SCIENCE LEARNING TARGETS

Anatomy and Physiology

Orientation to the Human Body

1. Develop and use models and appropriate terminology to identify regions, directions, planes, and cavities in the human body to locate organs and systems.

a) I can describe the standard anatomical position.
b) I can use appropriate terminology to investigate anatomical landmarks. (axilla, antebrachium, tarsus, thoracis, dorsum, lumbus, etc.)
c) I can relate directional terms to the anatomical position. (Superior/Inferior, Anterior/Posterior, Medial/Lateral, Superficial/Deep, Proximal/Distal, Supine/Prone, Cranial/Cephalic/Caudal)
d) I can classify the different anatomical body planes. (Frontal, Sagittal, Transverse, etc.)
e) I can identify the different body cavities and organize internal organs into the appropriate body cavities. (Pleural, Pericardial, Thoracic, Pelvic, Peritoneal, etc.)
f) I can identify anatomical quadrants and regions in the human body. (Abdominopelvic Quadrants, Abdominopelvic Regions)
g) I can develop and use a model to show the relationship among regions, directions, planes, and cavities in a human body.

Cellular Structures, Processes, and Histology

2. Analyze characteristics of tissue types (e.g., epithelial tissue) and construct an explanation of how the chemical and structural organizations of the cells that form these tissues are specialized to conduct the function of that tissue (e.g., lining, protecting).

a) I can relate the properties of water to its numerous functions in the body.
b) I can describe the transport of materials across the cell membrane. (e.g. osmosis, diffusion, glucose transport, etc.)
c) I can describe the process of cell division in relation to growth, repair, differentiation, and development.
d) I can describe the importance of cellular organelles to cellular processes.
e) I can relate uncontrolled cell division to various forms of cancer.
f) I can explain the importance and identify the primary locations of squamous, cuboidal, and columnar cells.
g) I can distinguish between simple and stratified cellular arrangement.
h) I can relate cellular arrangement to function and location in the body.
i) I can use a microscope to identify squamous, cuboidal, and columnar cells, as well as simple and stratified arrangement of those cells.
j) I can identify external cell structures such as microvilli, cilia, and flagella, and explain the importance of each.
k) I can use a microscope to identify external cell structures.
l) I can describe the various types, locations, and functions of the different tissue types (epithelial tissue, connective tissue, muscular tissue, and nervous tissue).

m) I can use a microscope to identify various types of epithelial tissue, connective tissue, muscular tissue (smooth, cardiac, skeletal), and nervous tissue.
n) I can examine the relationship between cells, tissues, organs, and organ systems in the organization of the human body.
o) I can recognize the importance of ATP as our preferred energy source.

Integumentary System

3. Analyze information to explain the integumentary system's structure and function, including layers and accessories of skin and types of membranes, and the effects of pathological conditions (e.g., burns, skin cancer, bacterial and viral infections, chemical dermatitis) to determine the body's attempt to maintain homeostasis.
a) I can identify the epidermal, dermal, and subcutaneous layers of the skin.
b) I can explain the basis for skin color.
c) I can describe the mechanisms behind the growth, color, and texture of hair.
d) I can distinguish between the glands of the skin and describe their function(s).
e) I can discuss the structure and growth of nails.
f) I can summarize the impact of aging on the skin.
g) I can relate the structure of the integumentary system to its various functions.
h) I can describe how injury to the skin is repaired.
i) I can explain the Rule of Nines and explain how it relates to burns.
j) I can describe the cause(s) and effect(s) of integumentary system disorders/diseases. (e.g. acne, albinism, jaundice, eczema, psoriasis, etc.)

Skeletal System

4. Use models to identify the structure and function of the skeletal system (e.g., classification of bones by shape, classification of joints and the appendicular and axial skeletons).
a) I can identify the major bones of the axial and appendicular skeleton.
b) I can categorize bones as long, flat, irregular, etc. and relate their shape to their function.
c) I can describe the internal anatomy of bone.
d) I can evaluate the numerous functions of bone.
e) I can differentiate between the various joints of the skeletal system.
f) I can relate the structure of the skeletal system to its function.
g) I can obtain and communicate information to demonstrate understanding of the growth and development of the skeletal system (e.g., bone growth and remodeling).
h) I can obtain and communicate information to demonstrate understanding of the pathology of the skeletal system (e.g., types of bone fractures and their treatment, osteoporosis, rickets, other bone diseases).

