To understand radiation safety

Evidence of Understanding

The students will:

- take chapter tests
- take quarterly Assessments
- take quizzes
- perform formal labs
- perform informal labs
- work collaboratively and independently on class work
- give oral presentations using Power Point

- give poster presentations
- read scientific literature

Course Outline

Unit	Essential Questions	Skills and Understandings	Assessment
Unit 1 **Introduction to Chemistry and Matter**	• What constitutes matter? • How do you differentiate between physical and chemical properties and changes? • Why are units essential when making measurements? • What types of data is collected in science?	• Identify all types of matter and changes it undergoes • use the scientific method and SI units of measurement • Use dimensional analysis to make unit conversions	• Chromatography Lab • Electrolysis of Water Lab • Density Lab • Separation of a Mixture Lab • Chapter Tests (1-2) • Quizzes • Homework
Unit 2 **Organization of Matter**	• How do we know the atom is not the smallest particle? • What is the significance of Avogadro's number? • How do we represent what we cannot see? • How did the periodic table evolve into the one we use today? • Why is this the best order of the elements? • How does the Periodic Table determine the type of bond formed? • How is the state of matter intermolecular interactions?	• Identify the parts of an atom and how they were discovered • Model the atom using the Bohr and Quantum models • Use the periodic table to predict properties of elements • Form covalent and ionic bonds between elements	• Subatomic Particle timeline • Atomic Target Practice activity • Determination of an element by Molar Mass Lab • Molecular Geometry Lab • Chapter Tests (3-6) • Quizzes • Homework
Unit 3 **Language of Chemistry**	• What is the value of having a standardized system for chemical notation? • Why are products formed and what possible products can be formed? • How does the amount of starting material relate to the amount of product formed?	• Name and write formulas for ionic and covalent compounds. • Predict the products of chemical reactions • Predict the amount of product that can be formed from a reaction.	• Formula of a Hydrate Lab • Activity Series Lab • Chapter Tests (7-9) • Quizzes • Homework
Unit 4 **Phases of Matter**	• Why does a real gas behave differently than an ideal gas? • How can the pressure, volume, temperature or number of moles of a gas be determined? • Why do gases diffuse at different rates?	• Explain the behavior of gases using the Kinetic Molecular Theory (KMT) • Identify real and ideal gases using the KMT • Solve for any of the variables in Boyles, Charles, Gay-Lussac, Combined or Ideal gas laws. • Use Graham's Law of Diffusion	• Charles Law Lab • Ideal Gas Law Lab • Chapter 10/11 Test • Quiz • Homework
	• Why are solutions made precisely in known concentrations?	• Make a solution with a given concentration • Modify the rate of	• Make molar solutions • pH Lab

Unit 5/6 **Solutions and Their Behavior**	• How does temperature, pressure and molecule size affect the solubility of a compound? • How is something classified as an acid or base? What do the pH values mean? • What happens to the equilibrium of a reaction after it is disturbed by adjusting reactants or products?	dissolution • Identify a molecule as an acid or base using various theories • Predict the product of an acid base reaction • Calculate pH and pOH of a solution • Predict the shift in a reaction at equilibrium	• Indicator Lab • Acid-Base Test • Quiz • Homework
Unit 7 **Unit 7 (cont.)** **Organic and Nuclear Chemistry**	• Why are some nuclei unstable and what do they decay into? • How long does a sample take to decay? • Where does fusion happen? • How is energy created at a nuclear power plant? • How can we protect ourselves from radiation?	• Identify unstable nuclei and decay rate (half-life) • Predict the products of alpha, beta and gamma decay. • Differentiate between fission and fusion • Identify the parts of a nuclear reactor and explain how energy is produced • Understand radiation safety	• Half-life Lab • Nuclear Chemistry Test • Power Plant Diagram

Advanced Placement Chemistry

Grade Level	11
Course Number	335
Subject Area	Science and Technology

Course Description

This course has been designed to be the equivalent of an introductory chemistry course offered to first year college students. Students will study quantitative and qualitative chemistry in depth. At the completion of this course, students will take the Advanced Placement Exam. Special emphasis will be placed on the five major areas of chemistry covered in the exam: acid-base chemistry, thermodynamics, kinetics, electrochemistry, and ionic reactions.

Content Standards

1. Properties of Matter

Central Concept: Physical and chemical properties reflect the nature of the interactions between molecules or atoms, and can be used to classify and describe matter.

1.1 Identify and explain physical properties (e.g., density, melting point, boiling point, conductivity, malleability) and chemical properties (e.g., the ability to form new substances). Distinguish between chemical and physical changes.

1.2 Explain the difference between pure substances (elements and compounds) and mixtures. Differentiate between heterogeneous and homogeneous mixtures.

1.3 Describe the three normal states of matter (solid, liquid, gas) in terms of energy, particle motion, and phase transitions.

2. Atomic Structure and Nuclear Chemistry

Central Concepts: Atomic models are used to explain atoms and help us understand the interaction of elements and compounds observed on a macroscopic scale. Nuclear chemistry deals with radioactivity, nuclear processes, and nuclear properties. Nuclear reactions produce tremendous amounts of energy and lead to the formation of elements.

2.1 Recognize discoveries from Dalton (atomic theory), Thomson (the electron), Rutherford (the nucleus), and Bohr (planetary model of atom), and understand how each discovery leads to modern theory.
2.2 Describe Rutherford's "gold foil" experiment that led to the discovery of the nuclear atom. Identify the major components (protons, neutrons, and electrons) of the nuclear atom and explain how they interact.
2.3 Interpret and apply the laws of conservation of mass, constant composition (definite proportions), and multiple proportions.
2.4 Write the electron configurations for the first twenty elements of the periodic table.
2.5 Identify the three main types of radioactive decay (alpha, beta, and gamma) and compare their properties (composition, mass, charge, and penetrating power).
2.6 Describe the process of radioactive decay by using nuclear equations, and explain the concept of half-life for an isotope (for example, C-14 is a powerful tool in determining the age of objects).
2.7 Compare and contrast nuclear fission and nuclear fusion.

3. Periodicity

Central Concepts: Repeating (periodic) patterns of physical and chemical properties occur among elements that define families with similar properties. The periodic table displays the repeating patterns, which are related to the atoms' outermost electrons.

3.1 Explain the relationship of an element's position on the periodic table to its atomic number. Identify families (groups) and periods on the periodic table.
3.2 Use the periodic table to identify the three classes of elements: metals, nonmetals, and metalloids.
3.3 Relate the position of an element on the periodic table to its electron configuration and compare its reactivity to the reactivity of other elements in the table.
3.4 Identify trends on the periodic table (ionization energy, electronegativity, and relative sizes of atoms and ions).

4. Chemical Bonding

Central Concept: Atoms bond with each other by transferring or sharing valence electrons to form compounds.

4.1 Explain how atoms combine to form compounds through both ionic and covalent bonding. Predict chemical formulas based on the number of valence electrons.
4.2 Draw Lewis dot structures for simple molecules and ionic compounds.
4.3 Use electronegativity to explain the difference between polar and nonpolar covalent bonds.
4.4 Use valence-shell electron-pair repulsion theory (VSEPR) to predict the molecular geometry (linear, trigonal planar, and tetrahedral) of simple molecules.
4.5 Identify how hydrogen bonding in water affects a variety of physical, chemical, and biological phenomena (e.g., surface tension, capillary action, density, boiling point).
4.6 Name and write the chemical formulas for simple ionic and molecular compounds, including those that contain the polyatomic ions: ammonium, carbonate, hydroxide, nitrate, phosphate, and sulfate.

5. Chemical Reactions and Stoichiometry

Central Concepts: In a chemical reaction, one or more reactants are transformed into one or more new products. Chemical equations represent the reaction and must be balanced. The conservation of atoms in a chemical reaction leads to the ability to calculate the amount of products formed and reactants used (stoichiometry).

5.1 Balance chemical equations by applying the laws of conservation of mass and constant composition (definite proportions).
5.2 Classify chemical reactions as synthesis (combination), decomposition, single displacement (replacement), double displacement, and combustion.
5.3 Use the mole concept to determine number of particles and molar mass for elements and compounds.
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Craft and Structure
4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 9–10 texts and topics*.
5. Analyze the structure of the relationships among concepts in a text, including relationships among key terms (e.g., *force, friction, reaction force, energy*).
6. Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, defining the question the author seeks to address.
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7. Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.
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10. By the end of grade 10, read and comprehend science/technical texts in the grades 9–10 text complexity band independently and proficiently.

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Text Types and Purposes

1. Write arguments focused on *discipline-specific content*.
- a. Introduce precise claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that establishes clear relationships among the claim(s), counterclaims, reasons, and evidence.
- b. Develop claim(s) and counterclaims fairly, supplying data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form and in a manner that anticipates the audience's knowledge level and concerns.
- c. Use words, phrases, and clauses to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims.
- d. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.
- e. Provide a concluding statement or section that follows from or supports the argument presented.

2. Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.
- a. Introduce a topic and organize ideas, concepts, and information to make important connections and distinctions; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.
- b. Develop the topic with well-chosen, relevant, and sufficient facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic.
- c. Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among ideas and concepts.
- d. Use precise language and domain-specific vocabulary to manage the complexity of the topic and convey a style appropriate to the discipline and context as well as to the expertise of likely readers.
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4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

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6. Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically.

Research to Build and Present Knowledge

7. Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

8. Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation.

9. Draw evidence from informational texts to support analysis, reflection, and research.

Range of Writing

10. Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

Essential Questions

- What patterns are seen on the periodic table?
- How do you write and balance the formula for a compound using chemical shorthand?
- How is energy involved in a chemical reaction?
- What are the groups of chemical reactions?
- How strong is a given acid and base?
- What can be done to speed up or slow down a reaction?
- What kinds of elements form ionic bonds versus covalent bonds?
- Why do molecules have specific shapes?
- Why are hybrid orbitals necessary for molecular bonding?
- Can the pressure, volume, temperature, and moles of a gas be determined?
- What is the difference between a force and a bond?
- Why do batteries stop working, and how do rechargeable batteries work?
- Why is there more than one definition for an acid and base?
- Why do systems move toward disorder if energy isn't put into the system?
- How can the movement of electrons generate electricity?
- What type of radioactive decay has the highest level of potential danger?
- What are the most common organic groups, and why are they important?
- What is the relationship between moles and grams in a chemical equation?
- How is equilibrium determined in a chemical equation?

Enduring Understandings

Students will learn how:

- To complete mathematical conversions in order to achieve appropriate units at the end of a problem.
- To follow a standard procedure for creating uniform solutions.
- To describe why the Quantum Mechanical model of the atom most accurately depicts the placement of the electrons in the atom.
- To explain why atoms are more stable with an octet of electrons in the outer energy level.
- To explain why the shape of a molecule can be predicted from its molecular geometry
- To describe how pressure, volume, temperature, and moles of a gas can be determined using the gas laws.
- To read heating curves to predict the melting point and boiling points of substances.
- To draw phase diagrams which illustrate the energy and pressure required for a given substance to change phases.
- To describe why when solute is added to a given solvent the BP is elevated, and the FP is depressed.
- To explain why the driving force of a chemical reaction is energy or enthalpy.
- To describe why chemical equilibrium is a dynamic process that is significant in many systems (biological, ecological, and geological).
- To understand there is more than one definition or theory for acids and bases.
- To study why systems move toward disorder or entropy.
- To understand why in an oxidation-reduction reaction one substance transfers electrons to another substance creating new compounds.
- To study the reasons why nuclear equations need to be balanced in order to obey the law of conservation of mass.
- To classify organic compounds into groups according to their function.

Evidence of Understanding

Twenty-first Century Learning Expectations

Academic Expectations:

1: The student reads actively and critically.

2: The student communicates clearly in speech.

3: The student writes effectively.

4: The student identifies, accesses, and utilizes a variety of resources for obtaining information.

5: The student employs multiple strategies in reasoning and problem solving both independently and collaboratively.

6: The student listens effectively and critically.

7: The student demonstrates knowledge and skills in a variety of forms.

Civic and Social Expectations:

8: The student demonstrates respect and tolerance.

9: The student acts responsibly and displays good citizenship.

The students will:

- participate in discussions
- complete formal laboratory reports
- calculate sample problems
- complete oral presentation on a research project
- take test and quizzes
- complete a research project with an experimental design
- participate in group laboratory investigations

Course Outline

Unit	Essential Questions	Skills and Understandings	Assessment
Electrochemistry Chapter 20	How can the movement of electrons generate electricity?	Identify and balance the oxidation and reduction reactions in a voltaic cell.	Redox lab Electrochemical lab Test Redox reactions and voltaic cells Quizzes Homework
Electronic Structure Chapter 6 Periodic Table Chapter 7	How is the electronic structure related to reactivity?	Identify the electronic structure of ions on the Periodic Table	Spectra lab CA State computer act. Test Ch. 6 & 7 Quizzes Homework
Stoichiometry Chapter 3	What is the relationship between moles and grams in a chemical equation?	Complete stoichiometry calculations.	Stoichiometry Test Gravimetric analysis of a salt lab Quizzes Homework Copper sulfate lab Limiting reagent lab
Gases Chapter 10	How do we deal with gases as mixtures composed of two or more different substances?	Complete molecular effusion and diffusion calculations.	Test on Gas Laws Graham's Law lab Quizzes Homework
Aqueous Reactions and Solution Stoichiometry Chapter 4 Chapter 13, properties of solutions	What is a net ionic equation?	Complete solution stoichiometry calculations.	Reactions and net ionic equations lab Solubility lab Molarity lab Test Chapter 4 & 13 Quizzes Homework

Acids and Bases Chapters 16,17	How strong is a given acid and base?	Outline the three definitions of acids and bases. Complete buffer calculations	pH lab Titration lab Test on acids and bases Quizzes Homework
Kinetics and Equilibrium Chapters 14, 15	What can be done to speed up or slow down a reaction? How is equilibrium determined in a chemical equation?	Complete kinetics and equilibrium calculations.	Kinetics lab Ka weak acid lab Keq lab Test rates and equilibrium Quizzes Homework
Chemical Bonding & Molecular Geometry Chapters 8,9 Intermolecular Forces Chapter 11	What kinds of elements form ionic bonds versus covalent bonds? Why do molecules have specific shapes?	Describe the structure of matter through atomic theory and chemical bonding.	Test on bonding Quizzes Homework Chemical reactions lab Lab on Technique Heating curve lab
Nuclear Chemistry Chapter 21	What type of radioactive decay has the highest level of potential danger?	Complete and balance reactions in nuclear chemistry.	Test Chapter 21 CA State computer act. Quizzes Homework
Organic Chemistry Chapter 25	What are the most common organic groups, and why are they important?	Identify and name the most common organic groups.	Chapter Test Organic groups lab Aspirin lab Quizzes Homework
Thermodynamics Chapters 5,19	How is energy involved in a chemical reaction?	Complete enthalpy, entropy, and Gibb's Free Energy calculations.	Calorimetry lab Reaction rates lab Test Ch. 5 & 19 Quizzes Homework

Physics: Honors

Grade Level	11, 12
Course Number	340
Subject Area	Science and Technology

Course Description

Students will study topics such as motion and forces, conservation of energy and momentum, heat and heat transfer, waves, electromagnetism, and electromagnetic radiation. Students will learn how to solve basic problems involving: vector and scalar quantities, vector addition using law of sines and cosines, velocity, acceleration, forces, component forces on incline planes, momentum, energy (potential, kinetic, and heat), elastic and inelastic collisions, wavelength, frequency, reflection, refraction, Doppler effect, voltage, electric current, and electrical resistance. Students will learn how these topics are applied to everyday situations during the course of study with the aid of laboratory experiments.

Content Standards

1. Motion and Forces

Central Concept: Newton's laws of motion and gravitation describe and predict the motion of most objects.

1.1 Compare and contrast vector quantities (such as, displacement, velocity, acceleration, force, and linear momentum) and scalar quantities (such as, distance, speed, energy, mass, and work).
1.2 Distinguish between displacement, distance, velocity, speed, and acceleration. Solve problems involving displacement, distance, velocity, speed, and constant acceleration.
1.3 Create and interpret graphs of 1-dimensional motion, such as position vs. time, distance vs. time, speed vs. time, velocity vs. time, and acceleration vs. time where acceleration is constant.
1.4 Interpret and apply Newton's three laws of motion.
1.5 Use a free-body force diagram to show forces acting on a system consisting of a pair of interacting objects. For a diagram with only co-linear forces, determine the net force acting on a system and between the objects.
1.6 Distinguish qualitatively between static and kinetic friction, and describe their effects on the motion of objects.
1.7 Describe Newton's law of universal gravitation in terms of the attraction between two objects, their masses, and the distance between them.
1.8 Describe conceptually the forces involved in circular motion.

2. Conservation of Energy and Momentum

Central Concept: The laws of conservation of energy and momentum provide alternate approaches to predict and describe the movement of objects.

2.1 Interpret and provide examples that illustrate the law of conservation of energy.
2.2 Interpret and provide examples of how energy can be converted from gravitational potential energy to kinetic energy and vice versa.
2.3 Describe both qualitatively and quantitatively how work can be expressed as a change in mechanical energy.
2.4 Describe both qualitatively and quantitatively the concept of power as work done per unit time.
2.5 Interpret and provide examples that linear momentum is the product of mass and velocity and is always conserved (law of conservation of momentum). Calculate the momentum of an object.

3. Heat and Heat Transfer

Central Concept: Heat is energy that is transferred by the processes of convection, conduction, and radiation between objects or regions that are at different temperatures.

3.1 Explain how heat energy is transferred by convection, conduction, and radiation.
3.2 Explain how heat energy will move from a higher temperature to a lower temperature until equilibrium is reached.
3.3 Describe the relationship between average molecular kinetic energy and temperature. Recognize that energy is absorbed when a substance changes from a solid to a liquid to a gas, and that energy is released when a substance changes from a gas to a liquid to a solid. Explain the relationships among evaporation, condensation, cooling, and warming.
3.4 Explain the relationships among temperature changes in a substance, the amount of heat transferred, the amount (mass) of the substance, and the specific heat of the substance.

4. Waves

Central Concept: Waves carry energy from place to place without the transfer of matter.

4.1 Describe the measurable properties of waves (velocity, frequency, wavelength, amplitude, and period) and explain the relationships among them. Recognize examples of simple harmonic motion.
4.2 Distinguish between mechanical and electromagnetic waves.
4.3 Distinguish between the two types of mechanical waves, transverse and longitudinal.
4.4 Describe qualitatively the basic principles of reflection and refraction of waves.
4.5 Recognize that mechanical waves generally move faster through a solid than through a liquid and faster through a liquid than through a gas.
4.6 Describe the apparent change in frequency of waves due to the motion of a source or a receiver (the Doppler effect).

5. Electromagnetism

Central Concept: Stationary and moving charged particles result in the phenomena known as electricity and magnetism.

5.1 Recognize that an electric charge tends to be static on insulators and can move on and in conductors, and explain that energy can produce a separation of charges.
5.2 Develop a qualitative and quantitative understanding of current, voltage, resistance, and the connection between them (Ohm's law).
5.3 Analyze simple arrangements of electrical components in both serial and parallel circuits. Recognize symbols and understand the functions of common circuit elements (battery, connecting wire, switch, fuse, and resistance) in a schematic diagram.
5.4 Describe conceptually the attractive or repulsive forces between objects relative to their charges and the distance between them (Coulomb's law).
5.5 Explain how electric current is a flow of charge caused by a potential difference (voltage) and how power is equal to current multiplied by voltage.
5.6 Recognize that moving electric charges produce magnetic forces and moving magnets produce electric forces. Recognize that the interplay of electric and magnetic forces is the basis for electric motors, generators, and other technologies.

6. Electromagnetic Radiation

Central Concept: Oscillating electric or magnetic fields can generate electromagnetic waves over a wide spectrum.

6.1 Recognize that electromagnetic waves are transverse waves and travel at the speed of light through a vacuum.
6.2 Describe the electromagnetic spectrum in terms of frequency and wavelength and identify the location of radio waves, microwaves, infrared radiation, visible light (red, orange, yellow, green, blue, indigo, and violet), ultraviolet rays, x-rays, and gamma rays on the spectrum.

Scientific Inquiry Skills Standards

SIS1. Make observations, raise questions, and formulate hypotheses.

- Observe the world from a scientific perspective.
- Pose questions and form hypotheses based on personal observations, scientific articles, experiments, and knowledge.
- Read, interpret, and examine the credibility and validity of scientific claims in different sources of information, such as scientific articles, advertisements, or media stories.

SIS2. Design and conduct scientific investigations.

- Articulate and explain the major concepts being investigated and the purpose of an investigation.
- Select required materials, equipment, and conditions for conducting an experiment.
- Identify independent and dependent variables.
- Write procedures that are clear and replicable.
- Employ appropriate methods for accurately and consistently
    - making observations
    - making and recording measurements at appropriate levels of precision
    - collecting data or evidence in an organized way
- Properly use instruments, equipment, and materials (e.g., scales, probeware, meter sticks, microscopes, computers) including set-up, calibration (if required), technique, maintenance, and storage.
- Follow safety guidelines.

SIS3. Analyze and interpret results of scientific investigations.

- Present relationships between and among variables in appropriate forms.
    - Represent data and relationships between and among variables in charts and graphs.
    - Use appropriate technology (e.g., graphing software) and other tools.
- Use mathematical operations to analyze and interpret data results.
- Assess the reliability of data and identify reasons for inconsistent results, such as sources of error or uncontrolled conditions.
- Use results of an experiment to develop a conclusion to an investigation that addresses the initial questions and supports or refutes the stated hypothesis.
- State questions raised by an experiment that may require further investigation.

SIS4. Communicate and apply the results of scientific investigations.

- Develop descriptions of and explanations for scientific concepts that were a focus of one or more investigations.

- Review information, explain statistical analysis, and summarize data collected and analyzed as the result of an investigation.
- Explain diagrams and charts that represent relationships of variables.
- Construct a reasoned argument and respond appropriately to critical comments and questions.
- Use language and vocabulary appropriately, speak clearly and logically, and use appropriate technology (e.g., presentation software) and other tools to present findings.
- Use and refine scientific models that simulate physical processes or phenomena.

Reading Standards for Literacy in Science

Key Ideas and Details

1. Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.

2. Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.

3. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.

Craft and Structure

4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 11–12 texts and topics*.

5. Analyze how the text structures information or ideas into categories or hierarchies, demonstrating understanding of the information or ideas.

6. Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, identifying important issues that remain unresolved.

Integration of Knowledge and Ideas

7. Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.

8. Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information.

9. Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.