Muscular System

5. Develop and use models to illustrate the anatomy of the muscular system, including muscle locations and groups, actions, origins and insertions.
a) I can identify the major muscles of the human body.

b) I can identify the origin and insertion of the major muscles in the human body.
c) I can explain the importance of skeletal, smooth, and cardiac muscle to the human body.
d) I can describe the anatomy of muscle tissue.

6. Plan and conduct investigations to explain the physiology of the muscular system (e.g., muscle contraction/relaxation, muscle fatigue, muscle tone), including pathological conditions (e.g., muscular dystrophy).

a) I can describe the physiology of muscle contraction.
b) I can evaluate how bones and skeletal muscles work together to enable movement.
c) I can relate ligaments, tendons, and cartilage to their importance in musculoskeletal interactions.
d) I can describe various musculoskeletal movements. (e.g. flexion, extension, rotation, circumduction, etc.)
e) I can describe the pathological conditions that relate to the muscular system.

Nervous System

7. Obtain, evaluate, and communicate information regarding how the central nervous system and peripheral nervous system interrelate, including how these systems affect all other body systems to maintain homeostasis.

a) I can explain the structure, organization, and function of the nervous system.
b) I can compare and contrast the central and peripheral nervous systems.
c) I can compare and contrast the autonomic and somatic nervous systems.
d) I can compare and contrast the sympathetic and parasympathetic nervous system.
e) I can describe the function of the limbic system.
f) I can identify the parts of a neuron.
g) I can explain how impulses are transmitted across synapses.
h) I can describe the steps in a reflex arc.
i) I can identify the anatomy of the brain and central nervous system.
j) I can describe what each major structure in the brain controls.
k) I can distinguish between white and gray matter.
l) I can identify the major nerves in the body.
m) I can describe the structure of the spinal cord and nerves.
n) I can explain the function of the spinal cord, nerves, and tracts.
o) I can explain how impulses are generated and move throughout the central and peripheral nervous system.
p) I can relate the role of neurotransmitters nervous system function.
q) I can relate the importance of our nervous system to the maintenance of homeostasis.
r) I can describe the anatomy and physiology of our special senses. (i.e. vision, taste, smell, and hearing)
s) I can describe how our body senses pain.
t) I can distinguish between different types of pain. (e.g. referred, acute, etc.)
u) I can analyze scientific evidence to evaluate the effects of pathology on the nervous system (e.g., Parkinson's disease, Alzheimer's disease, cerebral palsy, head trauma)
v) I can argue possible prevention and treatment options for the effects of pathology on the nervous system.

8. Design a medication to treat a disorder associated with neurotransmission, including mode of entry into the body, form of medication, and desired effects.

a) I can construct a model to show the importance of a medication as it pertains to the effects of a neurotransmitter.

b) I can demonstrate my understanding of the nervous system through the dissection of a mammal's brain.

c) I can demonstrate my understanding of eye anatomy and vision through the dissection of a mammal's eye.

Circulatory System

9. Use models to determine the relationship between the structures in and functions of the cardiovascular system (e.g., components of blood, blood circulation through the heart and systems of the body, ABO blood groups, anatomy of the heart, types of blood vessels).

a) I can distinguish between the functions of erythrocytes, lymphocytes, and thrombocytes.

b) I can describe the composition and function of plasma.

c) I can distinguish between the various human blood types.

d) I can demonstrate how blood types are inherited.

e) I can evaluate blood donor and blood recipient compatibility.

f) I can explain the importance of proper blood transfusions.

g) I can identify the various structures of the cardiovascular system and describe their functions.

h) I can locate the chambers, valves, and vessels of the heart.

i) I can describe how electrical impulses control the cardiac cycle of the heart.

j) I can trace the flow of blood through the pulmonary and systemic circulatory paths.

k) I can relate the cardiac cycle to blood pressure and pulse rate.

l) I can demonstrate factors that affect blood pressure and pulse rate.

m) I can demonstrate my understanding of heart anatomy through the dissection of a mammal's heart.

10. Engage in argument from evidence regarding possible prevention and treatment options related to the pathology of the cardiovascular system (e.g., myocardial infarction, mitral valve prolapse, varicose veins, arteriosclerosis, anemia, high blood pressure).

a) I can describe the causes and effects of various blood diseases/disorders. (e.g. hemophilia, anemia, etc.)

b) I can describe the cause(s) and effect(s) of various cardiovascular diseases. (e.g. hypertension, atherosclerosis, etc.)

Digestive System

11. Communicate scientific information to explain the relationship between the structures and functions, both mechanical (e.g., chewing, churning in stomach) and chemical (e.g., enzymes, hydrochloric acid [HCl] in stomach), of the digestive system, including the accessory organs (e.g., salivary glands, pancreas), and demonstrate an understanding of the disorders of the digestive system (e.g., ulcers, Crohn's disease, diverticulitis).

a) I can list the major organs of the gastrointestinal tract.
b) I can state the function of each gastrointestinal organ in the digestive process.
c) I can list the accessory organs/glands of the digestive tract.
d) I can identify the importance of accessory structures to the digestive process.
e) I can trace the movement of food through the digestive system.
f) I can relate the anatomy of the digestive tract to its ability to maximize nutrient absorption.
g) I can explain how the stomach helps to protect us from various pathogens.
h) I can summarize how solid waste is formed and eliminated from the body.
i) I can explain the importance of enzymes to proper metabolism.
j) I can demonstrate factors that impact an enzyme's effectiveness.
k) I can describe how waste products are created.
l) I can explain why waste must be eliminated from the body.
m) I can relate physiological processes such as digestion to energy production.
n) I can describe the functions of carbohydrates, proteins, lipids, and nucleic acids.
o) I can analyze various disorders of the digestive system. (e.g. ulcers, acid reflux, etc.)

Respiratory System

12. Develop and use a model from evidence to explain how the organs of the respiratory system function, and how environmental (e.g., cigarette smoke, polluted air) and genetic factors may affect the respiratory system, possibly leading to pathological conditions (e.g., cystic fibrosis).

a) I can describe the importance of oxygen to physiological processes.
b) I can identify the various structures of the respiratory system.
c) I can explain the physiology of breathing.
d) I can demonstrate factors that influence the breathing rate.
e) I can explain the importance of gas exchange and describe how it occurs.
f) I can relate physiological processes such as respiration to energy production.
g) I can investigate the causes and effects of various diseases of the respiratory system. (e.g. asthma, emphysema, etc.)

Reproductive System

13. Obtain, evaluate, and communicate information to differentiate between the male and female reproductive systems, including pathological conditions that affect each.

a) I can distinguish between structures of the male and female reproductive systems.
b) I can compare and contrast the processes of sperm and egg production.
c) I can assess the cause and effect of various sexually transmitted diseases. (e.g. herpes, AIDS, etc.)
d) I can explain the relationship between DNA and heredity.
e) I can relate human traits to the inheritance of genes.
f) I can trace the stages in the development of a human embryo from fertilization through birth.
g) I can describe the changes that occur in the human body as it develops from infancy through old age.

Urinary System

14. Use models to differentiate the structures of the urinary system and to analyze their functions, and interpret data related to the urinary system to show the relationship between homeostatic imbalances and disease (e.g., kidney stones, effects of pH imbalances).

a) I can state the function of each structure in the urinary system.
b) I can discuss the composition and production of urine.
c) I can trace the flow of urine from its production in the kidneys to its elimination from the body.
d) I can recognize the human body contains an aqueous solution.
e) I can analyze the effects of improper fluid balance and explain the impact on the body.
f) I can relate the importance of the kidneys to the removal of waste, maintenance of fluid balance, maintenance of blood composition, and regulation of blood pressure.
g) I can examine the cause(s) and effect(s) of various diseases/disorders of the urinary system. (e.g. urinary tract infections, cystitis, etc.)