Range of Reading and Level of Text Complexity

10. By the end of grade 12, read and comprehend science/technical texts in the grades 11–CCR text complexity band independently and proficiently.

Writing Standards

Text Types and Purposes

1. Write arguments focused on *discipline-specific content*.
   a. Introduce precise, knowledgeable claim(s), establish the significance of the claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that logically sequences the claim(s), counterclaims, reasons, and evidence.
   b. Develop claim(s) and counterclaims fairly and thoroughly, supplying the most relevant data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form that anticipates the audience's knowledge level, concerns, values, and possible biases.
   c. Use words, phrases, and clauses as well as varied syntax to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims.
   d. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.
   e. Provide a concluding statement or section that follows from or supports the argument presented.

2. Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.
   a. Introduce a topic and organize complex ideas, concepts, and information so that each new element builds on that which precedes it to create a unified whole; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.
   b. Develop the topic thoroughly by selecting the most significant and relevant facts, extended definitions, concrete

details, quotations, or other information and examples appropriate to the audience's knowledge of the topic.

c. Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among complex ideas and concepts.

d. Use precise language, domain-specific vocabulary and techniques such as metaphor, simile, and analogy to manage the complexity of the topic; convey a knowledgeable stance in a style that responds to the discipline and context as well as to the expertise of likely readers.

e. Provide a concluding statement or section that follows from and supports the information or explanation provided (e.g., articulating implications or the significance of the topic).

3. Students' narrative skills continue to grow in these grades. The standards require that students be able to incorporate narrative elements effectively into arguments and informative/explanatory texts. In history/social studies, students must be able to incorporate narrative accounts into their analyses of individuals or events of historical import. In science and technical subjects, students must be able to write precise enough descriptions of the step-by-step procedures they use in their investigations or technical work that others can replicate them and (possibly) reach the same results.

Production and Distribution of Writing

4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

5. Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.

6. Use technology, including the Internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments or information.

Research to Build and Present Knowledge

7. Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

8. Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation.

9. Draw evidence from informational texts to support analysis, reflection, and research.

Range of Writing

10. Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

Essential Questions

1.) Which metric units (i.e. kilogram, Newton, meter, meters/second) are for scalar measurements and which metric units are for vector measurements?
2.) How can a body that experiences either no motion, or constant velocity, or constant acceleration be described in terms of distance/time, velocity/time and acceleration/time?
3.) How does a body react when a force is applied to it? What if there is friction involved?
4.) What happens to a twirling object (in terms of velocity, force and direction) if the string that restrains the object in a circular motion breaks?
5.) If one object is dropped while another object at the same height is thrown horizontally which object will hit the ground first?
6.) If a force is exerted on an object but the object does not move, has work been performed?
7.) Does a simple machine eliminate work?
8.) If the lifting of an object is performed in half the usual time, does the amount of work required change? Does the amount of power required change?
9.) What happens to the potential energy of a falling object?
10.) What happens to the kinetic energy in an inelastic auto collision?
11.) Which is conserved in all collisions, momentum or kinetic energy?
12.) What are the three ways heat energy can be transferred?
13.) Which direction does heat travel, from a cold to a hot object or from a hot to a cold object?
14.) Temperature is a measure of what type of energy?
15.) If kinetic energy of matter can be measured by molecular movement, how is potential energy stored in matter?
16.) Why are steam burns more damaging than boiling water burns?
17.) If the frequency of light is changed is the velocity of light affected?

18.) Would it be more accurate to start a stopwatch at a track event when a timer sees the smoke from the starting gun or hears the sound of the starting gun?
19.) Does sound travel through outer space?
20.) What is the speed of light (electromagnetic radiation) in a vacuum?
21.) Why is there an image formed on the screen (film) of a camera?
22.) Why does the sun appear larger at sunset?
23.) Will the sound of an approaching train travel faster through the steel rails or through the air?
24.) Why does the horn on an approaching car lower in pitch after it passes?
25.) Are insulators of heat flow good or bad conductors of electricity?
26.) How does a car protect someone from a lightning strike?
27.) What is more dangerous to humans high voltage or high current?
28.) Why are household circuits wired in parallel as opposed to being wired in series?
29.) What is the difference between an electric motor and an electric generator?
30.) What is the speed of light (electromagnetic radiation) in a vacuum?
31.) If the electromagnetic spectrum travels at the same velocity what distinguishes different radiations (i.e. light, x-rays, radio waves)?

Enduring Understandings

Students will learn how:

1.) A scalar quantity is characterized by magnitude only, while a vector quantity is characterized by both magnitude and direction
2.) Vector addition (graphically) – tip-to-tail method; determination of the resultant (magnitude and direction)
3.) Vector addition (x and y components) - determination of the resultant (magnitude and direction) using sine and cosine
4.) The differences between displacement, distance, velocity, speed, and acceleration
5.) Interpret graphs of 1-dimensional motion, such as position vs. time, distance vs. time, speed vs. time, velocity vs. time, and acceleration vs. time where acceleration is constant
6.) Differences between mass (kilograms) and weight (Newtons)
7.) Nature of friction: distinguish between the coefficient of friction and the frictional force
8.) Direction of centripetal force, direction of centripetal acceleration, and the direction of circular velocity – motion of an object after resistance force is removed or exceeded
9.) An object that is dropped or thrown horizontally falls at the same rate and will hit the ground at the same time.
10.) The definition of work in physics is the product of force times distance.
11.) The definition of power is work divided by time.
12.) The total energy of a simple system (i.e. falling object) is the sum of the potential energy and kinetic energy.
13.) The law of conservation of energy – energy is not lost but transformed.
14.) The equation for potential energy = $m \cdot g \cdot h$; the equation for kinetic energy = $\frac{1}{2} \cdot m \cdot v^2$; the equation for momentum = $m \cdot v$.
15.) An impulse (force x time) applied to an object will have an effect on that object's momentum (mass x velocity).
16.) In an elastic collision both kinetic energy and momentum are conserved but in an inelastic collision only momentum is conserved.
17.) Heat energy travels from a hot object to a cold object.
18.) Heat energy transfer by convection involves the use of a fluid.
19.) Heat energy transfer by conduction involves objects that are in contact.
20.) Heat energy transfer by radiation involves electromagnetic waves.
21.) Steam burns are more damaging than boiling water burns due to (potential) energy stored in the phase change.
22.) The frequency of a wave equals the waves per second.
23.) The wavelength of a wave is the length of one complete cycle.
24.) The amplitude of a wave is the maximum displacement as measured from the equilibrium position.
25.) The velocity of a wave equals the frequency (Hz) multiplied by the wavelength (meters).
26.) The velocity of sound is dependent on the medium and the temperature.
27.) Electromagnetic radiation can travel through a vacuum.
28.) Charges are distributed along the surface of an object.
29.) Voltage in volts are work in joules per coulomb of charge.
30.) Current in amperes is the charge in coulombs divided by the time in seconds.
31.) Power equals the voltage multiplied by the current.
32.) Moving charges create magnetic fields.
33.) Forces are exerted on charges moving through magnetic fields.

34.) The velocity of electromagnetic radiation through a vacuum is 3×10^8 meters/second.
35.) When electromagnetic radiation passes from one medium to another its velocity can change.
36.) As light travels from one medium to another its frequency does not change but its wavelength does.
37.) Electromagnetic waves are transverse waves and sound waves are longitudinal waves.

Evidence of Understanding

The students will:

- Complete homework and classwork in a timely manner
- Communicate effectively in class discussions
- Participate in class exercises and demonstrations
- Take regular quizzes on reading material and problem solving
- Conduct experiments with group members
- Work collaboratively in group assignments
- Analyze data in informal and formal laboratory reports
- Write effectively in informal and formal laboratory reports
- Take regular tests on subject material from reading, laboratories and problem solving
- Adhere to NRHS' code of conduct

Course Outline

Unit	Essential Questions	Skills and Understandings	Assessment
Unit 1 **Motion and Forces**	• Which metric units (i.e. kilogram, Newton, meter, meters/second) are for scalar measurements and which metric units are for vector measurements? • How can a body that experiences either no motion, or constant velocity, or constant acceleration be described in terms of distance/time and velocity/time? • How does a body react when a force is applied to it? What if there is friction involved? • What happens to a twirling object (in terms of velocity, force and direction) if the string that restrains the object in a circular motion breaks? • If one object is dropped while another object at the same height is thrown horizontally which object will hit the ground first?	• Describe the nature of science, physics, matter and energy • Identify and use the metric/standard international (SI) system in problem solving and in the laboratory • Use common prefixes such as milli-, centi-, and kilo- • Conversions of SI units • Measure with accuracy and precision • Use scientific notation during addition, subtraction, multiplication, and division • Determine the correct number of significant figures while measuring • Determine the correct number of significant figures when performing addition, subtraction, multiplication, and division • Determine the percent error from experimental and theoretical values • Compare and contrast vector quantities (such as, displacement, velocity, acceleration,	• Chapter Tests: The Science of Physics and Displacement, Velocity and Acceleration; Scalars, Vectors and Projectile Motion; Forces and Friction; Circular Motion and Newton's Law of Universal Gravitation • Quizzes: The Science of Physics; Displacement and Velocity; Graphing Avg. and Inst. Velocity; Displacement, Velocity, and Acceleration ; Scalars and Vectors; Vector Addition at Right Angles; Vector Addition at non-Right Angles. Projectile Motion I; Projectile Motion II; Forces; Friction; Friction and Forces on an Incline; Circular Motion; Newton's Law of Universal Gravitation • Laboratories: Measurement Lab; Velocity and Acceleration; Projectile Motion Lab; Net Force and Friction • Homework Assignments • Classwork Assignments

		force, and linear momentum) and scalar quantities (such as, distance, speed, energy, mass, and work). (C.S. 1.1) • Perform vector addition at non-right angles (graphically) – tip-to-tail method; determination of the resultant (magnitude and direction) • Perform vector addition of more than 2 vectors at non-right angles (x and y components) - determination of the resultant (magnitude and direction) using sine and cosine • Perform vector addition at non-right angles (law of sines and the law of cosines) - determination of the resultant (magnitude and direction) • Distinguish between displacement, distance, velocity, speed, and acceleration. Solve problems involving displacement, distance, velocity, speed, and constant acceleration. (C.S. 1.2) • Create and interpret graphs of 1-dimensional motion, such as position vs. time, distance vs. time, speed vs. time, velocity vs. time, and acceleration vs. time where acceleration is constant. (C.S. 1.3) • Define average velocity and instantaneous velocity • Calculate the average velocity and instantaneous velocity from a graph • Define average acceleration and instantaneous acceleration	• Class participation

		• Calculate the average acceleration and instantaneous acceleration from a graph • Interpret and apply Newton's three laws of motion. (C.S. 1.4) • Use a free-body force diagram to show forces acting on a system consisting of a pair of interacting objects. For a diagram with only co-linear forces, determine the net force acting on a system and between the objects. (C.S. 1.5) • Describe the distance, velocity, and acceleration verses time of an object that experiences a net force • Define weight, normal force and parallel force on level and inclined plane • Resolve forces into components for an object on an inclined plane • Distinguish qualitatively between static and kinetic friction, and describe their effects on the motion of objects. (C.S. 1.6) • Calculate the coefficient of friction in the laboratory • Describe the reasons for differences in coefficients of friction among various materials • Describe Newton's law of universal gravitation in terms of the attraction between two objects, their masses, and the distance between them. (C.S. 1.7) • Determine the mass in kilograms and the weight of laboratory objects in Newtons • Describe how objects move in a curved path	

		• Calculate the velocities, times and distances traveled for objects traveling in a curved path (i.e. objects falling from an airplane or path of a projectile) • Describe conceptually the forces involved in circular motion. (C.S. 1.8)	
Unit 2 Conservation of Energy and Momentum	• If a force is exerted on an object but the object does not move, has work been performed? • Does a simple machine eliminate work? • If the lifting of an object is performed in half the usual time, does the amount of work required change? Does the amount of power required change? • What happens to the potential energy of a falling object? • What happens to the kinetic energy in an inelastic auto collision? • Which is conserved in all collisions, momentum or kinetic energy?	• Define and calculate work in the vertical and horizontal direction • Calculate work performed on a level plane and an incline plane with and without friction • Calculate the work performed on a spring • Define and calculate mechanical advantage, efficiency and power • Describe the theory of a simple machine - mechanical advantage (force multiplier) • Describe uses of a simple machine • Describe ways to improve efficiency of a simple machine • Determine mechanical advantage of a pulley system • Describe both qualitatively and quantitatively the concept of power as work done per unit time. (C.S. 2.4) • Use Excel spreadsheets to calculate formulas • Interpret and provide examples that illustrate the law of conservation of energy. (C.S. 2.1) • Define and calculate the total energy, potential energy and kinetic energy in a system • Interpret and provide examples of how energy can be converted from gravitational potential	• Chapter Tests: Mechanical Energy and Power; Momentum, Impulse and Collisions • Quizzes: Work; Kinetic and Potential Energy; Conservation of Mechanical Energy and Power; Momentum and Impulse; Collisions • Laboratories: Work and Simple Machines; Conservation of Mechanical Energy (student designed); Collisions • Homework Assignments • Classwork Assignments • Class participation

		energy to kinetic energy and vice versa. (C.S. 2.2) • Describe both qualitatively and quantitatively how work can be expressed as a change in mechanical energy (C.S. 2.3) • Describe how elastic (spring) potential energy can be converted into kinetic energy • Interpret and provide examples that linear momentum is the product of mass and velocity and is always conserved (law of conservation of momentum). Calculate the momentum of an object. (C.S. 2.5) • Calculate the impulse and determine the velocity and momentum of an object that experiences an impulse • Differentiate between elastic and inelastic collisions • Calculate the final velocities of objects involved in elastic and inelastic collisions	
Unit 3 **Heat and Heat Transfer**	• What are the three ways heat energy can be transferred? • Which direction does heat travel, from a cold to a hot object or from a hot to a cold object? • Temperature is a measure of what type of energy? • If kinetic energy of matter can be measured by molecular movement, how is potential energy stored in matter? • Why are steam burns more damaging than boiling water burns?	• Explain how heat energy is transferred by convection, conduction, and/or radiation. (C.S. 3.1) • Explain how heat energy will move from a higher temperature to a lower temperature until equilibrium is reached. (C.S. 3.2) • Describe the relationship between average molecular kinetic energy and temperature. Recognize that energy is absorbed when a substance changes from a solid to a liquid to a gas, and that energy is released	• Chapter Tests: Heat Energy • Quizzes: Heat Energy • Laboratories: Specific Heat; Heat of Fusion • Homework Assignments • Classwork Assignments • Class participation

		when a substance changes from a gas to a liquid to a solid. Explain the relationships between evaporation, condensation, cooling, and warming. (C.S. 3.3) • Explain the relationship among temperature change in a substance for a given amount of heat transferred, the amount (mass) of the substance, and the specific heat of the substance. (C.S. 3.4) • Calculate the amount of heat energy necessary to raise the temperature of a specific material (using specific heats). • Calculate the amount of energy to change a specific material from a solid to a liquid or liquid to a vapor (using heat of fusions and heat of vaporizations).	
Unit 4 **Waves**	• If the frequency of light is changed is the velocity of light affected? • Would it be more accurate to start a stopwatch at a track event when a timer sees the smoke from the starting gun or hears the sound of the starting gun? • Does sound travel through outer space? • What is the speed of light (electromagnetic radiation) in a vacuum? • Why is there an image formed on the screen (film) of a camera? • Why does the sun appear larger at sunset? • Will the sound of an approaching train travel faster through the steel rails or through the air? • Why does the horn on an approaching car lower in pitch after it passes?	• Describe the measurable properties of waves (velocity, frequency, wavelength, amplitude, and period) and explain the relationships among them. Recognize examples of simple harmonic motion (C.S. 4.1). • Solve for the velocity of a wave (mechanical, electromagnetic, and sound) given frequency and wavelength. • Distinguish between mechanical and electromagnetic waves (C.S. 4.2). • Define and solve for the velocity of electromagnetic radiation and the velocity of sound. • Distinguish between the two types of mechanical waves, transverse and longitudinal (C.S. 4.3).	• Chapter Tests: Mechanical and Electromagnetic Waves • Quizzes: Waves • Laboratories: Ripple Tanks • Homework Assignments • Classwork Assignments • Class participation

		• Describe qualitatively the basic principles of reflection and refraction of waves (C.S. 4.4). • Describe qualitatively the basic principles of diffraction. • Recognize that mechanical waves generally move faster through a solid than through a liquid and faster through a liquid than through a gas (C.S. 4.5). • Describe the fundamental mode (first harmonic) and the second harmonic as well as describing their wavelengths respectively. • Describe the apparent change in frequency of waves due to the motion of a source or a receiver (the Doppler effect) (C.S. 4.6).	
Unit 5 Electromagnetism	• Are insulators of heat flow good or bad conductors of electricity? • How does a car protect someone from a lightning strike? • What is more dangerous to humans high voltage or high current? • Why are household circuits wired in parallel as opposed to being wired in series? • What is the difference between an electric motor and an electric generator?	• Recognize that an electric charge tends to be static on insulators and can move on and in conductors, and explain that energy can produce a separation of charges (C.S. 5.1). • Develop a qualitative and quantitative understanding of current, voltage, resistance, and the connection between them (Ohm's law) (C.S. 5.2). • Analyze simple arrangements of electrical components in both serial and parallel circuits. Recognize symbols and understand the functions of common circuit elements (battery, connecting wire, switch, fuse, and resistance) in a schematic diagram (C.S.	• Chapter Tests: Electromagnetism • Quizzes: Electromagnetism • Laboratories: Voltage and Current • Homework Assignments • Classwork Assignments • Class participation

		5.3). • Describe conceptually the attractive or repulsive forces between objects relative to their charges and the distance between them (Coulomb's law) (C.S. 5.4). • Explain how electric current is a flow of charge caused by a potential difference (voltage) and how power is equal to current multiplied by voltage (C.S. 5.5). • Recognize that moving electric charges produce magnetic forces and moving magnets produce electric forces. Recognize that the interplay of electric and magnetic forces is the basis for electric motors, generators, and other technologies (C.S. 5.6).	
Unit 6 Electromagnetic Radiation	• What is the speed of light (electromagnetic radiation) in a vacuum? • If the electromagnetic spectrum travels at the same velocity what distinguishes different radiations (i.e. light, x-rays, radio waves)?	• Recognize that electromagnetic waves are transverse waves and travel at the speed of light through a vacuum (C.S. 6.1). • Calculate distances based on the velocity of electromagnetic waves and time. • Describe the electromagnetic spectrum in terms of frequency and wavelength and identify the location of radio waves, microwaves, infrared radiation, visible light (red, orange, yellow, green, blue, indigo, and violet), ultraviolet rays, x-rays, and gamma rays on the spectrum (C.S. 6.2). • Solve for the velocity of electromagnetic radiation in a medium using frequency and wavelength.	• Chapter Tests: Mechanical and Electromagnetic Waves • Quizzes: Waves • Homework Assignments • Classwork Assignments • Class participation

Physics: Academic

Grade Level	11, 12
Course Number	341
Subject Area	Science and Technology

Course Description

Students will study topics such as motion and forces, conservation of energy and momentum, heat and heat transfer, waves, electromagnetism, and electromagnetic radiation. Students will learn how to solve basic problems involving: vector and scalar quantities, velocity, acceleration, forces, component forces, momentum, energy (potential, kinetic, and heat), elastic and inelastic collisions, wavelength, frequency, reflection, refraction, Doppler effect, voltage, electric current, and electrical resistance. Students will learn how these topics are applied to everyday situations during the course of study with the aid of laboratory experiments.

Content Standards

1. Motion and Forces

Central Concept: Newton's laws of motion and gravitation describe and predict the motion of most objects.

1.9 Compare and contrast vector quantities (such as, displacement, velocity, acceleration, force, and linear momentum) and scalar quantities (such as, distance, speed, energy, mass, and work).
1.10 Distinguish between displacement, distance, velocity, speed, and acceleration. Solve problems involving displacement, distance, velocity, speed, and constant acceleration.
1.11 Create and interpret graphs of 1-dimensional motion, such as position vs. time, distance vs. time, speed vs. time, velocity vs. time, and acceleration vs. time where acceleration is constant.
1.12 Interpret and apply Newton's three laws of motion.
1.13 Use a free-body force diagram to show forces acting on a system consisting of a pair of interacting objects. For a diagram with only co-linear forces, determine the net force acting on a system and between the objects.
1.14 Distinguish qualitatively between static and kinetic friction, and describe their effects on the motion of objects.
1.15 Describe Newton's law of universal gravitation in terms of the attraction between two objects, their masses, and the distance between them.
1.16 Describe conceptually the forces involved in circular motion.

2. Conservation of Energy and Momentum

Central Concept: The laws of conservation of energy and momentum provide alternate approaches to predict and describe the movement of objects.

2.6 Interpret and provide examples that illustrate the law of conservation of energy.
2.7 Interpret and provide examples of how energy can be converted from gravitational potential energy to kinetic energy and vice versa.
2.8 Describe both qualitatively and quantitatively how work can be expressed as a change in mechanical energy.
2.9 Describe both qualitatively and quantitatively the concept of power as work done per unit time.
2.10 Interpret and provide examples that linear momentum is the product of mass and velocity and is always conserved (law of conservation of momentum). Calculate the momentum of an object.

3. Heat and Heat Transfer

Central Concept: Heat is energy that is transferred by the processes of convection, conduction, and radiation between objects or regions that are at different temperatures.

3.2 Explain how heat energy is transferred by convection, conduction, and radiation.
3.2 Explain how heat energy will move from a higher temperature to a lower temperature until equilibrium is reached.
3.3 Describe the relationship between average molecular kinetic energy and temperature. Recognize that energy is absorbed when a substance changes from a solid to a liquid to a gas, and that energy is released when a substance changes from a gas to a liquid to a solid. Explain the relationships among evaporation, condensation, cooling, and warming.
3.4 Explain the relationships among temperature changes in a substance, the amount of heat transferred, the amount (mass) of the substance, and the specific heat of the substance.

4. Waves

Central Concept: Waves carry energy from place to place without the transfer of matter.

4.7 Describe the measurable properties of waves (velocity, frequency, wavelength, amplitude, and period) and explain the relationships among them. Recognize examples of simple harmonic motion.
4.8 Distinguish between mechanical and electromagnetic waves.
4.9 Distinguish between the two types of mechanical waves, transverse and longitudinal.
4.10 Describe qualitatively the basic principles of reflection and refraction of waves.
4.11 Recognize that mechanical waves generally move faster through a solid than through a liquid and faster through a liquid than through a gas.
4.12 Describe the apparent change in frequency of waves due to the motion of a source or a receiver (the Doppler effect).

5. Electromagnetism

Central Concept: Stationary and moving charged particles result in the phenomena known as electricity and magnetism.

5.7 Recognize that an electric charge tends to be static on insulators and can move on and in conductors, and explain that energy can produce a separation of charges.
5.8 Develop a qualitative and quantitative understanding of current, voltage, resistance, and the connection between them (Ohm's law).
5.9 Analyze simple arrangements of electrical components in both serial and parallel circuits. Recognize symbols and understand the functions of common circuit elements (battery, connecting wire, switch, fuse, and resistance) in a schematic diagram.
5.10 Describe conceptually the attractive or repulsive forces between objects relative to their charges and the distance between them (Coulomb's law).
5.11 Explain how electric current is a flow of charge caused by a potential difference (voltage) and how power is equal to current multiplied by voltage.
5.12 Recognize that moving electric charges produce magnetic forces and moving magnets produce electric forces. Recognize that the interplay of electric and magnetic forces is the basis for electric motors, generators, and other technologies.

6. Electromagnetic Radiation

Central Concept: Oscillating electric or magnetic fields can generate electromagnetic waves over a wide spectrum.

6.3 Recognize that electromagnetic waves are transverse waves and travel at the speed of light through a vacuum.
6.4 Describe the electromagnetic spectrum in terms of frequency and wavelength and identify the location of radio waves, microwaves, infrared radiation, visible light (red, orange, yellow, green, blue, indigo, and violet), ultraviolet rays, x-rays, and gamma rays on the spectrum.

Scientific Inquiry Skills Standards

SIS1. Make observations, raise questions, and formulate hypotheses.

- Observe the world from a scientific perspective.
- Pose questions and form hypotheses based on personal observations, scientific articles, experiments, and knowledge.
- Read, interpret, and examine the credibility and validity of scientific claims in different sources of information, such as scientific articles, advertisements, or media stories.

SIS2. Design and conduct scientific investigations.

- Articulate and explain the major concepts being investigated and the purpose of an investigation.

- Select required materials, equipment, and conditions for conducting an experiment.
- Identify independent and dependent variables.
- Write procedures that are clear and replicable.
- Employ appropriate methods for accurately and consistently
    - making observations
    - making and recording measurements at appropriate levels of precision
    - collecting data or evidence in an organized way
- Properly use instruments, equipment, and materials (e.g., scales, probeware, meter sticks, microscopes, computers) including set-up, calibration (if required), technique, maintenance, and storage.
- Follow safety guidelines.

SIS3. Analyze and interpret results of scientific investigations.

- Present relationships between and among variables in appropriate forms.
    - Represent data and relationships between and among variables in charts and graphs.
    - Use appropriate technology (e.g., graphing software) and other tools.
- Use mathematical operations to analyze and interpret data results.
- Assess the reliability of data and identify reasons for inconsistent results, such as sources of error or uncontrolled conditions.
- Use results of an experiment to develop a conclusion to an investigation that addresses the initial questions and supports or refutes the stated hypothesis.
- State questions raised by an experiment that may require further investigation.

SIS4. Communicate and apply the results of scientific investigations.

- Develop descriptions of and explanations for scientific concepts that were a focus of one or more investigations.
- Review information, explain statistical analysis, and summarize data collected and analyzed as the result of an investigation.
- Explain diagrams and charts that represent relationships of variables.
- Construct a reasoned argument and respond appropriately to critical comments and questions.
- Use language and vocabulary appropriately, speak clearly and logically, and use appropriate technology (e.g., presentation software) and other tools to present findings.
- Use and refine scientific models that simulate physical processes or phenomena.

Reading Standards for Literacy in Science
Key Ideas and Details
1. Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.
2. Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.
3. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.
Craft and Structure
4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 11–12 texts and topics*.
5. Analyze how the text structures information or ideas into categories or hierarchies, demonstrating understanding of the information or ideas.
6. Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, identifying important issues that remain unresolved.
Integration of Knowledge and Ideas
7. Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.
8. Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information.
9. Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.

Range of Reading and Level of Text Complexity
10. By the end of grade 12, read and comprehend science/technical texts in the grades 11–CCR text complexity band independently and proficiently.
Writing Standards
Text Types and Purposes
1. Write arguments focused on *discipline-specific content*. a. Introduce precise, knowledgeable claim(s), establish the significance of the claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that logically sequences the claim(s), counterclaims, reasons, and evidence. b. Develop claim(s) and counterclaims fairly and thoroughly, supplying the most relevant data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form that anticipates the audience's knowledge level, concerns, values, and possible biases. c. Use words, phrases, and clauses as well as varied syntax to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims. d. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing. e. Provide a concluding statement or section that follows from or supports the argument presented.
2. Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. a. Introduce a topic and organize complex ideas, concepts, and information so that each new element builds on that which precedes it to create a unified whole; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension. b. Develop the topic thoroughly by selecting the most significant and relevant facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic. c. Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among complex ideas and concepts. d. Use precise language, domain-specific vocabulary and techniques such as metaphor, simile, and analogy to manage the complexity of the topic; convey a knowledgeable stance in a style that responds to the discipline and context as well as to the expertise of likely readers. e. Provide a concluding statement or section that follows from and supports the information or explanation provided (e.g., articulating implications or the significance of the topic).
3. Students' narrative skills continue to grow in these grades. The standards require that students be able to incorporate narrative elements effectively into arguments and informative/explanatory texts. In history/social studies, students must be able to incorporate narrative accounts into their analyses of individuals or events of historical import. In science and technical subjects, students must be able to write precise enough descriptions of the step-by-step procedures they use in their investigations or technical work that others can replicate them and (possibly) reach the same results.
Production and Distribution of Writing
4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
5. Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.
6. Use technology, including the Internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments or information.
Research to Build and Present Knowledge
7. Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.
8. Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation.
9. Draw evidence from informational texts to support analysis, reflection, and research.
Range of Writing
10. Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a

day or two) for a range of discipline-specific tasks, purposes, and audiences.

Essential Questions

32.) Which metric units (i.e. kilogram, Newton, meter, meters/second) are for scalar measurements and which metric units are for vector measurements?
33.) How can a body that experiences either no motion, or constant velocity, or constant acceleration be described in terms of distance/time, velocity/time and acceleration/time?
34.) How does a body react when a force is applied to it? What if there is friction involved?
35.) What happens to a twirling object (in terms of velocity, force and direction) if the string that restrains the object in a circular motion breaks?
36.) If one object is dropped while another object at the same height is thrown horizontally which object will hit the ground first?
37.) If a force is exerted on an object but the object does not move, has work been performed?
38.) Does a simple machine eliminate work?
39.) If the lifting of an object is performed in half the usual time, does the amount of work required change? Does the amount of power required change?
40.) What happens to the potential energy of a falling object?
41.) What happens to the kinetic energy in an inelastic auto collision?
42.) Which is conserved in all collisions, momentum or kinetic energy?
43.) What are the three ways heat energy can be transferred?
44.) Which direction does heat travel, from a cold to a hot object or from a hot to a cold object?
45.) Temperature is a measure of what type of energy?
46.) If kinetic energy of matter can be measured by molecular movement, how is potential energy stored in matter?
47.) Why are steam burns more damaging than boiling water burns?
48.) If the frequency of light is changed is the velocity of light affected?
49.) Would it be more accurate to start a stopwatch at a track event when a timer sees the smoke from the starting gun or hears the sound of the starting gun?
50.) Does sound travel through outer space?
51.) What is the speed of light (electromagnetic radiation) in a vacuum?
52.) Why is there an image formed on the screen (film) of a camera?
53.) Why does the sun appear larger at sunset?
54.) Will the sound of an approaching train travel faster through the steel rails or through the air?
55.) Why does the horn on an approaching car lower in pitch after it passes?
56.) Are insulators of heat flow good or bad conductors of electricity?
57.) How does a car protect someone from a lightning strike?
58.) What is more dangerous to humans high voltage or high current?
59.) Why are household circuits wired in parallel as opposed to being wired in series?
60.) What is the difference between an electric motor and an electric generator?
61.) What is the speed of light (electromagnetic radiation) in a vacuum?
62.) If the electromagnetic spectrum travels at the same velocity what distinguishes different radiations (i.e. light, x-rays, radio waves)?

Enduring Understandings

Students will learn how:

38.) A scalar quantity is characterized by magnitude only, while a vector quantity is characterized by both magnitude and direction
39.) Vector addition (graphically) – tip-to-tail method; determination of the resultant (magnitude and direction)
40.) Vector addition (x and y components) - determination of the resultant (magnitude and direction) using sine and cosine
41.) The differences between displacement, distance, velocity, speed, and acceleration
42.) Interpret graphs of 1-dimensional motion, such as position vs. time, distance vs. time, speed vs. time, velocity vs. time, and acceleration vs. time where acceleration is constant
43.) Differences between mass (kilograms) and weight (Newtons)
44.) Nature of friction: distinguish between the coefficient of friction and the frictional force
45.) Direction of centripetal force, direction of centripetal acceleration, and the direction of circular velocity – motion of an object after resistance force is removed or exceeded
46.) An object that is dropped or thrown horizontally falls at the same rate and will hit the ground at the same time.
47.) The definition of work in physics is the product of force times distance.

48.) The definition of power is work divided by time.
49.) The total energy of a simple system (i.e. falling object) is the sum of the potential energy and kinetic energy.
50.) The law of conservation of energy – energy is not lost but transformed.
51.) The equation for potential energy = $m \cdot g \cdot h$; the equation for kinetic energy = $\frac{1}{2} \cdot m \cdot v^2$; the equation for momentum = $m \cdot v$.
52.) An impulse (force x time) applied to an object will have an effect on that object's momentum (mass x velocity).
53.) In an elastic collision both kinetic energy and momentum are conserved but in an inelastic collision only momentum is conserved.
54.) Heat energy travels from a hot object to a cold object.
55.) Heat energy transfer by convection involves the use of a fluid.
56.) Heat energy transfer by conduction involves objects that are in contact.
57.) Heat energy transfer by radiation involves electromagnetic waves.
58.) Steam burns are more damaging than boiling water burns due to (potential) energy stored in the phase change.
59.) The frequency of a wave equals the waves per second.
60.) The wavelength of a wave is the length of one complete cycle.
61.) The amplitude of a wave is the maximum displacement as measured from the equilibrium position.
62.) The velocity of a wave equals the frequency (Hz) multiplied by the wavelength (meters).
63.) The velocity of sound is dependent on the medium and the temperature.
64.) Electromagnetic radiation can travel through a vacuum.
65.) Charges are distributed along the surface of an object.
66.) Voltage in volts are work in joules per coulomb of charge.
67.) Current in amperes is the charge in coulombs divided by the time in seconds.
68.) Power equals the voltage multiplied by the current.
69.) Moving charges create magnetic fields.
70.) Forces are exerted on charges moving through magnetic fields.
71.) The velocity of electromagnetic radiation through a vacuum is 3×10^8 meters/second.
72.) When electromagnetic radiation passes from one medium to another its velocity can change.
73.) As light travels from one medium to another its frequency does not change but its wavelength does.
74.) Electromagnetic waves are transverse waves and sound waves are longitudinal waves.

Evidence of Understanding

The students will:

- Complete homework and classwork in a timely manner
- Communicate effectively in class discussions
- Participate in class exercises and demonstrations
- Take regular quizzes on reading material and problem solving
- Conduct experiments with group members
- Work collaboratively in group assignments
- Analyze data in informal and formal laboratory reports
- Write effectively in informal and formal laboratory reports
- Take regular tests on subject material from reading, laboratories and problem solving
- Adhere to NRHS' code of conduct

Course Outline

Unit	Essential Questions	Skills and Understandings	Assessment
Unit 1 **Motion and Forces**	• Which metric units (i.e. kilogram, Newton, meter, meters/second) are for scalar measurements and which metric units are for vector measurements? • How can a body that experiences either no motion, or constant velocity, or constant acceleration be	• Describe the nature of science, physics, matter and energy • Identify and use the metric/standard international (SI) system in problem solving and in the laboratory • Use common prefixes such as milli-, centi-,	• Chapter Tests: The Science of Physics and Displacement, Velocity and Acceleration; Scalars, Vectors and Projectile Motion; Forces and Friction; Circular Motion and Newton's Law of Universal Gravitation

	described in terms of distance/time and velocity/time? • How does a body react when a force is applied to it? What if there is friction involved? • What happens to a twirling object (in terms of velocity, force and direction) if the string that restrains the object in a circular motion breaks? • If one object is dropped while another object at the same height is thrown horizontally which object will hit the ground first?	and kilo- • Conversions of SI units • Measure with accuracy and precision • Use scientific notation during addition, subtraction, multiplication, and division • Determine the correct number of significant figures while measuring • Determine the correct number of significant figures when performing addition, subtraction, multiplication, and division • Determine the percent error from experimental and theoretical values • Compare and contrast vector quantities (such as, displacement, velocity, acceleration, force, and linear momentum) and scalar quantities (such as, distance, speed, energy, mass, and work). (C.S. 1.1) • Perform vector addition at non-right angles (graphically) – tip-to-tail method; determination of the resultant (magnitude and direction) • Perform vector addition of more than 2 vectors at non-right angles (x and y components) - determination of the resultant (magnitude and direction) using sine and cosine • Distinguish between displacement, distance, velocity, speed, and acceleration. Solve problems involving displacement, distance, velocity, speed, and constant acceleration. (C.S. 1.2) • Create and interpret graphs of 1-dimensional	• Quizzes: The Science of Physics; Displacement and Velocity; Graphing Avg. and Inst. Velocity; Displacement, Velocity, and Acceleration ; Scalars and Vectors; Vector Addition at Right Angles; Vector Addition at non-Right Angles. Projectile Motion I; Projectile Motion II; Forces; Friction; Friction and Forces on an Incline; Circular Motion; Newton's Law of Universal Gravitation • Laboratories: Measurement Lab; Velocity and Acceleration; Projectile Motion Lab; Net Force and Friction • Homework Assignments • Classwork Assignments • Class participation

		motion, such as position vs. time, distance vs. time, speed vs. time, velocity vs. time, and acceleration vs. time where acceleration is constant. (C.S. 1.3) • Define average velocity and instantaneous velocity • Calculate the average velocity and instantaneous velocity from a graph • Define average acceleration and instantaneous acceleration • Calculate the average acceleration and instantaneous acceleration from a graph • Interpret and apply Newton's three laws of motion. (C.S. 1.4) • Use a free-body force diagram to show forces acting on a system consisting of a pair of interacting objects. For a diagram with only co-linear forces, determine the net force acting on a system and between the objects. (C.S. 1.5) • Describe the distance, velocity, and acceleration verses time of an object that experiences a net force • Define weight, normal force and parallel force on a level plane • Distinguish qualitatively between static and kinetic friction, and describe their effects on the motion of objects. (C.S. 1.6) • Calculate the coefficient of friction in the laboratory • Describe the reasons for differences in coefficients of friction among various materials	

		• Describe Newton's law of universal gravitation in terms of the attraction between two objects, their masses, and the distance between them. (C.S. 1.7) • Determine the mass in kilograms and the weight of laboratory objects in Newtons • Describe how objects move in a curved path • Calculate the velocities, times and distances traveled for objects traveling in a curved path (i.e. objects falling from an airplane or path of a projectile) • Describe conceptually the forces involved in circular motion. (C.S. 1.8)	
Unit 2 Conservation of Energy and Momentum	• If a force is exerted on an object but the object does not move, has work been performed? • Does a simple machine eliminate work? • If the lifting of an object is performed in half the usual time, does the amount of work required change? Does the amount of power required change? • What happens to the potential energy of a falling object? • What happens to the kinetic energy in an inelastic auto collision? • Which is conserved in all collisions, momentum or kinetic energy?	• Define and calculate work in the vertical and horizontal direction • Calculate work performed on a level plane and an incline plane with and without friction • Calculate the work performed on a spring • Define and calculate mechanical advantage, efficiency and power • Describe the theory of a simple machine - mechanical advantage (force multiplier) • Describe uses of a simple machine • Describe ways to improve efficiency of a simple machine • Determine mechanical advantage of a pulley system • Describe both qualitatively and quantitatively the concept of power as work done per unit time. (C.S. 2.4) • Use Excel spreadsheets	• Chapter Tests: Mechanical Energy and Power; Momentum, Impulse and Collisions • Quizzes: Work; Kinetic and Potential Energy; Conservation of Mechanical Energy and Power; Momentum and Impulse; Collisions • Laboratories: Work and Simple Machines; Conservation of Mechanical Energy (student designed); Collisions • Homework Assignments • Classwork Assignments • Class participation

		to calculate formulas • Interpret and provide examples that illustrate the law of conservation of energy. (C.S. 2.1) • Define and calculate the total energy, potential energy and kinetic energy in a system • Interpret and provide examples of how energy can be converted from gravitational potential energy to kinetic energy and vice versa. (C.S. 2.2) • Describe both qualitatively and quantitatively how work can be expressed as a change in mechanical energy (C.S. 2.3) • Describe how elastic (spring) potential energy can be converted into kinetic energy • Interpret and provide examples that linear momentum is the product of mass and velocity and is always conserved (law of conservation of momentum). Calculate the momentum of an object. (C.S. 2.5) • Calculate the impulse and determine the velocity and momentum of an object that experiences an impulse • Differentiate between elastic and inelastic collisions • Calculate the final velocities of objects involved in elastic and inelastic collisions	
Unit 3 **Heat and Heat Transfer**	• What are the three ways heat energy can be transferred? • Which direction does heat travel, from a cold to a hot object or from a hot to a cold object? • Temperature is a measure of what type of energy?	• Explain how heat energy is transferred by convection, conduction, and/or radiation. (C.S. 3.1) • Explain how heat energy will move from a higher temperature to a lower	• Chapter Tests: Heat Energy • Quizzes: Heat Energy • Laboratories: Specific Heat; Heat of Fusion • Homework Assignments • Classwork Assignments • Class participation

	• If kinetic energy of matter can be measured by molecular movement, how is potential energy stored in matter? • Why are steam burns more damaging than boiling water burns?	temperature until equilibrium is reached. (C.S. 3.2) • Describe the relationship between average molecular kinetic energy and temperature. Recognize that energy is absorbed when a substance changes from a solid to a liquid to a gas, and that energy is released when a substance changes from a gas to a liquid to a solid. Explain the relationships between evaporation, condensation, cooling, and warming. (C.S. 3.3) • Explain the relationship among temperature change in a substance for a given amount of heat transferred, the amount (mass) of the substance, and the specific heat of the substance. (C.S. 3.4) • Calculate the amount of heat energy necessary to raise the temperature of a specific material (using specific heats). • Calculate the amount of energy to change a specific material from a solid to a liquid or liquid to a vapor (using heat of fusions and heat of vaporizations).	
Unit 4 **Waves**	• If the frequency of light is changed is the velocity of light affected? • Would it be more accurate to start a stopwatch at a track event when a timer sees the smoke from the starting gun or hears the sound of the starting gun? • Does sound travel through outer space? • What is the speed of light (electromagnetic radiation) in a vacuum? • Why is there an image	• Describe the measurable properties of waves (velocity, frequency, wavelength, amplitude, and period) and explain the relationships among them. Recognize examples of simple harmonic motion (C.S. 4.1). • Solve for the velocity of a wave (mechanical, electromagnetic, and sound) given frequency and wavelength. • Distinguish between	• Chapter Tests: Mechanical and Electromagnetic Waves • Quizzes: Waves • Laboratories: Ripple Tanks • Homework Assignments • Classwork Assignments • Class participation

	formed on the screen (film) of a camera? • Why does the sun appear larger at sunset? • Will the sound of an approaching train travel faster through the steel rails or through the air? • Why does the horn on an approaching car lower in pitch after it passes?	mechanical and electromagnetic waves (C.S. 4.2). • Define and solve for the velocity of electromagnetic radiation and the velocity of sound. • Distinguish between the two types of mechanical waves, transverse and longitudinal (C.S. 4.3). • Describe qualitatively the basic principles of reflection and refraction of waves (C.S. 4.4). • Describe qualitatively the basic principles of diffraction. • Recognize that mechanical waves generally move faster through a solid than through a liquid and faster through a liquid than through a gas (C.S. 4.5). • Describe the fundamental mode (first harmonic) and the second harmonic as well as describing their wavelengths respectively. • Describe the apparent change in frequency of waves due to the motion of a source or a receiver (the Doppler effect) (C.S. 4.6).	
Unit 5 Electromagnetism	• Are insulators of heat flow good or bad conductors of electricity? • How does a car protect someone from a lightning strike? • What is more dangerous to humans high voltage or high current? • Why are household circuits wired in parallel as opposed to being wired in series? • What is the difference between an electric motor and an electric generator?	• Recognize that an electric charge tends to be static on insulators and can move on and in conductors, and explain that energy can produce a separation of charges (C.S. 5.1). • Develop a qualitative and quantitative understanding of current, voltage, resistance, and the connection between them (Ohm's law) (C.S. 5.2).	• Chapter Tests: Electromagnetism • Quizzes: Electromagnetism • Laboratories: Voltage and Current • Homework Assignments • Classwork Assignments • Class participation

		• Analyze simple arrangements of electrical components in both serial and parallel circuits. Recognize symbols and understand the functions of common circuit elements (battery, connecting wire, switch, fuse, and resistance) in a schematic diagram (C.S. 5.3). • Describe conceptually the attractive or repulsive forces between objects relative to their charges and the distance between them (Coulomb's law) (C.S. 5.4). • Explain how electric current is a flow of charge caused by a potential difference (voltage) and how power is equal to current multiplied by voltage (C.S. 5.5). • Recognize that moving electric charges produce magnetic forces and moving magnets produce electric forces. Recognize that the interplay of electric and magnetic forces is the basis for electric motors, generators, and other technologies (C.S. 5.6).	
Unit 6 Electromagnetic Radiation	• What is the speed of light (electromagnetic radiation) in a vacuum? • If the electromagnetic spectrum travels at the same velocity what distinguishes different radiations (i.e. light, x-rays, radio waves)?	• Recognize that electromagnetic waves are transverse waves and travel at the speed of light through a vacuum (C.S. 6.1). • Calculate distances based on the velocity of electromagnetic waves and time. • Describe the electromagnetic spectrum in terms of frequency and wavelength and identify the location of radio waves, microwaves,	• Chapter Tests: Mechanical and Electromagnetic Waves • Quizzes: Waves • Homework Assignments • Classwork Assignments • Class participation

		infrared radiation, visible light (red, orange, yellow, green, blue, indigo, and violet), ultraviolet rays, x-rays, and gamma rays on the spectrum (C.S. 6.2). • Solve for the velocity of electromagnetic radiation in a medium using frequency and wavelength.	