Lymphatic System

15. Obtain and communicate information to explain the lymphatic organs and their structure and function, and information to demonstrate an understanding of the disorders of the immune system (e.g., acquired immunodeficiency syndrome [AIDS], severe combined immunodeficiency [SCID]).

a) I can relate homeostasis to human illness and disease.
b) I can evaluate the importance of lymph.
c) I can illustrate where the major lymph nodes are located in the body.
d) I can explain why lymph nodes can be indicators of infection or cancer.
e) I can distinguish between autoimmune and immunodeficiency disorders.
f) I can explain the relationship between the structures of the lymphatic system and our body's immune response.
g) I can summarize the body's immune response.
h) I can distinguish between active and passive immunity.

Endocrine System

16. Analyze and communicate information to support the claim that the endocrine glands secrete hormones that help the body maintain homeostasis through feedback loops, and the effects of pathological conditions caused by imbalance of the hormones of the endocrine glands.

a) I can describe the location of the major glands and structures of the endocrine system.
b) I can explain the physiological importance of hormones in the body.
c) I can list the major hormones of the body, what they control, and what gland produces them.
d) I can explain the feedback mechanisms involved in hormones maintaining homeostasis.
e) I can explain the influence of the nervous system on the function of the endocrine system.
f) I can explain the relationship between the endocrine system and our circadian rhythm.
g) I can relate endocrine system functions to the process of puberty and sexual maturation.

h) I can describe the cause and effects of various diseases/disorders of the endocrine system. (i.e. diabetes, dwarfism, etc.).

General Biology

Molecules to Organisms: Structures and Processes

1. Use models to compare and contrast the structural characteristics of macromolecules and define their function in organisms.
a) I can model the structures of proteins, lipids, carbohydrates, and nucleic acids.
b) I can evaluate the structures of proteins, lipids, carbohydrates, and nucleic acids as each relates to other macromolecules.
c) I can analyze the functions of proteins, lipids, carbohydrates, and nucleic acids as they pertain to organisms in the ecosystem.

2. Plan and carry out investigations to explain feedback mechanisms and cellular processes that maintain homeostasis.
a) I can plan and carry out investigations to explain how the unique properties of water (e.g., polarity, cohesion, adhesion) are vital to maintaining homeostasis in organisms (e.g., sweating and shivering).
b) I can describe the types of passive and active transport in relation to homeostasis.
c) I can illustrate and compare the effects of hypotonic, hypertonic, and isotonic solutions in cells of organisms.

3. Obtain, evaluate, and communicate information to describe the function and diversity of organelles and structures in various types of cells.
a) I can distinguish and illustrate between prokaryotic and eukaryotic cells.
b) I can explain the difference between plant and animal cells(e.g., mitochondria, chloroplasts in plant cells).

Heredity: Inheritance and Variation of Traits

4. Develop and use a model to analyze the structure of chromosomes and how new genetic combinations occur through the process of meiosis and mitosis in multicellular organisms.
a) I can explain and model the stages of the mitotic cell cycle (e.g., normal growth and/or uncontrolled growth resulting in tumors).
b) I can analyze data to draw conclusions about genetic disorders caused by errors in meiosis (e.g., Down syndrome, Turner syndrome, hemophilia, sickle cell anemia, etc.)
c) I can identify and distinguish between the phases of meiosis.

5. Formulate an evidence-based explanation regarding how the composition of deoxyribonucleic acid (DNA) determines the structural organization of proteins.
a) I can obtain and evaluate experiments of major scientists and communicate their contributions to the development of the structure of DNA and to the development of the central dogma of molecular biology.

b) I can obtain, evaluate, and communicate information that explains how advancements in genetic technology have contributed to the understanding as to how a genetic change at the DNA level may affect proteins and, in turn, influence the appearance of traits.
c) I can obtain information to identify errors that occur during DNA replication (e.g., deletion, insertion, translocation, substitution, inversion, frame-shift, point mutations).

6. Analyze and interpret data collected from probability calculations to explain the variation of expressed traits within a population.
a) I can predict phenotypic and genotypic ratios and percentages by constructing Punnett squares, including using both homozygous and heterozygous allele pairs.
b) I can develop and use models to demonstrate codominance, incomplete dominance, and Mendel's laws of segregation and independent assortment.
c) I can analyze and interpret data regarding Mendelian and complex genetic disorders to determine patterns of genetic inheritance and disease risks from both genetic and environmental factors.