Advanced Placement Physics

Grade Level	11, 12
Course Number	345
Subject Area	Science and Technology

Course Description

This course is designed to be the equivalent of a college introductory Physics course offered to first year college students. Topics of study include Newtonian mechanics, fluid mechanics and thermal physics, electricity and magnetism, waves and optics, atomic and nuclear physics. The course is designed to reflect the academic expectations and rigor of a college-level course as delineated by the College Board. Summer assignments are required to be completed.

At the completion of this course, it is expected that the student will take the Advanced Placement Exam. Students are expected to take a more proactive role in preparation for class, labs, tests and the AP Exam. Completion and comprehension of assignments are a necessity for success in this class and on the AP Exam.

Content Standards

1. Newtonian Mechanics

- Understand the general relationships among position, velocity, and acceleration for the motion of a particle along a straight line, so that
- Understand the special case of motion with constant acceleration
- Add, subtract, and resolve displacement and velocity vectors
- Understand the motion of projectiles in a uniform gravitational field
- Analyze situations in which a particle remains at rest, or moves with constant velocity, under the influence of several forces
- Understand the relation between the force that acts on a object and the resulting change in the object's velocity
- Understand how Newton's Second Law, F = ma, applies to a body subject to forces such as gravity, the pull of strings, or contact forces
- Analyze situations in which an object moves with specified acceleration under the influence of
- one or more forces so they can determine the magnitude and direction of the net force, etc.
- Understand the significance of the coefficient of friction so they can:
- Understand the effect of drag forces on the motion of an object, so they can:
- Understand Newton's Third Law so that, for a given force, they can identify the force pairs and the objects on which they act, and state the magnitude and direction of each force
- Apply Newton's Third Law in analyzing the force of contact between two objects that accelerate together along a horizontal or vertical line, or between two surfaces that slide across one another

- Know that the tension is constant in a light string that passes over a massless pulley and should be able to use this fact in analyzing the motion of a system of two bodies joined by a string
- Solve problems in which application of Newton's Laws leads to two or three simultaneous linear equations involving unknown forces or accelerations
- Understand the concepts of mechanical energy and of total energy
- Understand conservation of energy
- Understand the definition of power
- Understand the definition of work, including when it is positive, negative, or zero
- Understand and be able to apply the work-energy theorem
- Understand the concept of potential energy
- Understand conservation of energy
- Understand the definition of power
- Understand impulse and linear momentum
- Understand linear momentum conservation
- Understand the uniform circular motion of a particle
- Understand angular momentum conservation
- Know Newton's Law of Universal Gravitation
- Understand the motion of a body in orbit under the influence of gravitational forces
- Understand the concept of torque
- Analyze problems in statics
- Understand the analogy between translational and rotational

2. Fluid Mechanics and Thermal Physics

- Understand that a fluid exerts pressure in all directions
- Understand that a fluid at rest exerts pressure perpendicular to any surface that it contacts
- Understand and be able to use the relationship between pressure and depth in a liquid
- Understand that the difference in the pressure on the upper and lower surfaces of an object immersed in liquid results in an upward force on the object
- Understand and be able to apply Archimedes' principle: the buoyant force on a submersed object is equal to the weight of the liquid it displaces
- Understand that for laminar flow, the flow rate of a liquid through its cross section is the same at any point along its path.
- Understand and be able to apply the equation continuity
- Understand that the pressure of a flowing liquid is low where the velocity is high and vice versa
- Understand and be able to apply Bernoulli's equation
- Understand heat transfer and thermal expansion
- Understand the kinetic theory model of an ideal gas
- Understand the "mechanical equivalent of heat"
- Understand the concepts of specific heat, heat of fusion, and heat of vaporization
- Apply the ideal gas law and thermodynamic principles
- Apply the first law of thermodynamics
- Understand the second law of thermodynamics, the concept of entropy, and heat engines and the Carnot cycle

3. Electricity and Magnetism

- Understand the concept of electric field
- Understand the nature of electric fields in and around conductors
- Describe and sketch a graph of the electric field and potential inside and outside a charged conducting sphere
- Understand induced charge and electrostatic shielding
- Understand Coulomb's Law and the principle of superposition
- Know the potential function for a point charge
- Know the definition of capacitance so they can relate stored charge and voltage for a capacitor
- Understand energy storage in capacitors
- Understand the physics of the parallel-plate capacitor
- Understand the behavior of dielectrics
- Describe how the insertion of a dielectric between the plates of a charged parallel-plate capacitor affects its capacitance

and the field strength and voltage between the plates.
- Understand the definition of electric current so they can relate the magnitude and direction of the current in a wire or ionized medium to the rate of flow of positive and negative charge
- Understand conductivity, resistivity, and resistance
- Understand the behavior of series and parallel combinations of resistors
- Understand the properties of ideal and real batteries
- Understand the properties of voltmeters and ammeters
- Understand the force experienced by a charged particle in a magnetic field
- Understand the force experienced by a current in a magnetic field
- Understand the magnetic field produced by a long straight current-carrying wire
- Understand the concept of magnetic flux
- Understand Faraday's Law and Lenz's Law

4. Waves and Optics

- Understand the kinematics of simple harmonic motion
- Apply their knowledge of simple harmonic motion to the case of a mass on a spring
- Apply their knowledge of simple harmonic motion to the case of a pendulum
- Understand the description of traveling waves
- Understand the physics of standing waves
- Understand the Doppler effect for sound
- Understand the principle of superposition so they apply it to traveling waves moving in opposite directions
- Describe how a standing wave may be formed by superposition.
- Understand the interference and diffraction of waves
- Apply the principles of interference to coherent sources oscillating in phase
- Apply the principles of interference and diffraction to waves that pass through a diffraction grating
- Apply the principles of interference to light reflected by thin films
- Understand dispersion and the electromagnetic spectrum
- Understand the transverse nature of light waves
- Understand the inverse-square law
- Understand the principles of reflection and refraction
- Understand image formation by plane or spherical mirrors
- Understand image formation by converging or diverging lenses

Atomic and Nuclear Physics

- Describe the Rutherford scattering experiment and to explain how it provides evidence for the existence of the atomic nucleus
- Know the properties of photons and understand the photoelectric effect
- Understand the concept of energy levels for atoms
- Understand the concept of DeBroglie wavelength
- Understand the nature and production of x-ray
- Understand Compton scattering
- Understand the significance of half-life in radioactive decay
- Understand the significance of the mass number and charge of nuclei
- Know the nature of the nuclear force
- Understand nuclear fission
- Understand the relationship between mass and energy

Scientific Inquiry Skills Standards

SIS1. Make observations, raise questions, and formulate hypotheses.

- Observe the world from a scientific perspective.
- Pose questions and form hypotheses based on personal observations, scientific articles, experiments, and knowledge.
- Read, interpret, and examine the credibility and validity of scientific claims in different sources of information, such

as scientific articles, advertisements, or media stories.

SIS2. Design and conduct scientific investigations.

- Articulate and explain the major concepts being investigated and the purpose of an investigation.
- Select required materials, equipment, and conditions for conducting an experiment.
- Identify independent and dependent variables.
- Write procedures that are clear and replicable.
- Employ appropriate methods for accurately and consistently
  - making observations
  - making and recording measurements at appropriate levels of precision
  - collecting data or evidence in an organized way
- Properly use instruments, equipment, and materials (e.g., scales, probeware, meter sticks, microscopes, computers) including set-up, calibration (if required), technique, maintenance, and storage.
- Follow safety guidelines.

SIS3. Analyze and interpret results of scientific investigations.

- Present relationships between and among variables in appropriate forms.
  - Represent data and relationships between and among variables in charts and graphs.
  - Use appropriate technology (e.g., graphing software) and other tools.
- Use mathematical operations to analyze and interpret data results.
- Assess the reliability of data and identify reasons for inconsistent results, such as sources of error or uncontrolled conditions.
- Use results of an experiment to develop a conclusion to an investigation that addresses the initial questions and supports or refutes the stated hypothesis.
- State questions raised by an experiment that may require further investigation.

SIS4. Communicate and apply the results of scientific investigations.

- Develop descriptions of and explanations for scientific concepts that were a focus of one or more investigations.
- Review information, explain statistical analysis, and summarize data collected and analyzed as the result of an investigation.
- Explain diagrams and charts that represent relationships of variables.
- Construct a reasoned argument and respond appropriately to critical comments and questions.
- Use language and vocabulary appropriately, speak clearly and logically, and use appropriate technology (e.g., presentation software) and other tools to present findings.
- Use and refine scientific models that simulate physical processes or phenomena.

Reading Standards for Literacy in Science

Key Ideas and Details

1. Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.

2. Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.

3. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.

Craft and Structure

4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 11–12 texts and topics*.

5. Analyze how the text structures information or ideas into categories or hierarchies, demonstrating understanding of the information or ideas.

6. Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, identifying important issues that remain unresolved.

Integration of Knowledge and Ideas

7. Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.

8. Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information.

9. Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.

Range of Reading and Level of Text Complexity

10. By the end of grade 12, read and comprehend science/technical texts in the grades 11–CCR text complexity band independently and proficiently.

Writing Standards

Text Types and Purposes

1. Write arguments focused on *discipline-specific content*.
   a. Introduce precise, knowledgeable claim(s), establish the significance of the claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that logically sequences the claim(s), counterclaims, reasons, and evidence.
   b. Develop claim(s) and counterclaims fairly and thoroughly, supplying the most relevant data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form that anticipates the audience's knowledge level, concerns, values, and possible biases.
   c. Use words, phrases, and clauses as well as varied syntax to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims.
   d. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.
   e. Provide a concluding statement or section that follows from or supports the argument presented.

2. Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.
   a. Introduce a topic and organize complex ideas, concepts, and information so that each new element builds on that which precedes it to create a unified whole; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.
   b. Develop the topic thoroughly by selecting the most significant and relevant facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic.
   c. Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among complex ideas and concepts.
   d. Use precise language, domain-specific vocabulary and techniques such as metaphor, simile, and analogy to manage the complexity of the topic; convey a knowledgeable stance in a style that responds to the discipline and context as well as to the expertise of likely readers.
   e. Provide a concluding statement or section that follows from and supports the information or explanation provided (e.g., articulating implications or the significance of the topic).

3. Students' narrative skills continue to grow in these grades. The standards require that students be able to incorporate narrative elements effectively into arguments and informative/explanatory texts. In history/social studies, students must be able to incorporate narrative accounts into their analyses of individuals or events of historical import. In science and technical subjects, students must be able to write precise enough descriptions of the step-by-step procedures they use in their investigations or technical work that others can replicate them and (possibly) reach the same results.

Production and Distribution of Writing

4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

5. Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.

6. Use technology, including the Internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments or information.

Research to Build and Present Knowledge

7. Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

8. Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source

and following a standard format for citation.

9. Draw evidence from informational texts to support analysis, reflection, and research.

Range of Writing

10. Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

Essential Questions

63.) Which metric units (i.e. kilogram, Newton, meter, meters/second) are for scalar measurements and which metric units are for vector measurements?
64.) How can a body that experiences either no motion, or constant velocity, or constant acceleration be described in terms of distance/time, velocity/time and acceleration/time?
65.) How does a body react when a force is applied to it? What if there is friction involved?
66.) What happens to a twirling object (in terms of velocity, force and direction) if the string that restrains the object in a circular motion breaks?
67.) If one object is dropped while another object at the same height is thrown horizontally which object will hit the ground first?
68.) If a force is exerted on an object but the object does not move, has work been performed?
69.) Does a simple machine eliminate work?
70.) If the lifting of an object is performed in half the usual time, does the amount of work required change? Does the amount of power required change?
71.) What happens to the potential energy of a falling object?
72.) What happens to the kinetic energy in an inelastic auto collision?
73.) Which is conserved in all collisions, momentum or kinetic energy?
74.) What are the three ways heat energy can be transferred?
75.) Which direction does heat travel, from a cold to a hot object or from a hot to a cold object?
76.) Temperature is a measure of what type of energy?
77.) If kinetic energy of matter can be measured by molecular movement, how is potential energy stored in matter?
78.) Why are steam burns more damaging than boiling water burns?
79.) If the frequency of light is changed is the velocity of light affected?
80.) Would it be more accurate to start a stopwatch at a track event when a timer sees the smoke from the starting gun or hears the sound of the starting gun?
81.) Does sound travel through outer space?
82.) What is the speed of light (electromagnetic radiation) in a vacuum?
83.) Why is there an image formed on the screen (film) of a camera?
84.) Why does the sun appear larger at sunset?
85.) Will the sound of an approaching train travel faster through the steel rails or through the air?
86.) Why does the horn of an approaching car lower in pitch after it passes?
87.) How does the double slit experiment illustrate the wave theory and particle theory of light?
88.) Are insulators of heat flow good or bad conductors of electricity?
89.) How does a car protect someone from a lightning strike?
90.) What is more dangerous to humans high voltage or high current?
91.) Why are household circuits wired in parallel as opposed to being wired in series?
92.) What is the difference between an electric motor and an electric generator?
93.) What is the speed of light (electromagnetic radiation) in a vacuum?
94.) If the electromagnetic spectrum travels at the same velocity what distinguishes different radiations (i.e. light, x-rays, radio waves)?
95.) How come electrons are emitted from an atom only when a certain threshold frequency of a photon is reached?
96.) What is the theory that matter can travel in waves?
97.) In a nuclear reaction what must be conserved?

Enduring Understandings

Students will learn how:

75.) A scalar quantity is characterized by magnitude only, while a vector quantity is characterized by both magnitude and direction
76.) Vector addition (graphically) – tip-to-tail method; determination of the resultant (magnitude and direction)
77.) Vector addition (x and y components) - determination of the resultant (magnitude and direction) using sine and cosine
78.) The differences between displacement, distance, velocity, speed, and acceleration

79.) Interpret graphs of 1-dimensional motion, such as position vs. time, distance vs. time, speed vs. time, velocity vs. time, and acceleration vs. time where acceleration is constant
80.) Differences between mass (kilograms) and weight (Newtons)
81.) Nature of friction: distinguish between the coefficient of friction and the frictional force
82.) Direction of centripetal force, direction of centripetal acceleration, and the direction of circular velocity – motion of an object after resistance force is removed or exceeded
83.) An object that is dropped or thrown horizontally falls at the same rate and will hit the ground at the same time.
84.) The definition of work in physics is the product of force times distance.
85.) The definition of power is work divided by time.
86.) The total energy of a simple system (i.e. falling object) is the sum of the potential energy and kinetic energy.
87.) The law of conservation of energy – energy is not lost but transformed.
88.) The equation for potential energy = $m \cdot g \cdot h$; the equation for kinetic energy = $\frac{1}{2} \cdot m \cdot v^2$; the equation for momentum = $m \cdot v$.
89.) An impulse (force x time) applied to an object will have an effect on that object's momentum (mass x velocity).
90.) In an elastic collision both kinetic energy and momentum are conserved but in an inelastic collision only momentum is conserved.
91.) Heat energy travels from a hot object to a cold object.
92.) Heat energy transfer by convection involves the use of a fluid.
93.) Heat energy transfer by conduction involves objects that are in contact.
94.) Heat energy transfer by radiation involves electromagnetic waves.
95.) Steam burns are more damaging than boiling water burns due to (potential) energy stored in the phase change.
96.) The frequency of a wave equals the waves per second.
97.) The wavelength of a wave is the length of one complete cycle.
98.) The amplitude of a wave is the maximum displacement as measured from the equilibrium position.
99.) The velocity of a wave equals the frequency (Hz) multiplied by the wavelength (meters).
100.) The energy of a wave is dependent on frequency and amplitude.
101.) The velocity of sound is dependent on the medium and the temperature.
102.) Electromagnetic radiation can travel through a vacuum.
103.) Charges are distributed along the surface of an object.
104.) Voltage in volts are work in joules per coulomb of charge.
105.) Current in amperes is the charge in coulombs divided by the time in seconds.
106.) Power equals the voltage multiplied by the current.
107.) Moving charges create magnetic fields.
108.) Forces are exerted on charges moving through magnetic fields.
109.) The velocity of electromagnetic radiation through a vacuum is 3×10^8 meters/second.
110.) When electromagnetic radiation passes from one medium to another its velocity can change.
111.) As light travels from one medium to another its frequency does not change but its wavelength does.
112.) Electromagnetic waves are transverse waves and sound waves are longitudinal waves.
113.) Light exhibits properties of a wave and properties of a particle.
114.) Understand the differences among reflection, refraction and diffraction.
115.) Mirrors instead of lenses are used in high power telescopes because of the reduction in aberrations.
116.) Emission spectrum of elements results from energy levels in atoms.
117.) Electrons exhibit wave properties.

Evidence of Understanding

The students will:

- Complete homework and classwork in a timely manner
- Communicate effectively in class discussions
- Participate in class exercises and demonstrations
- Take regular quizzes on reading material and problem solving
- Conduct experiments with group members
- Work collaboratively in group assignments
- Analyze data in informal and formal laboratory reports
- Write effectively in informal and formal laboratory reports
- Take regular tests on subject material from reading, laboratories and problem solving
- Adhere to NRHS' code of conduct

Course Outline			
Unit	Essential Questions	Skills and Understandings	Assessment
Unit 1 **Newtonian Mechanics**	• Which metric units (i.e. kilogram, Newton, meter, meters/second) are for scalar measurements and which metric units are for vector measurements? • How can a body that experiences either no motion, or constant velocity, or constant acceleration be described in terms of distance/time and velocity/time? • How does a body react when a force is applied to it? What if there is friction involved? • What happens to a twirling object (in terms of velocity, force and direction) if the string that restrains the object in a circular motion breaks? • If one object is dropped while another object at the same height is thrown horizontally which object will hit the ground first? • If a force is exerted on an object but the object does not move, has work been performed? • Does a simple machine eliminate work? • If the lifting of an object is performed in half the usual time, does the amount of work required change? Does the amount of power required change? • What happens to the potential energy of a falling object? • What happens to the kinetic energy in an inelastic auto collision? • Which is conserved in all collisions, momentum or kinetic energy?	• Describe the nature of science, physics, matter and energy • Identify and use the metric/standard international (SI) system in problem solving and in the laboratory • Use common prefixes such as milli-, centi-, and kilo- • Conversions of SI units • Measure with accuracy and precision • Use scientific notation during addition, subtraction, multiplication, and division • Determine the correct number of significant figures while measuring • Determine the correct number of significant figures when performing addition, subtraction, multiplication, and division • Determine the percent error from experimental and theoretical values • Compare and contrast vector quantities (such as, displacement, velocity, acceleration, force, and linear momentum) and scalar quantities (such as, distance, speed, energy, mass, and work). (C.S. 1.1) • Perform vector addition at non-right angles (graphically) – tip-to-tail method; determination of the resultant (magnitude and direction) • Perform vector addition of more than 2 vectors at non-right angles (x and y components) - determination of the resultant (magnitude and direction) using sine and	• Chapter Tests: Motion, Vectors and Forces; Energy, Momentum and Collisions; Rotational Motion, Law of Gravity and Rotational Dynamics • Chapter Quizzes • Laboratories: Coffee Filters and Air Resistance; Elastic Collisions; Circular Motion (Mythbusters 360 degree Swing); Whirlygig • Homework Assignments • Classwork Assignments • Class participation

		cosine • Perform vector addition at non-right angles (law of sines and the law of cosines) - determination of the resultant (magnitude and direction) • Distinguish between displacement, distance, velocity, speed, and acceleration. Solve problems involving displacement, distance, velocity, speed, and constant acceleration. (C.S. 1.2) • Create and interpret graphs of 1-dimensional motion, such as position vs. time, distance vs. time, speed vs. time, velocity vs. time, and acceleration vs. time where acceleration is constant. (C.S. 1.3) • Define average velocity and instantaneous velocity • Calculate the average velocity and instantaneous velocity from a graph • Define average acceleration and instantaneous acceleration • Calculate the average acceleration and instantaneous acceleration from a graph • Interpret and apply Newton's three laws of motion. (C.S. 1.4) • Use a free-body force diagram to show forces acting on a system consisting of a pair of interacting objects. For a diagram with only co-linear forces, determine the net force acting on a system and between the objects. (C.S. 1.5) • Describe the distance, velocity, and	

		acceleration verses time of an object that experiences a net force • Define weight, normal force and parallel force on level and inclined plane • Resolve forces into components for an object on an inclined plane • Distinguish qualitatively between static and kinetic friction, and describe their effects on the motion of objects. (C.S. 1.6) • Calculate the coefficient of friction in the laboratory • Describe the reasons for differences in coefficients of friction among various materials • Describe Newton's law of universal gravitation in terms of the attraction between two objects, their masses, and the distance between them. (C.S. 1.7) • Determine the mass in kilograms and the weight of laboratory objects in Newtons • Describe how objects move in a curved path • Calculate the velocities, times and distances traveled for objects traveling in a curved path (i.e. objects falling from an airplane or path of a projectile) • Describe conceptually the forces involved in circular motion. (C.S. 1.8) • Define and calculate work in the vertical and horizontal direction • Calculate work performed on a level plane and an incline plane with and without friction • Calculate the work	

		performed on a spring • Define and calculate mechanical advantage, efficiency and power • Describe the theory of a simple machine - mechanical advantage (force multiplier) • Describe uses of a simple machine • Describe ways to improve efficiency of a simple machine • Determine mechanical advantage of a pulley system • Describe both qualitatively and quantitatively the concept of power as work done per unit time. (C.S. 2.4) • Use Excel spreadsheets to calculate formulas • Interpret and provide examples that illustrate the law of conservation of energy. (C.S. 2.1) • Define and calculate the total energy, potential energy and kinetic energy in a system • Interpret and provide examples of how energy can be converted from gravitational potential energy to kinetic energy and vice versa. (C.S. 2.2) • Describe both qualitatively and quantitatively how work can be expressed as a change in mechanical energy (C.S. 2.3) • Describe how elastic (spring) potential energy can be converted into kinetic energy • Interpret and provide examples that linear momentum is the product of mass and velocity and is always conserved (law of conservation of momentum). Calculate	

		the momentum of an object. (C.S. 2.5) • Calculate the impulse and determine the velocity and momentum of an object that experiences an impulse • Differentiate between elastic and inelastic collisions • Calculate the final velocities of objects involved in elastic and inelastic collisions	
Unit 2 **Fluid Mechanics and Thermal Physics**	• What are the three ways heat energy can be transferred? • Which direction does heat travel, from a cold to a hot object or from a hot to a cold object? • Temperature is a measure of what type of energy? • If kinetic energy of matter can be measured by molecular movement, how is potential energy stored in matter? • Why are steam burns more damaging than boiling water burns?	• Explain how heat energy is transferred by convection, conduction, and/or radiation. (C.S. 3.1) • Explain how heat energy will move from a higher temperature to a lower temperature until equilibrium is reached. (C.S. 3.2) • Describe the relationship between average molecular kinetic energy and temperature. Recognize that energy is absorbed when a substance changes from a solid to a liquid to a gas, and that energy is released when a substance changes from a gas to a liquid to a solid. Explain the relationships between evaporation, condensation, cooling, and warming. (C.S. 3.3) • Explain the relationship among temperature change in a substance for a given amount of heat transferred, the amount (mass) of the substance, and the specific heat of the substance. (C.S. 3.4) • Calculate the amount of heat energy necessary to raise the temperature of a specific material (using specific heats).	• Chapter Tests: Solids and Fluids, Thermal Physics and Heat Energy; Laws of Thermodyanmics • Chapter Quizzes • Homework Assignments • Classwork Assignments • Class participation

		• Calculate the amount of energy to change a specific material from a solid to a liquid or liquid to a vapor (using heat of fusions and heat of vaporizations).	
Unit 3 **Waves and Optics**	• If the frequency of light is changed is the velocity of light affected? • Would it be more accurate to start a stopwatch at a track event when a timer sees the smoke from the starting gun or hears the sound of the starting gun? • Does sound travel through outer space? • What is the speed of light (electromagnetic radiation) in a vacuum? • Why is there an image formed on the screen (film) of a camera? • Why does the sun appear larger at sunset? • Will the sound of an approaching train travel faster through the steel rails or through the air? • Why does the horn on an approaching car lower in pitch after it passes?	• Describe the measurable properties of waves (velocity, frequency, wavelength, amplitude, and period) and explain the relationships among them. Recognize examples of simple harmonic motion (C.S. 4.1). • Solve for the velocity of a wave (mechanical, electromagnetic, and sound) given frequency and wavelength. • Distinguish between mechanical and electromagnetic waves (C.S. 4.2). • Define and solve for the velocity of electromagnetic radiation and the velocity of sound. • Distinguish between the two types of mechanical waves, transverse and longitudinal (C.S. 4.3). • Describe qualitatively the basic principles of reflection and refraction of waves (C.S. 4.4). • Describe qualitatively the basic principles of diffraction. • Recognize that mechanical waves generally move faster through a solid than through a liquid and faster through a liquid than through a gas (C.S. 4.5). • Describe the fundamental mode (first harmonic) and the second harmonic as well as describing their wavelengths	• Chapter Tests: Vibrations, Waves and Sound; Reflection and Refraction, and Geometrical Optics • Chapter Quizzes • Laboratories: Hooke's Law and Harmonic Motion; Geometrical Optics • Homework Assignments • Classwork Assignments • Class participation

		respectively. • Describe the apparent change in frequency of waves due to the motion of a source or a receiver (the Doppler effect) (C.S. 4.6). • Recognize that electromagnetic waves are transverse waves and travel at the speed of light through a vacuum (C.S. 6.1). • Calculate distances based on the velocity of electromagnetic waves and time. • Describe the electromagnetic spectrum in terms of frequency and wavelength and identify the location of radio waves, microwaves, infrared radiation, visible light (red, orange, yellow, green, blue, indigo, and violet), ultraviolet rays, x-rays, and gamma rays on the spectrum (C.S. 6.2). • Solve for the velocity of electromagnetic radiation in a medium using frequency and wavelength.	
Unit 4 **Electricity and Magnetism**	• Are insulators of heat flow good or bad conductors of electricity? • How does a car protect someone from a lightning strike? • What is more dangerous to humans high voltage or high current? • Why are household circuits wired in parallel as opposed to being wired in series? • What is the difference between an electric motor and an electric generator?	• Recognize that an electric charge tends to be static on insulators and can move on and in conductors, and explain that energy can produce a separation of charges (C.S. 5.1). • Develop a qualitative and quantitative understanding of current, voltage, resistance, and the connection between them (Ohm's law) (C.S. 5.2). • Analyze simple arrangements of electrical components in both serial and parallel	• Chapter Tests: Electric Forces, Capacitance, Current and Resistance; Magnetism, Induced Currents and Voltages • Chapter Quizzes • Laboratories: Parallel Plate Capacitors; Ohm's Law; Magnetism • Homework Assignments • Classwork Assignments • Class participation

		circuits. Recognize symbols and understand the functions of common circuit elements (battery, connecting wire, switch, fuse, and resistance) in a schematic diagram (C.S. 5.3). • Describe conceptually the attractive or repulsive forces between objects relative to their charges and the distance between them (Coulomb's law) (C.S. 5.4). • Explain how electric current is a flow of charge caused by a potential difference (voltage) and how power is equal to current multiplied by voltage (C.S. 5.5). • Recognize that moving electric charges produce magnetic forces and moving magnets produce electric forces. Recognize that the interplay of electric and magnetic forces is the basis for electric motors, generators, and other technologies (C.S. 5.6).	
Unit 5 **Atomic and Nuclear Physics**	• What is the speed of light (electromagnetic radiation) in a vacuum? • If the electromagnetic spectrum travels at the same velocity what distinguishes different radiations (i.e. light, x-rays, radio waves)?	• Relate the energy of a photon in joules or electron-volts to its wavelength or frequency • Relate the linear momentum of a photon to its energy or wavelength, and apply linear momentum to simple processes involving emission, absorption, or reflection of photons • Calculate the number of photons per second emitted by a monochromatic source • Describe a typical photoelectric effect experiment and explain observations	• Chapter Tests: Quantum, Atomic and Nuclear Physics • Chapter Quizzes • Homework Assignments • Classwork Assignments • Class participation

		• Describe qualitatively how the number of photoelectrons and their max KE depend on wavelength and intensity • When given the max KE of photoelectrons, determine max KE of photoelectrons for a different photon energy of wavelength • Sketch or identify a graph of stopping potential versus frequency • Calculate the energy or wavelength of the photon emitted or absorbed in a transitions between specified levels, or the energy or wavelength required to ionize an atom • Explain qualitatively the origin of emission of absorption spectra of gases • Given wavelengths or energies of photons emitted or absorbed in a two-step transition, calculate the wavelength or energy for a single-step transition • Write an expression for the energy levels of hydrogen in terms of ground-state energy, draw a diagram • State the assumption and conclusions for the Bohr model for the hydrogen atom • Calculate the wavelength of a particle as a function of its momentum • Describe the Cavisson-Germer experiment • Describe Compton's experiment, and state what resulted • Account qualitatively for the increase of photon wavelength that is observed, and explain	

		the significance of the Compton wavelength • Recognize that half-life is independent of the number of nuclei present or of external conditions • Sketch or identify a graph to indicate what fraction of a radioactive sample remains • Determine for an isotope of specified half-life, what fraction of the nuclei have decayed after a given time • Interpret symbols of nuclei that indicate these quantities • Use conservation of mass number and charge to complete nuclear reactions • Determine the mass number and charge of a nucleus after it has undergone specified decay processes • Describe the process of alpha, beta and gamma decay and write a reaction describe each • Explain why the existence of the neutrino had to be postulated in order to reconcile experimental data from beta decay • Qualitatively relate the energy released in nuclear processes to the change in mass • Apply the relationship $E = mc^2$ in analyzing nuclear processes	

Advanced Placement Environmental Science	
Grade Level	11, 12
Course Number	347
Subject Area	Science and Technology

Course Description

This course is designed to be the equivalent of a college-level introductory environmental science course. It is composed of seven general areas of study: earth systems and resources; the living world; population; land and water use; energy resources and consumption; pollution; and global change. The major themes will include: science as a process; energy conversions; earth as an interconnected system; how humans alter nature; cultural and social context of environmental problems; and sustainable practices. Emphasis is placed on laboratory and field work. The course is designed to reflect the academic expectations and rigor of a college-level course as delineated by the College Board. The course is designed to reflect the academic expectations and rigor of a college-level course as delineated by the College Board. Summer assignments are required to be completed. It is the responsibility of the student to obtain this summer work prior to leaving school in June.

Content Standards

5. Evolution (Biology)

Central Concepts: Evolution is the result of genetic changes that occur in constantly changing environments. Over many generations, changes in the genetic make-up of populations may affect biodiversity through speciation and extinction.

5.3 Explain how evolution through natural selection can result in changes in biodiversity through the increase or decrease of genetic diversity within a population.

6. Ecology (Biology)

Central Concept: Ecology is the interaction among organisms and between organisms and their environment.

6.1 Explain how birth, death, immigration, and emigration influence population size.
6.2 Analyze changes in population size and biodiversity (speciation and extinction) that result from the following: natural causes, changes in climate, human activity, and the introduction of invasive, non-native species.
6.3 Use a food web to identify and distinguish producers, consumers, and decomposers, and explain the transfer of energy through trophic levels. Describe how relationships among organisms (predation, parasitism, competition, commensalism, mutualism) add to the complexity of biological communities.
6.4 Explain how water, carbon, and nitrogen cycle between abiotic resources and organic matter in an ecosystem, and how oxygen cycles through photosynthesis and respiration.

2. Energy Resources in the Earth System (Earth and Space Science)

Central Concepts: Energy resources are used to sustain human civilization. The amount and accessibility of these resources influence their use and their impact on the environment.

2.1 Recognize, describe, and compare renewable energy resources (e.g., solar, wind, water, biomass) and nonrenewable energy resources (e.g., fossil fuels, nuclear energy).
2.2 Describe the effects on the environment and on the carbon cycle of using both renewable and nonrenewable sources of energy.

3. Earth Processes and Cycles (Earth and Space Science)

Central Concepts: Earth is a dynamic interconnected system. The evolution of Earth has been driven by interactions between the lithosphere, hydrosphere, atmosphere, and biosphere. Over geologic time, the internal motions of Earth have continuously altered the topography and geography of the continents and ocean basins by both constructive and destructive processes.

3.1 Explain how physical and chemical weathering leads to erosion and the formation of soils and sediments, and creates various types of landscapes. Give examples that show the effects of physical and chemical weathering on the environment.
3.2 Describe the carbon cycle.
3.3 Describe the nitrogen cycle.
3.4 Explain how water flows into and through a watershed. Explain the roles of aquifers, wells, porosity, permeability, water table, and runoff.
3.5 Describe the processes of the hydrologic cycle, including evaporation, condensation, precipitation, surface runoff and groundwater percolation, infiltration, and transpiration.

Scientific Inquiry Skills Standards

SIS1. Make observations, raise questions, and formulate hypotheses.

- Observe the world from a scientific perspective.
- Pose questions and form hypotheses based on personal observations, scientific articles, experiments, and knowledge.
- Read, interpret, and examine the credibility and validity of scientific claims in different sources of information, such as scientific articles, advertisements, or media stories.

SIS2. Design and conduct scientific investigations.

- Articulate and explain the major concepts being investigated and the purpose of an investigation.
- Select required materials, equipment, and conditions for conducting an experiment.
- Identify independent and dependent variables.
- Write procedures that are clear and replicable.
- Employ appropriate methods for accurately and consistently
    - making observations
    - making and recording measurements at appropriate levels of precision
    - collecting data or evidence in an organized way
- Properly use instruments, equipment, and materials (e.g., scales, probeware, meter sticks, microscopes, computers) including set-up, calibration (if required), technique, maintenance, and storage.
- Follow safety guidelines.

SIS3. Analyze and interpret results of scientific investigations.

- Present relationships between and among variables in appropriate forms.
    - Represent data and relationships between and among variables in charts and graphs.
    - Use appropriate technology (e.g., graphing software) and other tools.
- Use mathematical operations to analyze and interpret data results.
- Assess the reliability of data and identify reasons for inconsistent results, such as sources of error or uncontrolled conditions.
- Use results of an experiment to develop a conclusion to an investigation that addresses the initial questions and supports or refutes the stated hypothesis.
- State questions raised by an experiment that may require further investigation.

SIS4. Communicate and apply the results of scientific investigations.

- Develop descriptions of and explanations for scientific concepts that were a focus of one or more investigations.
- Review information, explain statistical analysis, and summarize data collected and analyzed as the result of an investigation.
- Explain diagrams and charts that represent relationships of variables.
- Construct a reasoned argument and respond appropriately to critical comments and questions.
- Use language and vocabulary appropriately, speak clearly and logically, and use appropriate technology (e.g., presentation software) and other tools to present findings.
- Use and refine scientific models that simulate physical processes or phenomena.

Reading Standards for Literacy in Science

Key Ideas and Details

1. Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.

2. Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text.

3. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text.

Craft and Structure

4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 9–10 texts and topics*.

5. Analyze the structure of the relationships among concepts in a text, including relationships among key terms (e.g., *force, friction, reaction force, energy*).
6. Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, defining the question the author seeks to address.
Integration of Knowledge and Ideas
7. Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.
8. Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem.
9. Compare and contrast findings presented in a text to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts.
Range of Reading and Level of Text Complexity
10. By the end of grade 10, read and comprehend science/technical texts in the grades 9–10 text complexity band independently and proficiently.
Writing Standards
Text Types and Purposes
1. Write arguments focused on *discipline-specific content*. a. Introduce precise claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that establishes clear relationships among the claim(s), counterclaims, reasons, and evidence. b. Develop claim(s) and counterclaims fairly, supplying data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form and in a manner that anticipates the audience's knowledge level and concerns. c. Use words, phrases, and clauses to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims. d. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing. e. Provide a concluding statement or section that follows from or supports the argument presented.
2. Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. a. Introduce a topic and organize ideas, concepts, and information to make important connections and distinctions; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension. b. Develop the topic with well-chosen, relevant, and sufficient facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic. c. Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among ideas and concepts. d. Use precise language and domain-specific vocabulary to manage the complexity of the topic and convey a style appropriate to the discipline and context as well as to the expertise of likely readers. e. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing. f. Provide a concluding statement or section that follows from and supports the information or explanation presented (e.g., articulating implications or the significance of the topic).
3. Students' narrative skills continue to grow in these grades. The standards require that students be able to incorporate narrative elements effectively into arguments and informative/explanatory texts. In history/social studies, students must be able to incorporate narrative accounts into their analyses of individuals or events of historical import. In science and technical subjects, students must be able to write precise enough descriptions of the step-by-step procedures they use in their investigations or technical work that others can replicate them and (possibly) reach the same results.
Production and Distribution of Writing
4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
5. Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.
6. Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically.
Research to Build and Present Knowledge

7. Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.
8. Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation.
9. Draw evidence from informational texts to support analysis, reflection, and research.
Range of Writing
10. Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

Essential Questions

- How do Earth systems work together to maintain equilibrium on the planet?
- How do anthropogenic actions affect Earth systems?
- How can environmental problems be resolved or prevented?
- How can we live more sustainably?

Enduring Understandings

Students will learn how:

- Describe how Earth's systems respond to disturbances
- Discuss how Earth's systems support life and how species interact
- Explain the importance of biodiversity
- Analyze solutions to protect and sustain Earth's ecosystems
- Analyze how population size, affluence, and technology affect environmental impact
- Identify advantages and disadvantages of energy resources
- Describe how food is produced and how we can produce food more sustainably
- Discuss mineral resources and sustainable practices
- Identify sources and hazards of waste and the importance of recycling
- Identify causes and effects of air pollution
- Analyze climate change data and possible solutions
- Discuss water resources and water pollution
- Examine best practices for water use and sustainability
- Identify the connections between economics, politics, society, and environmental science
- Analyze data to determine how we can live more sustainably

Evidence of Understanding

The students will:

- Take formative and summative quizzes and tests on paper and online
- Complete homework and projects
- Conduct formal and informal labs
- Analyze data and share findings through presentations and written reports
- Conduct research and apply to technical writing
- Write critically and creatively
- Collaborate on group projects
- Present information to the class
- Participate in formal and informal class discussions
- Contribute to the class website
- Read actively and critically
- Communicate clearly in speech
- Write effectively
- Identify, access, and utilize a variety of resources for obtaining information
- Employ multiple strategies in reasoning and problem solving both independently and collaboratively
- Listen effectively and critically
- Demonstrate knowledge and skills in a variety of forms
- Demonstrate respect and tolerance

- Act responsible and display good citizenship

Course Outline

Unit	Essential Questions	Skills and Understandings	Assessment
Introduction to Environmental Science, Matter and Energy	Why do we have environmental problems? How do matter, energy, and systems respond to change?	• efine sustainability • dentify characteristics of environmentally sustainable societies • escribe connections between environmental and economic sustainability • ssess their own ecological footprint and compare to others • efine pollution and identify point and nonpoint sources of pollution • dentify causes of environmental problems • iscuss the impact that worldviews have on the identification and treatment of environmental problems • dentify the four scientific principles of sustainability • se scientific method to collect and analyze data • tate and apply the law of conservation of matter • tate and apply the first and second laws of thermodynamics • Relate the above laws to earth's systems	• Online quiz • Test
Earth, Ecology, and Ecosystems	What keeps us and other organisms alive? What is biodiversity and why is it important? How do species interact?	• Define ecology • Discuss how life is sustained by the flow of energy, the cycling of matter, and gravity • List major biotic and abiotic components of ecosystems	• Online quiz • Test • Persuasive essay • Biogeochemical cycle story • Biodiversity lab report • Invasive species wanted poster

		• Discuss how organisms obtain nutrients • Explain how energy flows through ecosystems using food webs and decreases at each succeeding trophic level • Identify major components of biogeochemical cycles of matter and discuss how humans are altering these cycles • Define biodiversity on different levels (genes, species, ecosystems, processes) • Discuss how evolution occurs through natural selection • Identify geological processes and climate change affect evolution • Explain how speciation and extinction affect biodiversity • Address how humans affect extinction • Discuss the importance of species diversity • Identify different roles species can play in an environment, such as invasive and keystone • List the ways that species interact: competition, predation, symbiosis • Explain how competition affects natural selection • Identify limitations on population growth • Discuss how ecosystems respond to changing environmental conditions	
Biodiversity	What are the major threats to terrestrial and aquatic ecosystems? What role do humans play in the extinction of species? How can ecosystems best be protected and sustained?	• List factors that influence climate • Address how climate affects the nature and location of biomes • Discuss how humans have affected terrestrial ecosystems • Identify key factors that determine biodiversity in aquatic ecosystems • Discuss how humans have affected marine and	• Online quiz • Test • Biome project • Biodiversity hotspot research and presentation • Wetland quality assessment

		freshwater ecosystems • Identify how humans accelerate species extinction and why we should care • Explain how humans can prevent wild species from extinction resulting from our activities • Identify major threats to forest ecosystems • Discuss how forests, grasslands, and nature reserves should be managed and sustained • Describe the ecosystem approach to sustaining biodiversity • Identify major threats to aquatic biodiversity • Discuss how marine fisheries, wetlands, and freshwater systems should be protected and managed	
Human Population	How many people can the Earth support? How can we slow human population growth, and should we? What types of hazards do we face, and how can we avoid the worst of them?	• Calculate human population growth rates • List factors that increase and decrease the size of the human population • Utilize population age structures to determine growth or decline • Discuss methods of slowing human population growth • Identify major health, biological, and chemical hazards faced by humans • Evaluate chemical hazards • Discuss risk perception	• Online quiz • Test • Analysis of population data and projection • Fishbowl discussion
Energy Resources	What are the advantages and disadvantages of our nonrenewable and renewable energy resources? How can we make the transition to a more sustainable energy future?	• List major sources of energy • Identify advantages and disadvantages of oil, natural gas, coal, and nuclear energy • Discuss the importance of energy efficiency • Identify ways to reduce energy waste • Identify advantages and disadvantages of solar energy, hydroelectricity, wind energy, biomass, geothermal, and hydrogen energy	• Online quiz • Test • Renewable energy research and presentation • Analysis of alternative energy tradeoffs

		• Discuss obstacles to transitioning to more sustainable energy sources	
Land Resources	What environmental problems arise from food production, and how can we produce food more sustainably? How can we use mineral resources more sustainably? How can we make the transition to a more sustainable low-waste society?	• Define food security and identify obstacles in attaining food security • Explain how food is produced • Identify environmental problems that arise from food production • Discuss sustainable pest protection • Discuss how food can be produced more sustainably • Identify major geological processes and hazards • Identify processes in the rock cycle • List mineral resources • Discuss the environmental effects of mineral extraction • Connect mineral resources with cost and supply • Discuss how mineral resources can be used more sustainably • List sources of solid and hazardous wastes • Identify problems with solid and hazardous wastes • Explain why reusing and recycling materials is so important • Describe advantages and disadvantages of solid waste disposal methods • Discuss how we should deal with hazardous waste	• Online quiz • Test • Mining project • Superfund research and presentation
Air Resources	What are the different types of air pollution, and how should we deal with them? What can we do to slow projected climate disruption?	• Identify components of the atmosphere • List major outdoor air pollution problems • Describe acid deposition and the problems it causes • List major indoor air pollution problems • Discuss health effects of air pollution • State evidence that shows the earth's atmosphere is warming rapidly	• Online quiz • Test • Mock Congressional hearing • Acid deposition lab and lab report

		• Identify human activities that affect climate • List possible effects of a warming climate • Discuss individual and government actions that can slow climate change • Identify the effect of human activities on the amount of ozone in the stratosphere	
Water Resources	Will we have enough water? What are the different types of water pollution, and how can we best deal with them?	• Identify how much usable water is available • Discuss differences in water availability around the world • List advantages and disadvantages to extracting groundwater, building dams, transferring water, and seawater conversion • Identify methods to reduce the threat of flooding • Discuss how humans can use water more sustainably • List causes and effects of water pollution • Identify major water pollution problems in streams, lakes, groundwater, drinking water, and oceans • Discuss how humans can best deal with water pollution	• Online quiz • Test • Analysis of water quality
Toward a Sustainable Future: Law, Politics, Economics	How can cities become more sustainable and livable? How are economic systems related to the biosphere? What is the role of government in making the transition to more sustainable societies? How can we live more sustainably?	• Connect economic systems and ecological systems • Discuss the valuation of natural capital, pollution control, and resource use and how that can be used to reduce environmental problems • Describe how poverty reduction helps to reduce environmental problems • Discuss the creation of more environmentally sustainable economies • Discuss the role of government in transitioning to more sustainable societies	• Online quiz • Test • Environmental law research and presentation

		• Explain the processes involved in the making of environmental policies • Identify the role of environmental law in dealing with environmental problems • Discuss the implications of environmental security on global security • Identify major population trends and resource problems in urban areas • Explain the role of transportation and land use planning on urban environmental impact • Discuss how cities can become more sustainable and livable • Identify major environmental worldviews	

Genetics: Honors

Grade Level	11, 12
Course Number	350
Subject Area	Science and Technology

Course Description

This rigorous course will offer an in-depth study of genetics, including the following topics: inheritance, genetic disorders, population genetics, DNA technology, embryological development, bioethics, and the future of genetics in medicine, agriculture, and your life. Mathematical analysis of laboratory activities and inquiry-based work will guide students through the material. An emphasis will be placed on problem solving and decision-making skills.