Ecosystems: Interactions, Energy, and Dynamics
7. Analyze and interpret data from investigations to explain the role of products and reactants of photosynthesis and cellular respiration in the cycling of matter and the flow of energy.
a) I can plan and carry out investigations to explain the interactions among pigments, absorption of light, and reflection of light.
b) I can evaluate how light plays an integral role in the pigments that absorb and reflect different wavelengths of light.
c) I can analyze how the products of photosynthesis act as the reactants in cellular respiration as energy cycles through an ecosystem.
d) I can construct a model to show how the energy produced through cellular respiration is transferred into an energy pyramid.

8. Develop and use models to illustrate examples of ecological hierarchy levels, including biosphere, biome, ecosystem, community, population, and organism.
a) I can obtain and evaluate the levels of organization in order from cells to biosphere.
b) I can identify biomes based on the environmental factors, location and native organisms.

9. Develop and use models to describe the cycling of matter and flow of energy between abiotic and biotic factors in ecosystems.

a) I can trace and describe the flow of energy as it decreases from producers to consumers in food chains, food webs, and energy pyramids.
b) I can illustrate biogeochemical cycles through the environment, including water, oxygen, and nitrogen, and carbon.
10. Use mathematical comparisons and visual representations to support, construct or refute explanations of factors that affect population growth.
a) I can evaluate data and construct graphs in relation to population growth.

b) I can discuss the ways humans have altered ecosystems.
c) I can discuss the ways humans have altered ecosystems (ex. greenhouse effect, climate change, etc.)
d) I can construct an explanation and design a real-world solution to address changing conditions and ecological succession caused by density-dependent and/or density-independent factors.

Unity and Diversity

11. Obtain, evaluate, and communicate information to explain how organisms are classified by physical characteristics, organized into levels of taxonomy, and identified by binomial nomenclature.
a) I can engage in argument to justify the grouping of viruses in a category separate from living things.
b) I can identify the hierarchy of classification including domain to species.
c) I can classify organisms into the appropriate kingdom based on their physical characteristics.

12. Engage in argument from evidence and analyze scientific evidence to support the theory of common ancestry and biological evolution to explain the diversity of organisms.
a) I can interpret evidence that supports evolution (i.e. fossil record, geographic isolation, vestigial structures, and homologous structures).
b) I can describe the contributions that lead to the theory of evolution (i.e. Lamarck, Lyell, Malthus, Wallace, etc.)
c) I can explain Darwin's Theory of Evolution.
d) I can identify ways in which the theory of evolution explains the diversity of organisms.
e) I can analyze and interpret data to evaluate adaptations resulting from natural and artificial selection that may cause changes in populations over time.
f) I can interpret evidence that support the theory of evolution.
g) I can describe adaptations of animals (i.e. mimicry, camouflage, beak type).

Earth and Space Science

Earth's Place in the Universe

1. Engage in argument from evidence to compare various theories for the formation and changing nature of the universe and our solar system (e.g., Big Bang Theory, Hubble's law, steady state theory, light spectra, motion of distant galaxies, and composition of matter in the universe).
a) I can draw conclusions regarding the general structure of the Universe.
b) I can construct models containing the major components of our solar system.
c) I can compare and contrast smaller bodies including comets and asteroids and their role in formation of the earth (cooling, original crust), formation of the moon via collision of earth with another body.

d) I can analyze red and blue shifts and investigate how they are related to the Doppler Effect.
e) I can critique evidence for the Big Bang Theory.
f) I can draw conclusions regarding how the Impact Theory informs current theories of planetary and lunar development.
g) I can prove Hubble's law and cite evidence related to the concept of the Expanding Universe.
h) I can analyze and critique the nebular hypothesis for the origin of the solar system.

2. Evaluate and communicate scientific information (e.g., Hertzsprung-Russell diagram) in reference to the life cycle of stars using data of both atomic emission and absorption spectra of stars to make inferences about the presence of certain elements.
a) I can analyze Hertsprung-Russell diagram in describing stellar evolution.
b) I can describe the relationship between life cycle and nuclear reactions of stars
c) I can describe how the reception of solar radiation is affected by atmospheric and lithospheric conditions.
d) I can develop and use models to illustrate the lifespan of the sun, including energy released during nuclear fusion that eventually reaches Earth through radiation.
e) I can analyze the nuclear reactions occurring in stars and the formation of heavy elements.
f) I can describe the formation of white dwarfs, black holes, etc., and supernovae.

3.Apply mathematics and computational thinking in reference to Kepler's laws, Newton's laws of motion, and Newton's gravitational laws to predict the orbital motion of natural and man-made objects in the solar system.
a) I can compute the orbital period of a planet about its star given its distance in AU.
b) I can compute the gravitational force between two celestial bodies given their masses and distance between them.
c) I can summarize how the motion of a celestial object in space is determine by Newton's Laws of Motion.
d) I can use mathematics to explain the relationship of the seasons to the tilt of Earth's axis (e.g., zenith angle, solar angle, surface area) and its revolution about the sun, addressing intensity and distribution of sunlight on Earth's surface.
e) I can identify the main components of the night sky, the celestial sphere, celestial poles, equator, ecliptic , motions (and phases where appropriate) of the sun, moon, and planets.
f) I can discuss right ascension and declination, tilt/orientation of the earth's axis of rotation relative to plane of revolution around sun, and the precession of the poles.
g) I can investigate how tilt of the Earth affects the distribution of energy between the northern and southern hemispheres.
h) I can obtain and evaluate information about Copernicus, Galileo, Kepler, Newton, and Einstein to communicate how their findings challenged conventional thinking and allowed for academic advancements and space exploration.

Earth's Systems

4. Analyze and interpret evidence regarding the theory of plate tectonics, including geologic activity along plate boundaries and magnetic patterns in undersea rocks, to explain the ages and movements of continental and oceanic crusts.

a) I can cite the evidence for and against Alfred Wegener's Continental Drif.
b) I can discuss the process of seafloor spreading and how it led to the theory of plate tectonics.
c) I can predict what happens at each type of plate boundaries and provide evidence for each.
d) I can develop a logical argument of how earth's history of magnetic reversals has provided evidence for seafloor spreading.
e) I can describe the changes in the plates from Pangaea to the present and predict changes for the future.
f) I can analyze the mechanism that drives plate tectonics.
g) I can calculate the rate of plate movement.
h) I can connect the formation of "hot spot" islands plate tectonics to the location of specific island chains (ex. Hawaii).
i) I can relate the age of the seafloor relates to mid-ocean ridges, depth of seafloor, and sediment thicknesses.
j) I can summarize how guyots are interpreted to have formed.
k) I can summarize the processes that occur within, in front of, and behind island arcs.
l) I can develop a model of Earth's layers using available evidence to explain the role of thermal convection in the movement of Earth's materials (e.g., seismic waves, movement of tectonic plates).

5. Develop a time scale model of Earth's biological and geological history to establish relative and absolute age of major events in Earth's history (e.g., radiometric dating, models of geologic cross sections, sedimentary layering, fossilization, early life forms, folding, faulting, igneous intrusions).

a) I can list the following eras in the history of the Earth: Precambrian, Paleozoic, Mesozoic and Cenozoic, and describe major events that occurred in each
b) I can interpret rock layers based upon principles of original horizontality, superposition, cross-cutting relationships, and faunal succession.
c) I can anaylze the following formations: unconformity, disconformity, nonconformity, and angular unconformity.
d) I can explain the principle of radiometric dating.

6. Obtain, evaluate, and communicate information to explain how constructive and destructive processes (e.g., weathering, erosion, volcanism, orogeny, plate tectonics, tectonic uplift) shape Earth's land features (e.g., mountains, valleys, plateaus) and sea features (e.g., trenches, ridges, seamounts).