Content Standards

3. Genetics (Biology)

Central Concepts: Genes allow for the storage and transmission of genetic information. They are a set of instructions encoded in the nucleotide sequence of each organism. Genes code for the specific sequences of amino acids that comprise the proteins characteristic to that organism.

3.1 Describe the basic structure (double helix, sugar/phosphate backbone, linked by complementary nucleotide pairs) of DNA, and describe its function in genetic inheritance.

3.2 Describe the basic process of DNA replication and how it relates to the transmission and conservation of the genetic code. Explain the basic processes of transcription and translation, and how they result in the expression of genes. Distinguish among the end products of replication, transcription, and translation.

3.3 Explain how mutations in the DNA sequence of a gene may or may not result in phenotypic change in an organism. Explain how mutations in gametes may result in phenotypic changes in offspring.

3.4 Distinguish among observed inheritance patterns caused by several types of genetic traits (dominant, recessive, codominant, sex-linked, polygenic, incomplete dominance, multiple alleles).

3.5 Describe how Mendel's laws of segregation and independent assortment can be observed through patterns of inheritance (e.g., dihybrid crosses).
3.6 Use a Punnett Square to determine the probabilities for genotype and phenotype combinations in monohybrid crosses.

4. Anatomy & Physiology (Biology)

Central Concepts: There is a relationship between the organization of cells into tissues and the organization of tissues into organs. The structures and functions of organs determine their relationships within body systems of an organism. Homeostasis allows the body to perform its normal functions..

4.8 Recognize that the body's systems interact to maintain homeostasis. Describe the basic function of a physiological feedback loop.

Scientific Inquiry Skills Standards

SIS1. Make observations, raise questions, and formulate hypotheses.

- Observe the world from a scientific perspective.
- Pose questions and form hypotheses based on personal observations, scientific articles, experiments, and knowledge.
- Read, interpret, and examine the credibility and validity of scientific claims in different sources of information, such as scientific articles, advertisements, or media stories.

SIS2. Design and conduct scientific investigations.

- Articulate and explain the major concepts being investigated and the purpose of an investigation.
- Select required materials, equipment, and conditions for conducting an experiment.
- Identify independent and dependent variables.
- Write procedures that are clear and replicable.
- Employ appropriate methods for accurately and consistently
    - making observations
    - making and recording measurements at appropriate levels of precision
    - collecting data or evidence in an organized way
- Properly use instruments, equipment, and materials (e.g., scales, probeware, meter sticks, microscopes, computers) including set-up, calibration (if required), technique, maintenance, and storage.
- Follow safety guidelines.

SIS3. Analyze and interpret results of scientific investigations.

- Present relationships between and among variables in appropriate forms.
    - Represent data and relationships between and among variables in charts and graphs.
    - Use appropriate technology (e.g., graphing software) and other tools.
- Use mathematical operations to analyze and interpret data results.
- Assess the reliability of data and identify reasons for inconsistent results, such as sources of error or uncontrolled conditions.
- Use results of an experiment to develop a conclusion to an investigation that addresses the initial questions and supports or refutes the stated hypothesis.
- State questions raised by an experiment that may require further investigation.

SIS4. Communicate and apply the results of scientific investigations.

- Develop descriptions of and explanations for scientific concepts that were a focus of one or more investigations.
- Review information, explain statistical analysis, and summarize data collected and analyzed as the result of an investigation.
- Explain diagrams and charts that represent relationships of variables.
- Construct a reasoned argument and respond appropriately to critical comments and questions.
- Use language and vocabulary appropriately, speak clearly and logically, and use appropriate technology (e.g., presentation software) and other tools to present findings.

- Use and refine scientific models that simulate physical processes or phenomena.

Reading Standards for Literacy in Science

Key Ideas and Details

1. Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.

2. Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text.

3. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text.

Craft and Structure

4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 9–10 texts and topics*.

5. Analyze the structure of the relationships among concepts in a text, including relationships among key terms (e.g., *force, friction, reaction force, energy*).

6. Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, defining the question the author seeks to address.

Integration of Knowledge and Ideas

7. Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.

8. Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem.

9. Compare and contrast findings presented in a text to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts.

Range of Reading and Level of Text Complexity

10. By the end of grade 10, read and comprehend science/technical texts in the grades 9–10 text complexity band independently and proficiently.

Writing Standards

Text Types and Purposes

1. Write arguments focused on *discipline-specific content*.

a. Introduce precise claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that establishes clear relationships among the claim(s), counterclaims, reasons, and evidence.

b. Develop claim(s) and counterclaims fairly, supplying data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form and in a manner that anticipates the audience's knowledge level and concerns.

c. Use words, phrases, and clauses to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims.

d. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.

e. Provide a concluding statement or section that follows from or supports the argument presented.

2. Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.

a. Introduce a topic and organize ideas, concepts, and information to make important connections and distinctions; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.

b. Develop the topic with well-chosen, relevant, and sufficient facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic.

c. Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among ideas and concepts.

d. Use precise language and domain-specific vocabulary to manage the complexity of the topic and convey a style appropriate to the discipline and context as well as to the expertise of likely readers.

e. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.

f. Provide a concluding statement or section that follows from and supports the information or explanation presented

(e.g., articulating implications or the significance of the topic).

3. Students' narrative skills continue to grow in these grades. The standards require that students be able to incorporate narrative elements effectively into arguments and informative/explanatory texts. In history/social studies, students must be able to incorporate narrative accounts into their analyses of individuals or events of historical import. In science and technical subjects, students must be able to write precise enough descriptions of the step-by-step procedures they use in their investigations or technical work that others can replicate them and (possibly) reach the same results.

Production and Distribution of Writing

4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

5. Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.

6. Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically.

Research to Build and Present Knowledge

7. Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

8. Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation.

9. Draw evidence from informational texts to support analysis, reflection, and research.

Range of Writing

10. Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

Essential Questions

- What role do genes play in my life?
- What effect will genetics have on my future?

Enduring Understandings

Students will learn how:

- The field of genetics has been experiencing rapid growth in recent decades. Scientists have been studying the mechanisms and applied uses of genetics for over 150 years. The scientific method has played an integral role in these studies.
  The cell cycle, particularly mitosis and meiosis, is essential for genetic information to be passed on to offspring. The steps of mitosis are finely executed within all cells to ensure that each cell is identical. Meiosis is responsible for the formation of gametes in sexually reproducing populations.
- Gregor Mendel's work with garden pea plants in the 1860s laid the foundation for genetics research. His methods can still be applied today. As Mendel noted, the field of genetics is dependent upon the use of probability and statistics. Many of Mendel's observations can be observed firsthand in human genetics and the genetics of the common fruit fly, *Drosophila melanogaster*.
- The basic principles presented by Mendel can be extended to incorporate more complicated genetic patterns such as multiple alleles, sex-linked inheritance, and epistasis.
- Karyotypes can be used to determine whole chromosomal abnormalities that result from deletion, duplication, translocation, inversion, and nondisjunction. The effects of these abnormalities vary widely. Genetic screening of newborns can test for many of these abnormalities, but the benefits and drawbacks of such screening must first be evaluated.
- Genetic disorders vary widely in terms of patterns of inheritance, prognosis, and treatment. Future studies in genetics will greatly influence the diagnosis, prognosis, and treatment of genetic disorders. Proper research techniques include the use of an annotated bibliography and in-text citations.
- Eukaryotic chromosomes contain many genes that are linked together and thus do not follow the law of independent assortment. Gene linkage and crossing over can be used to construct chromosome maps.
- Cancer is a genetic disease that involves an accumulation of mutations. Treatments for cancer will change as new genetic research is conducted. While cancer has a genetic basis, individuals can reduce their risk of cancer by taking certain precautionary steps beginning at a young age.

- Evolution, the unifying concept of biological studies, is based on population genetics. The allele frequencies of a population will vary as different forces drive selection factors. Studying population genetics allows scientists to learn more about evolution, including human migration patterns.

Evidence of Understanding

The students will:

- Take formative and summative quizzes and tests on paper and online
- Complete homework and projects
- Conduct formal and informal labs
- Analyze data and share findings through presentations and written reports
- Conduct research and apply to technical writing
- Write critically and creatively
- Collaborate on group projects
- Present information to the class
- Participate in formal and informal class discussions
- Contribute to the class website
- Read actively and critically
- Communicate clearly in speech
- Write effectively
- Identify, access, and utilize a variety of resources for obtaining information
- Employ multiple strategies in reasoning and problem solving both independently and collaboratively
- Listen effectively and critically
- Demonstrate knowledge and skills in a variety of forms
- Demonstrate respect and tolerance
- Act responsible and display good citizenship

Course Outline

Unit	Essential Questions	Skills and Understandings	Assessment
History of Genetics	Why is genetics studied? What methods have been used in the past? How can genetic information be used to change the future?	• Organize genetic milestones chronologically as well as by category • Discuss significance of certain events, including Darwin's publication of On the Origin of Species, Morgan's research with D. melanogaster, and Chase & Hershey's model of DNA • Identify the steps of the scientific method in a series of examples from previous genetic studies • Apply the steps of the scientific method in a simple study of genetics • Evaluate data in terms of correlation	• Quiz
Mitosis & Meiosis	How do all cells within an organism contain the same genetic information? Why is meiosis important for sexually reproducing populations?	• Identify the stages of the cell cycle (G1, S, G2, M, G0) and the significant events that occur in each stage • Describe and illustrate the stages of mitosis (prophase, metaphase,	• Online quiz • Test • Onion root tip analysis • Meiosis cartoon

		anaphase, telophase, cytokinesis) • View a cell and identify which stage of the cell cycle the cell is in • Explain the goal of meiosis • Illustrate and describe the stages of meiosis (I and II)	
Mendelian Genetics & Probability	Why was Mendel's work with pea plants so important? Why are model organisms, such as the fruit fly, still important today? Why can't genetics be studied without an understanding of probability and statistics?	• Use probability to predict patterns • Apply probability and statistics to genetics • Describe the work of Gregor Mendel in the 1860s and its significance to genetics today • Identify Mendel's first four postulates • Use Punnett squares to predict genotypes and phenotypes of offspring • Predict results of dihybrid and trihybrid crosses using the forked-line method • Describe the life cycle of a fruit fly (egg, pupa, adult) • Use chi-square analysis to determine if a null hypothesis can be rejected • Analyze Drosophila crosses using chi-square analysis • Predict and analyze mono-, di-, and trihybrid fruit fly crosses • Create a pedigree of one's family • Analyze inheritance and determine genotype using a pedigree	• Online quiz • Test • Analysis of *Drosophila* crosses • Family pedigree project
Extensions of Mendelian Genetics	Why don't all genetics concepts follow the laws established by Mendel?	• Review the relationship between DNA, proteins, and genetics • Identify genetic characteristics that do not follow Mendel's laws of genetics • Define incomplete dominance and codominance in terms of phenotype	• Online quiz • Test • Blood analysis lab • Analysis of *Drosophila* cross

		• Describe the genetic differences between incomplete dominance and codominance in terms of proteins • Explain how human blood types illustrate multiple alleles and codominance • Identify structure of blood and how blood varies based on blood type • Determine blood types using agglutination • Predict offspring and parental blood types given certain information • Describe the Bombay phenotype in terms of phenotype, genotype, and protein structures • Explain and predict results of epistasis • Explain the differences between X-linked traits and sex-influenced traits • Predict phenotypic ratios of X-linked crosses • Describe X-inactivation and significance to genetics • Identify factors that influence phenotype (regardless of genotype)	
Karyotypes and Chromosomal Abnormalities	What can you learn from a karyotype? Should all newborns be screened for genetic disorders?	• Identify chromosome characteristics (length, centromere location, banding patterns) • Use chromosome characteristics to construct karyotypes • Label regions of chromosomes on karyotypes • Explain how the Y chromosome determines maleness in humans • Examine karyotypes for genetic abnormalities • Identify genetic disorders based on karyotypes • Describe genetic screening procedures • Discuss implications of genetic screening of newborns	• Online quiz • Test • Analysis of karyotype • Persuasive essay about genetic screening

		• Evaluate genetic screening options and determine which tests should be mandatory • Describe different types of chromosomal aberrations and how they occur • Discuss cause and effect of chromosomal aberrations • Explain the genetic relationship between Fragile X syndrome and mental retardation	
Genetic Disorders	What causes genetic disorders? What resources are available for researching genetic disorders? What makes for a good presentation?	• Explain the cause, diagnosis, prognosis, and treatment of a genetic disorder • Illustrate the inheritance pattern of a genetic disorder using Punnett squares, pedigrees, or karyotypes • Use multiple resources to find and evaluate information • Prepare an annotated bibliography • Organize and write a research paper using in-text citations • Present findings to the class • Prepare a presentation visual • Evaluate peer presentations using checklist developed as a class	• Research paper and presentation on genetic disorder
Chromosome Mapping in Eukaryotes	Why don't all genes follow the law of independent assortment? How do geneticists know where certain genes can be found on a chromosome?	• Explain the law of independent assortment • Describe the mechanisms of crossing over during meiosis I • Describe chromosomal linkage and how it can be used to determine gene location • Use crossing outcomes to determine relative location of two genes on one chromosome • Use three-point mapping to determine relative	• Online quiz • Test • Analysis of *Drosophila* cross

		locations of three genes on one chromosome • Explain why the observed frequency of double crossovers is typically less than the expected frequency (interference)	
Cancer and Genetics	What is cancer? What can I do to reduce my risk of developing cancer?	• Define cancer • Describe cancer as a multi-step process involving multiple genes • Define apoptosis • Explain the connection between the cell cycle, apoptosis, and cancer • Describe the latest genetic technology and how it may be used to treat cancer • Explain how cancer develops and spreads to other tissues • Describe the effects of leukemia and treatments • Explain the role of specific genes in the cell cycle and their connection to cancer • Differentiate between inheriting a gene and inheriting cancer • Develop a public service campaign for teenagers to reduce the risk of cancer • Evaluate the implications of genetic testing for cancer • Create a brochure that addresses questions involving the identified genes for breast cancer	• Online quiz • Test • Public service campaign
Population Genetics	Why is type O blood the most common, even though it is recessive? How do we know the migration patters of ancient hominids?	• Describe the work of Hardy and Weinberg • Identify necessary conditions for a population to reach Hardy-Weinberg (H-W) equilibrium • Define each symbol in the H-W equilibrium calculation: $p^2 + 2pq + q^2 = 1$ • Apply H-W equilibrium	• Online quiz • Test • Hardy-Weinberg project

		to various genes within populations, including human populations • Calculate H-W equilibrium for non-Mendelian traits (multiple alleles, X-linked traits) • Explain the role of natural selection in changing allele frequencies within a population • Discuss the effects of migration, mutation, and genetic drift on the gene pool of a population • Use H-W equilibrium and known frequencies for genetic counseling • Explain how population genetics can be used to determine migration patterns of early humans	

Bioethics and Fauna: Honors

Grade Level	11, 12
Course Number	356
Subject Area	Science and Technology

Course Description

Students will continue their study of biology by delving deeper into the study of animals and applying knowledge in the realm of bioethics. The first semester of the course will serve as an introduction to zoology and the second semester will introduce students to the subject of bioethics. The zoological study will provide students a perspective on the animal kingdom by investigating the various groups of animals in the zoological world using a systematic approach. Students will obtain a general knowledge of the anatomical and physiological components of vertebrates and invertebrates. Course themes will include the application of zoology in everyday life, stressing environmental concerns, bioethics, health concerns, and careers in the field. The second semester of bioethics will offer students the skills necessary to deliberate and consider the medical, scientific, societal, and political factors that result in troubling dilemmas for individuals and societies faced in the scientific and biomedical field. Students will use ethical inquiry to develop thoughtful positions on complex bioethical issues including, but not limited to, Bioethics Concepts and Skills; Balancing Individual and Community Claims; Establishing State Vaccination Policies; Organ Transplantation; Genetic Testing; Human Experimentation; and Human Responsibilities toward Animals. This course is designed for students who are planning to pursue further study in biology or who are interested in pursuing their knowledge of structure, habits, and taxonomy of the animal kingdom and exploring ethical questions related to the life sciences.

Content Standards

2. Cell Biology

Central Concepts: Cells have specific structures and functions that make them distinctive. Processes in a cell can be classified broadly as growth, maintenance, and reproduction.

2.1 Relate cell parts/organelles (plasma membrane, nuclear envelope, nucleus, nucleolus, cytoplasm, mitochondrion, endoplasmic reticulum, Golgi apparatus, lysosome, ribosome, vacuole, cell wall, chloroplast, cytoskeleton, centriole, cilium, flagellum, pseudopod) to their functions. Explain the role of cell membranes as a highly selective barrier (diffusion, osmosis, facilitated diffusion, active transport).
2.2 Compare and contrast, at the cellular level, the general structures and degrees of complexity of prokaryotes and eukaryotes.
2.3 Use cellular evidence (e.g., cell structure, cell number, cell reproduction) and modes of nutrition to describe the six kingdoms (Archaebacteria, Eubacteria, Protista, Fungi, Plantae, Animalia).
2.4 Identify the reactants, products, and basic purposes of photosynthesis and cellular respiration. Explain the interrelated nature of photosynthesis and cellular respiration in the cells of photosynthetic organisms.
2.6 Explain the role of mitosis in the formation of new cells, and its importance in maintaining chromosome number during asexual reproduction.
2.7 Describe how the process of meiosis results in the formation of haploid cells. Explain the importance of this process in sexual reproduction, and how gametes form diploid zygotes in the process of fertilization.

4. Anatomy and Physiology

Central Concepts: There is a relationship between the organization of cells into tissues and the organization of tissues into organs. The structures and functions of organs determine their relationships within body systems of an organism. Homeostasis allows the body to perform its normal functions.

4.1 Explain generally how the digestive system (mouth, pharynx, esophagus, stomach, small and large intestines, rectum) converts macromolecules from food into smaller molecules that can be used by cells for energy and for repair and growth.
4.2 Explain how the circulatory system (heart, arteries, veins, capillaries, red blood cells) transports nutrients and oxygen to cells and removes cell wastes. Describe how the kidneys and the liver are closely associated with the circulatory system as they perform the excretory function of removing waste from the blood. Recognize that kidneys remove nitrogenous wastes, and the liver removes many toxic compounds from blood.
4.3 Explain how the respiratory system (nose, pharynx, larynx, trachea, lungs, alveoli) provides exchange of oxygen and carbon dioxide.
4.4 Explain how the nervous system (brain, spinal cord, sensory neurons, motor neurons) mediates communication among different parts of the body and mediates the body's interactions with the environment. Identify the basic unit of the nervous system, the neuron, and explain generally how it works.
4.5 Explain how the muscular/skeletal system (skeletal, smooth and cardiac muscles, bones, cartilage, ligaments, tendons) works with other systems to support the body and allow for movement. Recognize that bones produce blood cells.
4.6 Recognize that the sexual reproductive system allows organisms to produce offspring that receive half of their genetic information from their mother and half from their father, and that sexually produced offspring resemble, but are not identical to, either of their parents.
4.7 Recognize that communication among cells is required for coordination of body functions. The nerves communicate with electrochemical signals, hormones circulate through the blood, and some cells produce signals to communicate only with nearby cells.
4.8 Recognize that the body's systems interact to maintain homeostasis. Describe the basic function of a physiological feedback loop.

5. Evolution and Biodiversity

Central Concepts: Evolution is the result of genetic changes that occur in constantly changing environments. Over many generations, changes in the genetic make-up of populations may affect biodiversity through speciation and extinction.

5.1 Explain how evolution is demonstrated by evidence from the fossil record, comparative anatomy, genetics, molecular biology, and examples of natural selection.
5.2 Describe species as reproductively distinct groups of organisms. Recognize that species are further classified into a hierarchical taxonomic system (kingdom, phylum, class, order, family, genus, species) based on morphological, behavioral, and molecular similarities. Describe the role that geographic isolation can play in speciation.

6. Ecology

Central Concept: Ecology is the interaction among organisms and between organisms and their environment.

6.1 Explain how birth, death, immigration, and emigration influence population size.
6.2 Analyze changes in population size and biodiversity (speciation and extinction) that result from the following: natural causes, changes in climate, human activity, and the introduction of invasive, non-native species.
6.3 Use a food web to identify and distinguish producers, consumers, and decomposers, and explain the transfer of energy through trophic levels. Describe how relationships among organisms (predation, parasitism, competition, commensalism, mutualism) add to the complexity of biological communities.

Scientific Inquiry Skills Standards

SIS1. Make observations, raise questions, and formulate hypotheses.

- Observe the world from a scientific perspective.
- Pose questions and form hypotheses based on personal observations, scientific articles, experiments, and knowledge.
- Read, interpret, and examine the credibility and validity of scientific claims in different sources of information, such as scientific articles, advertisements, or media stories.

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- Select required materials, equipment, and conditions for conducting an experiment.
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- Follow safety guidelines.

SIS3. Analyze and interpret results of scientific investigations.

- Present relationships between and among variables in appropriate forms.
    - Represent data and relationships between and among variables in charts and graphs.
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- Use mathematical operations to analyze and interpret data results.
- Assess the reliability of data and identify reasons for inconsistent results, such as sources of error or uncontrolled conditions.
- Use results of an experiment to develop a conclusion to an investigation that addresses the initial questions and supports or refutes the stated hypothesis.
- State questions raised by an experiment that may require further investigation.

SIS4. Communicate and apply the results of scientific investigations.

- Develop descriptions of and explanations for scientific concepts that were a focus of one or more investigations.
- Review information, explain statistical analysis, and summarize data collected and analyzed as the result of an investigation.
- Explain diagrams and charts that represent relationships of variables.
- Construct a reasoned argument and respond appropriately to critical comments and questions.
- Use language and vocabulary appropriately, speak clearly and logically, and use appropriate technology (e.g., presentation software) and other tools to present findings.
- Use and refine scientific models that simulate physical processes or phenomena.

Reading Standards for Literacy in Science
Key Ideas and Details
1. Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.
2. Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text.
3. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text.
Craft and Structure
4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 9–10 texts and topics*.
5. Analyze the structure of the relationships among concepts in a text, including relationships among key terms (e.g., *force, friction, reaction force, energy*).
6. Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, defining the question the author seeks to address.
Integration of Knowledge and Ideas
7. Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.
8. Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem.
9. Compare and contrast findings presented in a text to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts.
Range of Reading and Level of Text Complexity
10. By the end of grade 10, read and comprehend science/technical texts in the grades 9–10 text complexity band independently and proficiently.
Writing Standards
Text Types and Purposes
1. Write arguments focused on *discipline-specific content*. a. Introduce precise claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that establishes clear relationships among the claim(s), counterclaims, reasons, and evidence. b. Develop claim(s) and counterclaims fairly, supplying data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form and in a manner that anticipates the audience's knowledge level and concerns. c. Use words, phrases, and clauses to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims. d. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing. e. Provide a concluding statement or section that follows from or supports the argument presented.
2. Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. a. Introduce a topic and organize ideas, concepts, and information to make important connections and distinctions; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension. b. Develop the topic with well-chosen, relevant, and sufficient facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic. c. Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among ideas and concepts. d. Use precise language and domain-specific vocabulary to manage the complexity of the topic and convey a style appropriate to the discipline and context as well as to the expertise of likely readers. e. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing. f. Provide a concluding statement or section that follows from and supports the information or explanation presented (e.g., articulating implications or the significance of the topic).

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6. Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically.
Research to Build and Present Knowledge
7. Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.
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9. Draw evidence from informational texts to support analysis, reflection, and research.
Range of Writing
10. Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

Essential Questions

- What is the study of zoology?
- How are all animals alike?
- How are invertebrates and vertebrates alike? Different?
- How are animals classified?

Enduring Understandings

Students will learn how:

- To understand that Zoology is a discipline that interconnects with many other life sciences.
- To differentiate between the patterns of organization that unify all members of the Kingdom Animalia.
- To understand that the Kingdom Animalia comprises of invertebrates and vertebrates and includes animals that range in complexity (ex. Sponges →mammals).
- To study how Scientists constantly work to classify animals.
- To understand that Invertebrates include: protists, poriferans, cnidarians, platyhelminthes, mollusks, annelids, arthropods, and echinoderms.
- To understand that Vertebrates include: fish, amphibians, reptiles, birds and mammals.
- To discuss how Animals can be compared based on their anatomical and physiological characteristics:
  - Support, Protection and Movement
  - Excretion and Temperature Regulation
  - Internal Fluids and Respiration
  - Digestion and Nutrition

Evidence of Understanding

Students will represent their mastering of the material via the following:

- Teacher observation of reading, class discussion, student analysis and responses to chapter review questions.
- Students will observe, analyze and be able to identify anatomical and physiological parts of specimen.

- Students will construct a simple dichotomous key; use a dichotomous key; collect freshwater invertebrate specimen; identify those organisms and develop a dichotomous key for the organisms found; develop an informational booklet on the invertebrate phyla; construct a simple dichotomous key; collecting freshwater invertebrate specimen; identify those organisms and developing a dichotomous key for the organisms found.
- Students will be assessed on exams, quizzes, HW/Class-work, labs and projects. In addition at the end of each quarter students will complete an interim assessment that will be incorporated into their quarter grade.
- Additionally, in the fourth quarter, students will be responsible for teaching a 70 minute lesson on a Mammalian group.

Course Outline

Unit	Essential Questions	Skills and Understandings	Assessment
Zoology as a Discipline	• How does the knowledge of zoology impact everyday life? • Why is life difficult to define? • How does the hierarchial organization of life lead to the emergence of new properties at different levels of biological complexity?	• Students will read about the study of zoology. They will learn about the profession and then education that is needed to work in that field of work. • Students will research careers that are in the field of study. • Complete short answer essay on how zoology impacts them. • Develop a table defining the current issues in zoology today and students will vote to choose which topic the class will debate; class debate of the topic will follow.	• Online quizzes, tests, labs • End of the year Capstone Project: students will apply all that they have learned for the year in a community service project or zoo project that
Patterns in Kingdom Animalia	• What are the five levels of organization in life's organisms? • How does each level of succession become more complex than the one preceding it? • Why does complexity always increase with body size? • Why, during the evolutionary history of animals, has there been a tendency for the maximum body size to increase?	• Students will read about the study of zoology. They will learn about the profession and then education that is needed to work in that field of work. • Students will research careers that are in the field of study. • Complete short answer essay on how zoology impacts them. • Develop a table defining the current issues in zoology today and students will vote to choose which topic the class will debate;	• Online quizzes, tests, labs

		class debate of the topic will follow.	
Classification	• Why do we classify life's organisms? • How do scientists classify animals? • What are the characteristics of animals that distinguish them from other kingdoms? • What is binomial nomenclature? • How are dichotomous keys used to identify organisms? • What is the distinction between scientific and common names?	• Read about the Linneas system of classification and answer review questions. • Research and write out complete classifications for: chimpanzee, Human, Dog, Wolf, Cat, and Grasshopper. • Practice using cladograms and phylogenetic trees. • Develop a simple dichotomous key. • Use a dichotomous key. • Collect freshwater invertebrate specimen and develop a key for the organisms found.	• Online quizzes, tests, labs • Interpreting Cladograms • Taxonomy Project
Invertebrates	• What are the defining characteristics in the major invertebrate phyla? • How are each of these groups classified? • What is the value or economic importance to man for these various groups of animals?	• Review anatomy; basic anatomical and physiological characteristics of each phyla. • Devise a table distinguishing the invertebrate phyla. • Construct a booklet of information on vertebrate phyla (ongoing throughout the semester). • Dissect and observe specimen: such as a earthworm, sea star, crayfish. • Observe freshwater invertebrate specimen.	• Testing the Health of the Ipswich River Park Lab
Vertebrates	• What are the defining characteristics in the major vertebrate phyla? • How are each of these groups classified? • What is the value or economic importance to man for these various groups of animals?	• Review anatomy; basic anatomical and physiological characteristics of each class. • Devise a table distinguishing the vertebrate classes. • Construct a booklet of information on vertebrate classes (ongoing throughout the semester). • Dissect and observe specimen: such as a fish, pig, and shark. • Design and teach their	• Animal Behavior Study • Online quizzes, tests, labs • Dissections

		own lesson on Mammals.	
Animal Behavior	• How do animals behave? • What brings about an animals innate behavior? • How does an animal's behavior learned? • How does an animals environment affect their behavior?	• Students will understand that animal behavior is either innate or learned. Innate behavior is preprogrammed behavior that comes about due to the genetic makeup of the animal and the environmental factors that act on them. Learned behavior is better defined as modification of behavior through experience. Behavioral biologists study how and why animals behave they way that they do.	• Online quizzes, tests, labs

Computer Aided Design: Academic

Grade Level	9, 10, 11, 12
Course Number	361
Subject Area	Science and Technology

Course Description

This course is a continuation of Introduction to Engineering Design. It is intended to build on the skills learned with a primary focus on use of Computer Aided Design software. This course covers in depth the use of 3-D model creation. Students will use standard software AutoCAD to create 3-D objects from 2-D objects and modify 3-D objects. They will also learn parametric design using Autodesk Inventor. Students will be able to create orthographic, isometric, section views and other manufacturing drawings using these tools.

Content Standards

1. Engineering Design

Central Concepts: Engineering design involves practical problem solving, research, development, and invention/innovation, and requires designing, drawing, building, testing, and redesigning. Students should demonstrate the ability to use the engineering design process to solve a problem or meet a challenge.

1.3 Produce and analyze multi-view drawings (orthographic projections) and pictorial drawings (isometric, oblique, perspective), using various techniques.
1.4 Interpret and apply scale and proportion to orthographic projections and pictorial drawings (e.g., ¼" = 1'0", 1 cm = 1 m).
1.5 Interpret plans, diagrams, and working drawings in the construction of prototypes or models.
.

2. Construction Technologies

Central Concepts: The construction process is a series of actions taken to build a structure, including preparing a site, setting a foundation, erecting a structure, installing utilities, and finishing a site. Various materials, processes, and systems are used to build structures. Students should demonstrate and apply the concepts of construction technology through building and constructing either full-size models or scale models using various materials commonly used in construction. Students should demonstrate the ability to use the engineering design process to solve a problem or meet a challenge in construction technology.

2.1 Identify and explain the engineering properties of materials used in structures (e.g., elasticity, plasticity, R value, density, strength).
2.6 Recognize the purposes of zoning laws and building codes in the design and use of structures.

4. Energy and Power Technologies – Thermal Systems

Central Concepts: Thermal systems involve transfer of energy through conduction, convection, and radiation, and are used to control the environment. Students should demonstrate the ability to use the engineering design process to solve a problem or meet a challenge in a thermal system.

4.3 Explain how environmental conditions such as wind, solar angle, and temperature influence the design of buildings.

Reading Standards for Literacy in Science

Key Ideas and Details

1. Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.

2. Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text.

3. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text.

Craft and Structure

4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 9–10 texts and topics*.

5. Analyze the structure of the relationships among concepts in a text, including relationships among key terms (e.g., *force*, *friction*, *reaction force*, *energy*).

6. Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, defining the question the author seeks to address.

Integration of Knowledge and Ideas

7. Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.

8. Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem.

9. Compare and contrast findings presented in a text to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts.

Range of Reading and Level of Text Complexity

10. By the end of grade 10, read and comprehend science/technical texts in the grades 9–10 text complexity band independently and proficiently.

Writing Standards

Text Types and Purposes

1. Write arguments focused on *discipline-specific content*.
   a. Introduce precise claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that establishes clear relationships among the claim(s), counterclaims, reasons, and evidence.
   b. Develop claim(s) and counterclaims fairly, supplying data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form and in a manner that anticipates the audience's knowledge level and concerns.
   c. Use words, phrases, and clauses to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims.

d. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.
e. Provide a concluding statement or section that follows from or supports the argument presented.

2. Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.
a. Introduce a topic and organize ideas, concepts, and information to make important connections and distinctions; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.
b. Develop the topic with well-chosen, relevant, and sufficient facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic.
c. Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among ideas and concepts.
d. Use precise language and domain-specific vocabulary to manage the complexity of the topic and convey a style appropriate to the discipline and context as well as to the expertise of likely readers.
e. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.
f. Provide a concluding statement or section that follows from and supports the information or explanation presented (e.g., articulating implications or the significance of the topic).

3. Students' narrative skills continue to grow in these grades. The standards require that students be able to incorporate narrative elements effectively into arguments and informative/explanatory texts. In history/social studies, students must be able to incorporate narrative accounts into their analyses of individuals or events of historical import. In science and technical subjects, students must be able to write precise enough descriptions of the step-by-step procedures they use in their investigations or technical work that others can replicate them and (possibly) reach the same results.

Production and Distribution of Writing

4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

5. Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.

6. Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically.

Research to Build and Present Knowledge

7. Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

8. Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation.

9. Draw evidence from informational texts to support analysis, reflection, and research.

Range of Writing

10. Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

Essential Questions

- How are 3D objects related to their 2D representations.
- How do engineers represent objects for production.
- How do I look at a complex object and break it into manageable shapes.
- How do I create very complicated 3D shapes.
- How do engineers represent assemblies of many complex 3 dimensional objects that work together to form a single unit.
- How do CAD drafters show more about complex 3D objects.
- Are there other ways to draw 3D objects

Enduring Understandings

Students will learn how:

- To draw 3D objects by extruding and revolving 2D objects

- Break down complex 3D objects into component parts
- Combine simple 3D objects to created complex objects
- Engineering representation of 3D objects using software
- Draw complex assemblies
- Draw using more than one CAD program

Evidence of Understanding

The students will:

- Drawings of Complex 3D objects
- Student journal of learning
- Midyear and final exams

Course Outline

Unit	Essential Questions	Skills and Understandings	Assessment
Create 3 D drawings from 2D drawings	• How are 3D objects related to their 2D representations.	• Extrude • Revolve • Boolean Opertions • Views • Axis'	• Drawings of 3D objects • Journals
Create orthographic drawings from 3D object drawings.	• How do engineers represent objects for production.	• Orthographic projection • Isometric drawings	• Drawings • Journals
Create complex 3D objects from simple 3D objects.	• How do I look at a complex object and break it into manageable shapes.	• Box • Cylinder • Pyramid	• Drawing of 3D objects • Journals
Create more complex 3-D objects using all 3-D skills.	• How do I create very complicated 3D shapes.	• Modify commands	• Drawing of 3-D objects • Journals
Assemblies	• How do engineers represent assemblies of many complex 3 dimensional objects that work together to form a single unit.	• Assembly representation	• Drawings • Journals
Section views	• How do CAD drafters show more about complex 3D objects.	• Sections	• Drawings • Journals
Parametric Drawing	• Are there other ways to draw 3D objects	• Use Parametric Drafting software to create complex 3D shapes.	• Drawings • Journals

Introduction to Engineering Design: Academic

Grade Level	11, 12
Course Number	363

Subject Area	Science and Technology

Course Description

This course is intended for students in grades 11 and 12 who have an interest in engineering and would like to explore the different types of engineering available for study in college. This course will introduce students the application of the principles learned in math and science courses to meet engineering requirements. Topics of study include: Surveying, stress and strain, strengths of materials, thermal considerations, circuit design, manufacturing and robotics.

Content Standards

1. Engineering Design

Central Concepts: Engineering design involves practical problem solving, research, development, and invention/innovation, and requires designing, drawing, building, testing, and redesigning. Students should demonstrate the ability to use the engineering design process to solve a problem or meet a challenge.

1.1 Identify and explain the steps of the engineering design process: identify the problem, research the problem, develop possible solutions, select the best possible solution(s), construct prototypes and/or models, test and evaluate, communicate the solutions, and redesign.
1.2 Understand that the engineering design process is used in the solution of problems and the advancement of society. Identify examples of technologies, objects, and processes that have been modified to advance society, and explain why and how they were modified.
1.3 Produce and analyze multi-view drawings (orthographic projections) and pictorial drawings (isometric, oblique, perspective), using various techniques.
1.4 Interpret and apply scale and proportion to orthographic projections and pictorial drawings (e.g., ¼" = 1'0", 1 cm = 1 m).
1.5 Interpret plans, diagrams, and working drawings in the construction of prototypes or models.
.

2. Construction Technologies

Central Concepts: The construction process is a series of actions taken to build a structure, including preparing a site, setting a foundation, erecting a structure, installing utilities, and finishing a site. Various materials, processes, and systems are used to build structures. Students should demonstrate and apply the concepts of construction technology through building and constructing either full-size models or scale models using various materials commonly used in construction. Students should demonstrate the ability to use the engineering design process to solve a problem or meet a challenge in construction technology.

2.1 Identify and explain the engineering properties of materials used in structures (e.g., elasticity, plasticity, R value, density, strength).
2.2 Distinguish among tension, compression, shear, and torsion, and explain how they relate to the selection of materials in structures.
2.3 Explain Bernoulli's principle and its effect on structures such as buildings and bridges.
2.4 Calculate the resultant force(s) for a combination of live loads and dead loads.
2.5 Identify and demonstrate the safe and proper use of common hand tools, power tools, and measurement devices used in construction.
2.6 Recognize the purposes of zoning laws and building codes in the design and use of structures.

3. Energy and Power Technologies – Fluid Systems

Central Concepts: Fluid systems are made up of liquids or gases and allow force to be transferred from one location to another. They can also provide water, gas, and/or oil, and/or remove waste. They can be moving or stationary and have associated pressures and velocities. Students should demonstrate the ability to use the engineering design process to solve a problem or meet a challenge in a fluid system.

3.1 Explain the basic differences between open fluid systems (e.g., irrigation, forced hot air system, air compressors) and closed fluid systems (e.g., forced hot water system, hydraulic brakes).
3.2 Explain the differences and similarities between hydraulic and pneumatic systems, and explain how each relates to manufacturing and transportation systems.
3.3 Calculate and describe the ability of a hydraulic system to multiply distance, multiply force, and effect directional

change.

3.4 Recognize that the velocity of a liquid moving in a pipe varies inversely with changes in the cross-sectional area of the pipe.

3.5 Identify and explain sources of resistance (e.g., 45º elbow, 90º elbow, changes in diameter) for water moving through a pipe.

4. Energy and Power Technologies – Thermal Systems

Central Concepts: Thermal systems involve transfer of energy through conduction, convection, and radiation, and are used to control the environment. Students should demonstrate the ability to use the engineering design process to solve a problem or meet a challenge in a thermal system.

4.1 Differentiate among conduction, convection, and radiation in a thermal system (e.g., heating and cooling a house, cooking).

4.2 Give examples of how conduction, convection, and radiation are considered in the selection of materials for buildings and in the design of a heating system.

4.3 Explain how environmental conditions such as wind, solar angle, and temperature influence the design of buildings.

4.4 Identify and explain alternatives to nonrenewable energies (e.g., wind and solar energy conversion systems).

5. Energy and Power Technologies – Electrical Systems

Central Concepts: Electrical systems generate, transfer, and distribute electricity. Students should demonstrate the ability to use the engineering design process to solve a problem or meet a challenge in an electrical system.

5.1 Explain how to measure and calculate voltage, current, resistance, and power consumption in a series circuit and in a parallel circuit. Identify the instruments used to measure voltage, current, power consumption, and resistance.

5.2 Identify and explain the components of a circuit, including sources, conductors, circuit breakers, fuses, controllers, and loads. Examples of some controllers are switches, relays, diodes, and variable resistors.

5.3 Explain the relationships among voltage, current, and resistance in a simple circuit, using Ohm's law.

5.4 Recognize that resistance is affected by external factors (e.g., temperature).

5.5 Compare and contrast alternating current (AC) and direct current (DC), and give examples of each.

Reading Standards for Literacy in Science

Key Ideas and Details

1. Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.

2. Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text.

3. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text.

Craft and Structure

4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 9–10 texts and topics*.

5. Analyze the structure of the relationships among concepts in a text, including relationships among key terms (e.g., *force*, *friction*, *reaction force*, *energy*).

6. Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, defining the question the author seeks to address.

Integration of Knowledge and Ideas

7. Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.

8. Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem.

9. Compare and contrast findings presented in a text to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts.

Range of Reading and Level of Text Complexity

10. By the end of grade 10, read and comprehend science/technical texts in the grades 9–10 text complexity band independently and proficiently.

Writing Standards

Text Types and Purposes

1. Write arguments focused on *discipline-specific content*.
- a. Introduce precise claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that establishes clear relationships among the claim(s), counterclaims, reasons, and evidence.
- b. Develop claim(s) and counterclaims fairly, supplying data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form and in a manner that anticipates the audience's knowledge level and concerns.
- c. Use words, phrases, and clauses to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims.
- d. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.
- e. Provide a concluding statement or section that follows from or supports the argument presented.

2. Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.
- a. Introduce a topic and organize ideas, concepts, and information to make important connections and distinctions; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.
- b. Develop the topic with well-chosen, relevant, and sufficient facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic.
- c. Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among ideas and concepts.
- d. Use precise language and domain-specific vocabulary to manage the complexity of the topic and convey a style appropriate to the discipline and context as well as to the expertise of likely readers.
- e. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.
- f. Provide a concluding statement or section that follows from and supports the information or explanation presented (e.g., articulating implications or the significance of the topic).

3. Students' narrative skills continue to grow in these grades. The standards require that students be able to incorporate narrative elements effectively into arguments and informative/explanatory texts. In history/social studies, students must be able to incorporate narrative accounts into their analyses of individuals or events of historical import. In science and technical subjects, students must be able to write precise enough descriptions of the step-by-step procedures they use in their investigations or technical work that others can replicate them and (possibly) reach the same results.

Production and Distribution of Writing

4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

5. Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.

6. Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically.

Research to Build and Present Knowledge

7. Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

8. Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation.

9. Draw evidence from informational texts to support analysis, reflection, and research.

Range of Writing

10. Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

Essential Questions

- What is the procedure that engineers follow to develop and design solutions to problems.
- What is the reaction of forces when combined and applied at an angle.
- How does electricity work, and how do electrical engineers use this with other components to have a desired outcome?
- What are the main methods of heat transfer and how are they affected by outside changes.
- How does Newton's second law of motion affect speed when coupled with drag and friction?
- How are property lines established?

Enduring Understandings

Students will learn how:

- Name and use the seven steps of the design process.
- Calculate forces in systems.
- Create circuits for a desired outcome.
- Use the laws of thermodynamics and heat transfer.
- Combine many effects for a desired outcome.
- Survey and draw a surveyed area.

Evidence of Understanding

The students will:

- take tests
- take quizzes
- work collaboratively and independently on class work
- Make prototypes
- Essay after action reviews

Course Outline

Unit	Essential Questions	Skills and Understandings	Assessment
Seven steps of the design process	What is the procedure that engineers follow to develop and design solutions to problems.	Name and use the seven steps of the design process.	• Test • Small project using steps • Paper on after action review
Statics and force systems	What is the reaction of forces when combined and applied at an angle.	Calculate forces in systems.	• Test • Bridge building project • Paper on after action review.
Circuits	How does electricity work, and how do electrical engineers use this with other components to have a desired outcome?	Create circuits for a desired outcome.	• Test • Circuits • Journal on circuit design
Thermal Systems	What are the main methods of heat transfer and how are they affected by outside changes.	Use the laws of thermodynamics and heat transfer.	• Test • Solar cooker project • Paper on after action review
Speed Friction and drag	How does Newton's second law of motion affect speed when coupled with drag and friction?	Combine many effects for a desired outcome.	• Test • Drag racing project • Paper on after action review
Surveying	How are property lines established?	Survey and draw a surveyed area.	• Test • Surveying project

Principles of Engineering: Academic

Grade Level	11, 12
Course Number	330
Subject Area	Science and Technology

Course Description

This course is intended for students in grades 11 and 12 who have an interest in engineering and would like to explore the different types of engineering available for study in college. This course will introduce students the application of the principles learned in math and science courses to meet engineering requirements. Topics of study include: Surveying, stress and strain, strengths of materials, thermal considerations, circuit design, manufacturing and robotics.

Content Standards

1. Engineering Design

Central Concepts: Engineering design involves practical problem solving, research, development, and invention/innovation, and requires designing, drawing, building, testing, and redesigning. Students should demonstrate the ability to use the engineering design process to solve a problem or meet a challenge.

1.1 Identify and explain the steps of the engineering design process: identify the problem, research the problem, develop possible solutions, select the best possible solution(s), construct prototypes and/or models, test and evaluate, communicate the solutions, and redesign.
1.2 Understand that the engineering design process is used in the solution of problems and the advancement of society. Identify examples of technologies, objects, and processes that have been modified to advance society, and explain why and how they were modified.
1.3 Produce and analyze multi-view drawings (orthographic projections) and pictorial drawings (isometric, oblique, perspective), using various techniques.
1.4 Interpret and apply scale and proportion to orthographic projections and pictorial drawings (e.g., ¼" = 1'0", 1 cm = 1 m).
1.5 Interpret plans, diagrams, and working drawings in the construction of prototypes or models.
.

2. Construction Technologies

Central Concepts: The construction process is a series of actions taken to build a structure, including preparing a site, setting a foundation, erecting a structure, installing utilities, and finishing a site. Various materials, processes, and systems are used to build structures. Students should demonstrate and apply the concepts of construction technology through building and constructing either full-size models or scale models using various materials commonly used in construction. Students should demonstrate the ability to use the engineering design process to solve a problem or meet a challenge in construction technology.

2.1 Identify and explain the engineering properties of materials used in structures (e.g., elasticity, plasticity, R value, density, strength).
2.2 Distinguish among tension, compression, shear, and torsion, and explain how they relate to the selection of materials in structures.
2.3 Explain Bernoulli's principle and its effect on structures such as buildings and bridges.
2.4 Calculate the resultant force(s) for a combination of live loads and dead loads.
2.5 Identify and demonstrate the safe and proper use of common hand tools, power tools, and measurement devices used in construction.
2.6 Recognize the purposes of zoning laws and building codes in the design and use of structures.

3. Energy and Power Technologies – Fluid Systems

Central Concepts: Fluid systems are made up of liquids or gases and allow force to be transferred from one location to another. They can also provide water, gas, and/or oil, and/or remove waste. They can be moving or stationary and have associated pressures and velocities. Students should demonstrate the ability to use the engineering design process to solve a

problem or meet a challenge in a fluid system.

3.1 Explain the basic differences between open fluid systems (e.g., irrigation, forced hot air system, air compressors) and closed fluid systems (e.g., forced hot water system, hydraulic brakes).
3.2 Explain the differences and similarities between hydraulic and pneumatic systems, and explain how each relates to manufacturing and transportation systems.
3.3 Calculate and describe the ability of a hydraulic system to multiply distance, multiply force, and effect directional change.
3.4 Recognize that the velocity of a liquid moving in a pipe varies inversely with changes in the cross-sectional area of the pipe.
3.5 Identify and explain sources of resistance (e.g., 45º elbow, 90º elbow, changes in diameter) for water moving through a pipe.

4. Energy and Power Technologies – Thermal Systems

Central Concepts: Thermal systems involve transfer of energy through conduction, convection, and radiation, and are used to control the environment. Students should demonstrate the ability to use the engineering design process to solve a problem or meet a challenge in a thermal system.

4.1 Differentiate among conduction, convection, and radiation in a thermal system (e.g., heating and cooling a house, cooking).
4.2 Give examples of how conduction, convection, and radiation are considered in the selection of materials for buildings and in the design of a heating system.
4.3 Explain how environmental conditions such as wind, solar angle, and temperature influence the design of buildings.
4.4 Identify and explain alternatives to nonrenewable energies (e.g., wind and solar energy conversion systems).

5. Energy and Power Technologies – Electrical Systems

Central Concepts: Electrical systems generate, transfer, and distribute electricity. Students should demonstrate the ability to use the engineering design process to solve a problem or meet a challenge in an electrical system.

5.1 Explain how to measure and calculate voltage, current, resistance, and power consumption in a series circuit and in a parallel circuit. Identify the instruments used to measure voltage, current, power consumption, and resistance.
5.2 Identify and explain the components of a circuit, including sources, conductors, circuit breakers, fuses, controllers, and loads. Examples of some controllers are switches, relays, diodes, and variable resistors.
5.3 Explain the relationships among voltage, current, and resistance in a simple circuit, using Ohm's law.
5.4 Recognize that resistance is affected by external factors (e.g., temperature).
5.5 Compare and contrast alternating current (AC) and direct current (DC), and give examples of each.

Reading Standards for Literacy in Science

Key Ideas and Details

1. Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.

2. Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text.

3. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text.

Craft and Structure

4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 9–10 texts and topics*.

5. Analyze the structure of the relationships among concepts in a text, including relationships among key terms (e.g., *force, friction, reaction force, energy*).

6. Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, defining the question the author seeks to address.

Integration of Knowledge and Ideas

7. Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.

8. Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem.

9. Compare and contrast findings presented in a text to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts.

Range of Reading and Level of Text Complexity

10. By the end of grade 10, read and comprehend science/technical texts in the grades 9–10 text complexity band independently and proficiently.

Writing Standards

Text Types and Purposes

1. Write arguments focused on *discipline-specific content*.

a. Introduce precise claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that establishes clear relationships among the claim(s), counterclaims, reasons, and evidence.

b. Develop claim(s) and counterclaims fairly, supplying data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form and in a manner that anticipates the audience's knowledge level and concerns.

c. Use words, phrases, and clauses to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims.

d. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.

e. Provide a concluding statement or section that follows from or supports the argument presented.

2. Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.

a. Introduce a topic and organize ideas, concepts, and information to make important connections and distinctions; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.

b. Develop the topic with well-chosen, relevant, and sufficient facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic.

c. Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among ideas and concepts.

d. Use precise language and domain-specific vocabulary to manage the complexity of the topic and convey a style appropriate to the discipline and context as well as to the expertise of likely readers.

e. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.

f. Provide a concluding statement or section that follows from and supports the information or explanation presented (e.g., articulating implications or the significance of the topic).

3. Students' narrative skills continue to grow in these grades. The standards require that students be able to incorporate narrative elements effectively into arguments and informative/explanatory texts. In history/social studies, students must be able to incorporate narrative accounts into their analyses of individuals or events of historical import. In science and technical subjects, students must be able to write precise enough descriptions of the step-by-step procedures they use in their investigations or technical work that others can replicate them and (possibly) reach the same results.

Production and Distribution of Writing

4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

5. Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.

6. Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically.

Research to Build and Present Knowledge

7. Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

8. Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation.

9. Draw evidence from informational texts to support analysis, reflection, and research.

Range of Writing

10. Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

Essential Questions

- What is the procedure that engineers follow to develop and design solutions to problems.
- What is the reaction of forces when combined and applied at an angle.
- How does electricity work, and how do electrical engineers use this with other components to have a desired outcome?
- What are the main methods of heat transfer and how are they affected by outside changes.
- How does Newton's second law of motion affect speed when coupled with drag and friction?
- How are property lines established?

Enduring Understandings

Students will learn how:

- Name and use the seven steps of the design process.
- Calculate forces in systems.
- Create circuits for a desired outcome.
- Use the laws of thermodynamics and heat transfer.
- Combine many effects for a desired outcome.
- Survey and draw a surveyed area.

Evidence of Understanding

The students will:

- take tests
- take quizzes
- work collaboratively and independently on class work
- Make prototypes
- Essay after action reviews

Course Outline

Unit	Essential Questions	Skills and Understandings	Assessment
Seven steps of the design process	What is the procedure that engineers follow to develop and design solutions to problems.	Name and use the seven steps of the design process.	• Test • Small project using steps • Paper on after action review
Statics and force systems	What is the reaction of forces when combined and applied at an angle.	Calculate forces in systems.	• Test • Bridge building project • Paper on after action review.
Circuits	How does electricity work, and how do electrical engineers use this with other components to have a desired outcome?	Create circuits for a desired outcome.	• Test • Circuits • Journal on circuit design
Thermal Systems	What are the main methods of heat transfer and how are they affected by outside changes.	Use the laws of thermodynamics and heat transfer.	• Test • Solar cooker project • Paper on after action review
Speed Friction and drag	How does Newton's second law of motion affect speed when coupled with drag and friction?	Combine many effects for a desired outcome.	• Test • Drag racing project • Paper on after action

			review
Surveying	How are property lines established?	Survey and draw a surveyed area.	• Test • Surveying project

Architectural Design: Academic

Grade Level	9, 10, 11, 12
Course Number	370
Subject Area	Science and Technology

Course Description

This course is an introduction to Architecture as a career with a concentration on duties and considerations as an architect. Special attention is paid to Architectural drawing, considerations and architectural history.

Content Standards

1. Engineering Design

Central Concepts: Engineering design involves practical problem solving, research, development, and invention/innovation, and requires designing, drawing, building, testing, and redesigning. Students should demonstrate the ability to use the engineering design process to solve a problem or meet a challenge.

1.3 Produce and analyze multi-view drawings (orthographic projections) and pictorial drawings (isometric, oblique, perspective), using various techniques.
1.4 Interpret and apply scale and proportion to orthographic projections and pictorial drawings (e.g., ¼" = 1'0", 1 cm = 1 m).
1.5 Interpret plans, diagrams, and working drawings in the construction of prototypes or models.
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2. Construction Technologies

Central Concepts: The construction process is a series of actions taken to build a structure, including preparing a site, setting a foundation, erecting a structure, installing utilities, and finishing a site. Various materials, processes, and systems are used to build structures. Students should demonstrate and apply the concepts of construction technology through building and constructing either full-size models or scale models using various materials commonly used in construction. Students should demonstrate the ability to use the engineering design process to solve a problem or meet a challenge in construction technology.

2.1 Identify and explain the engineering properties of materials used in structures (e.g., elasticity, plasticity, R value, density, strength).
2.6 Recognize the purposes of zoning laws and building codes in the design and use of structures.

4. Energy and Power Technologies – Thermal Systems

Central Concepts: Thermal systems involve transfer of energy through conduction, convection, and radiation, and are used to control the environment. Students should demonstrate the ability to use the engineering design process to solve a problem or meet a challenge in a thermal system.

4.3 Explain how environmental conditions such as wind, solar angle, and temperature influence the design of buildings.

Reading Standards for Literacy in Science
Key Ideas and Details
1. Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.
2. Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text.
3. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text.
Craft and Structure
4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 9–10 texts and topics*.
5. Analyze the structure of the relationships among concepts in a text, including relationships among key terms (e.g., *force, friction, reaction force, energy*).
6. Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, defining the question the author seeks to address.
Integration of Knowledge and Ideas
7. Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.
8. Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem.
9. Compare and contrast findings presented in a text to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts.
Range of Reading and Level of Text Complexity
10. By the end of grade 10, read and comprehend science/technical texts in the grades 9–10 text complexity band independently and proficiently.
Writing Standards
Text Types and Purposes
1. Write arguments focused on *discipline-specific content*. a. Introduce precise claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that establishes clear relationships among the claim(s), counterclaims, reasons, and evidence. b. Develop claim(s) and counterclaims fairly, supplying data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form and in a manner that anticipates the audience's knowledge level and concerns. c. Use words, phrases, and clauses to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims. d. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing. e. Provide a concluding statement or section that follows from or supports the argument presented.
2. Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. a. Introduce a topic and organize ideas, concepts, and information to make important connections and distinctions; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension. b. Develop the topic with well-chosen, relevant, and sufficient facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic. c. Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among ideas and concepts. d. Use precise language and domain-specific vocabulary to manage the complexity of the topic and convey a style appropriate to the discipline and context as well as to the expertise of likely readers. e. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing. f. Provide a concluding statement or section that follows from and supports the information or explanation presented (e.g., articulating implications or the significance of the topic).
3. Students' narrative skills continue to grow in these grades. The standards require that students be able to incorporate narrative elements effectively into arguments and informative/explanatory texts. In history/social studies, students

must be able to incorporate narrative accounts into their analyses of individuals or events of historical import. In science and technical subjects, students must be able to write precise enough descriptions of the step-by-step procedures they use in their investigations or technical work that others can replicate them and (possibly) reach the same results.
Production and Distribution of Writing
4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
5. Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.
6. Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically.
Research to Build and Present Knowledge
7. Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.
8. Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation.
9. Draw evidence from informational texts to support analysis, reflection, and research.
Range of Writing
10. Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

Essential Questions

- How do architects communicate to stakeholders?
- How do architects communicate to stakeholders?
- What else do architects worry about when building a house?
- How do houses stand up?
- What design considerations do architects use when designing a building?
- How do architects show how a building will look before it is built that constitutes matter?

Enduring Understandings

Students will learn how:

- Draw a full floor plan
- Draw an elevation and create a schedule.
- Draw a plot plan.
- Build a model of a framed home.
- Name the major architectural periods and their key characteristics.
- Draw 1point and 2 point perspective drawings.

Evidence of Understanding

The students will:

- take tests
- take quizzes
- work collaboratively and independently on class work
- draw a floor-plan
- draw an elevation
- build a model of a house
- give oral presentations using Power Point
- give poster presentations
- read architecture specific literature

Course Outline

Unit	Essential Questions	Skills and Understandings	Assessment

Floor Plan drawings	• How do architects communicate to stakeholders?	• Draw a full floor plan	• Work Sheets • Tests on symbols • Major floor plan drawing
Elevation Drawings and schedules	• How do architects communicate to stakeholders?	• Draw an elevation • Create a schedule. • Roof styles.	• Work sheets • Tests • Roof drawings • Major Elevation drawing
Site considerations and Zoning	• What else do architects worry about when building a house?	• Draw a plot plan.	• Test on zoning • Draw a plot plan
Framing	• How do houses stand up?	• Build a model of a framed home. • Understand soil types • Understand foundation types.	• Test on foundations • Test on soil types • Build house model
Architectural History	• What design considerations do architects use when designing a building?	• Name the major architectural periods and their key characteristics.	• Test on history • Quiz on history • Presentation on history to class.
Perspective drawing	How do architects show how a building will look before it is built?	Draw 1point and 2 point perspective drawings.	• Perspective drawings

Introduction to Engineering Design

Grade Level	9
Course Number	363
Subject Area	Science and Technology

Course Description

Introduction to Engineering Design extends the content of Technical Drawing to further develop students' problem solving skills with a focus on the development of three-dimensional solid models. Students will work from drawing simple geometric shapes to applying a solid modeling computer software package. Students will learn a problem-solving design process and how it is used in industry to manufacture a product. A Computer Aided Design program will also be used to analyze and evaluate the product design. This course is a prerequisite for those students seeking to enroll in the Principles of Engineering course.

Content Standards

1. Engineering Design

Central Concepts: Engineering design involves practical problem solving, research, development, and invention/innovation, and requires designing, drawing, building, testing, and redesigning. Students should demonstrate the ability to use the engineering design process to solve a problem or meet a challenge.

1.1 Identify and explain the steps of the engineering design process: identify the problem, research the problem, develop possible solutions, select the best possible solution(s), construct prototypes and/or models, test and evaluate, communicate the solutions, and redesign.
1.2 Understand that the engineering design process is used in the solution of problems and the advancement of society. Identify examples of technologies, objects, and processes that have been modified to advance society, and explain why and how they were modified.
1.3 Produce and analyze multi-view drawings (orthographic projections) and pictorial drawings (isometric, oblique, perspective), using various techniques.
1.4 Interpret and apply scale and proportion to orthographic projections and pictorial drawings (e.g., ¼" = 1'0", 1 cm = 1 m).
1.5 Interpret plans, diagrams, and working drawings in the construction of prototypes or models.
.

2. Construction Technologies

Central Concepts: The construction process is a series of actions taken to build a structure, including preparing a site, setting a foundation, erecting a structure, installing utilities, and finishing a site. Various materials, processes, and systems are used to build structures. Students should demonstrate and apply the concepts of construction technology through building and constructing either full-size models or scale models using various materials commonly used in construction. Students should demonstrate the ability to use the engineering design process to solve a problem or meet a challenge in construction technology.

2.1 Identify and explain the engineering properties of materials used in structures (e.g., elasticity, plasticity, R value, density, strength).
2.2 Distinguish among tension, compression, shear, and torsion, and explain how they relate to the selection of materials in structures.
2.3 Explain Bernoulli's principle and its effect on structures such as buildings and bridges.
2.5 Identify and demonstrate the safe and proper use of common hand tools, power tools, and measurement devices used in construction.
2.6 Recognize the purposes of zoning laws and building codes in the design and use of structures.

3. Energy and Power Technologies – Fluid Systems

Central Concepts: Fluid systems are made up of liquids or gases and allow force to be transferred from one location to

another. They can also provide water, gas, and/or oil, and/or remove waste. They can be moving or stationary and have associated pressures and velocities. Students should demonstrate the ability to use the engineering design process to solve a problem or meet a challenge in a fluid system.

3.1 Explain the basic differences between open fluid systems (e.g., irrigation, forced hot air system, air compressors) and closed fluid systems (e.g., forced hot water system, hydraulic brakes).
3.2 Explain the differences and similarities between hydraulic and pneumatic systems, and explain how each relates to manufacturing and transportation systems.
3.3 Calculate and describe the ability of a hydraulic system to multiply distance, multiply force, and effect directional change.
3.4 Recognize that the velocity of a liquid moving in a pipe varies inversely with changes in the cross-sectional area of the pipe.

4. Energy and Power Technologies – Thermal Systems

Central Concepts: Thermal systems involve transfer of energy through conduction, convection, and radiation, and are used to control the environment. Students should demonstrate the ability to use the engineering design process to solve a problem or meet a challenge in a thermal system.

4.1 Differentiate among conduction, convection, and radiation in a thermal system (e.g., heating and cooling a house, cooking).
4.2 Give examples of how conduction, convection, and radiation are considered in the selection of materials for buildings and in the design of a heating system.
4.3 Explain how environmental conditions such as wind, solar angle, and temperature influence the design of buildings.
4.4 Identify and explain alternatives to nonrenewable energies (e.g., wind and solar energy conversion systems).

5. Energy and Power Technologies – Electrical Systems

Central Concepts: Electrical systems generate, transfer, and distribute electricity. Students should demonstrate the ability to use the engineering design process to solve a problem or meet a challenge in an electrical system.

5.1 Explain how to measure and calculate voltage, current, resistance, and power consumption in a series circuit and in a parallel circuit. Identify the instruments used to measure voltage, current, power consumption, and resistance.
5.2 Identify and explain the components of a circuit, including sources, conductors, circuit breakers, fuses, controllers, and loads. Examples of some controllers are switches, relays, diodes, and variable resistors.
5.3 Explain the relationships among voltage, current, and resistance in a simple circuit, using Ohm's law.
5.4 Recognize that resistance is affected by external factors (e.g., temperature).
5.5 Compare and contrast alternating current (AC) and direct current (DC), and give examples of each.

7. Manufacturing Technologies

Central Concepts: Manufacturing processes can be classified into six groups: casting/molding, forming, separating, conditioning, assembling, and finishing. Students should demonstrate the ability to use the engineering design process to solve a problem or meet a challenge in a manufacturing technology.

7.1 Describe the manufacturing processes of casting and molding, forming, separating, conditioning, assembling, and finishing.
7.2 Identify the criteria necessary to select safe tools and procedures for a manufacturing process (e.g., properties of materials, required tolerances, end-uses).
7.3 Describe the advantages of using robotics in the automation of manufacturing processes (e.g., increased production, improved quality, safety).

Reading Standards for Literacy in Science

Key Ideas and Details

1. Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.

2. Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text.

3. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text.

Craft and Structure

4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 9–10 texts and topics*.

5. Analyze the structure of the relationships among concepts in a text, including relationships among key terms (e.g., *force*, *friction*, *reaction force*, *energy*).

6. Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, defining the question the author seeks to address.

Integration of Knowledge and Ideas

7. Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.

8. Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem.

9. Compare and contrast findings presented in a text to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts.

Range of Reading and Level of Text Complexity

10. By the end of grade 10, read and comprehend science/technical texts in the grades 9–10 text complexity band independently and proficiently.

Writing Standards

Text Types and Purposes

1. Write arguments focused on *discipline-specific content*.

a. Introduce precise claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that establishes clear relationships among the claim(s), counterclaims, reasons, and evidence.
b. Develop claim(s) and counterclaims fairly, supplying data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form and in a manner that anticipates the audience's knowledge level and concerns.
c. Use words, phrases, and clauses to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims.
d. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.
e. Provide a concluding statement or section that follows from or supports the argument presented.

2. Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.

a. Introduce a topic and organize ideas, concepts, and information to make important connections and distinctions; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.
b. Develop the topic with well-chosen, relevant, and sufficient facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic.
c. Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among ideas and concepts.
d. Use precise language and domain-specific vocabulary to manage the complexity of the topic and convey a style appropriate to the discipline and context as well as to the expertise of likely readers.
e. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.
f. Provide a concluding statement or section that follows from and supports the information or explanation presented (e.g., articulating implications or the significance of the topic).

3. Students' narrative skills continue to grow in these grades. The standards require that students be able to incorporate narrative
elements effectively into arguments and informative/explanatory texts. In history/social studies, students must be able to incorporate narrative accounts into their analyses of individuals or events of historical import. In science and technical subjects, students must be able to write precise enough descriptions of the step-by-step procedures they use in their investigations or technical work that others can replicate them and (possibly) reach the same results.

Production and Distribution of Writing

4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose,

and audience.
5. Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.
6. Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically.
Research to Build and Present Knowledge
7. Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.
8. Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation.
9. Draw evidence from informational texts to support analysis, reflection, and research.
Range of Writing
10. Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

Essential Questions

- How are 3D objects related to their 2D representations?
- How do engineers effectively design a new product?
- How do engineers represent objects for production?

Enduring Understandings

Students will learn how:

- To draw three dimensional and two dimensional representations of objects, both freehand and using a CAD system
- To effectively implement the engineering design process to design new products and objects
- To correctly manage the cost of producing a new product
- To analyze physical attributes of different materials.

Evidence of Understanding

The students will:

- Drawings of Complex 3D objects
- Presentations
- Project reports
- Quizzes
- Midyear and Final Exams

Course Outline

Unit	Essential Questions	Skills and Understandings	Assessment
Intro to Engineering	• What is engineering?	• Main branches of engineering and their functions • University engineering programs • Engineering salaries	• Presentation
Technical Drawing	• How are 3D objects related to their 2D representations? • How do engineers communicate their new designs to manufacturers and clients?	• Orthographic projection drawings including dimensioning and tolerancing • AutoCAD	• Drawings of 3D objects • Quiz
Camera Case Design	• How do engineers come	• Engineering design process:	• Project report

	up with new, cost-effective designs in a timely manner?	○ Brainstorming ○ Manufacturing costs • Gantt charts	• Worksheets
Energy Efficient House Design	• How do engineers take into account zoning laws and the properties of materials into their designs?	• Engineering design process: ○ Research ○ Test and Evaluate • Stress and strain measurements	• Project report • Lab report • Quiz
Putt-Putt Boat Design	• How do engineers reevaluate their design to optimize their product? • What are the fluid properties that need to be addressed when designing a boat?	• Engineering design process: ○ Research – IP review ○ Redesign • Fluid properties	• Project Report • Lab Report • Quiz
Toy Design	• How do engineers take into account the needs and wants of the public in their designs? • What are the electrical considerations for designing a small toy?	• Engineering design process: ○ Research – target population needs/wants ○ Communicate solutions • Properties of electricity	• Project Report • Lab Report • Quiz