a) I can describe the tectonic forces that result in dip slip faults, normal faults, reverse and thrust faults, strike slip faults, right lateral and left lateral faults.
b) I can compare and contrast different kinds of folds and interpret surface outcrops of the following: anticlines and synclines, plunging and non-plunging, basins and domes.
c) I can cite evidence of the elastic rebound theory.
d) I can distinguish among the speed and of movement of p-waves, s-waves and surface waves.
e) I can interpret seismograms in order to determine the following: SP-wave interval, Location of epicenter, Richter magnitude
f) I can describe the effects of earthquakes: shaking, liquefaction, landslides, tsunamis, and fires

g) I can distinguish between magnitude and intensity and determine the appropriate scale required.
h) I can analyze seismic risk, tsunami warning and earthquake prediction.
i) I can obtain and communicate information about significant geologic characteristics (e.g., types of rocks and geologic ages, earthquake zones, sinkholes, caves, abundant fossil fauna, mineral and energy resources) that impact life in Alabama and the southeastern United States.
j) I can analyze and interpret data of interactions between the hydrologic and rock cycles to explain the mechanical impacts (e.g., stream transportation and deposition, erosion, frost-wedging) and chemical impacts (e.g., oxidation, hydrolysis, carbonation) of Earth materials by water's properties.

7. Construct an explanation from evidence for the processes that generate the transformation of rocks in Earth's crust, including chemical composition of minerals and characteristics of sedimentary, igneous, and metamorphic rocks.
a) I can investigate the properties that are used to know the properties of minerals.
b) I can compare and contrast the major mineral forming elements and determine whether they are found as anions or cations.
c) I can perform experiments to test the physical properties on a mineral sample in order to correctly identify the mineral.
d) I can classify common minerals that possess each of the following physical properties: crystal structure, Moh's Hardness Scale, Cleavage, Streak, Acid test, Luster, Fracture, Density (specific gravity), Magnetism, and Optical properties
e) I can analyze silicate structures and give examples of each: Isolated, Single- chain, Double chain, Sheet, Framework
f) I can determine the classification of a mineral when given its chemical formula.
g) I can compare and contrast each part of the rock cycle to one another.
h) I can analyze intrusive and extrusive igneous rocks.
i) I can distinguish among felsic, intermediate, and mafic igneous rocks
j) I can describe the mineral composition and formation of the following igneous rocks: phaneritic, aphanitic, and glassy/pyroclastic.
k) I can explain and apply a Bowen's Reaction Series chart.
l) I can connect igneous rock formation to plate tectonic settings.
m) I can compare and contrast the formation of the following intrusive features: dikes and sills, batholiths, laccoliths, stocks, volcanic neck, and hydrothermal veins.
n) I can describe the formation of the following volcanic features: lava flows, pyroclastic flows, craters, calderas, lava tubes, and tephra.
o) I can cite evidence of the effects of volcanoes on humans and the environment.
p) I can compare and contrast clast sizes: clay, silt, sand, granule, pebble, cobble and boulder
q) I can describe sedimentary environments and the kind of sediment found in each.
r) I can explain how oil is created and stored in sedimentary rocks.
s) I can identify sedimentary rocks and determine mineral composition, likely environments of their formation.
t) I can illustrate the formation of ripple marks and soil.
u) I can investigate the causes and effects of metamorphism and distinguish between regional and contact metamorphism.
v) I can analyze the changes in texture of metamorphic rocks as more pressure is applied.

w) I can predict the parent rock and degree of metamorphism for samples of foliated and unfoliated rocks.

8. Obtain, evaluate, and communicate information to verify that weather (e.g., temperature, relative humidity, air pressure, dew point, adiabatic cooling, condensation, precipitation, winds, ocean currents, barometric pressure, wind velocity) is influenced by energy transfer within and among the atmosphere, lithosphere, biosphere, and hydrosphere.

a) I can analyze patterns in weather data to predict various systems, including fronts and severe storms.
b) I can utilize maps and other visualizations to analyze large data sets that illustrate the frequency, magnitude, and resulting damage from severe weather events in order to predict the likelihood and severity of future events.
c) I can illustrate how seismic waves give us information about the interior of the Earth.
d) I can describe the composition and thickness of the Earth's atmosphere including gaseous components and vertical subdivisions/layers of the atmosphere.
e) I can relate the change in pressure and temperature with altitude.
f) I can communicate the pattern of energy flow between the sun, the earth, and various components of the atmosphere at a given location.
g) I can explain heat capacity and methods of heat transfer.
h) I can describe how large-scale global surface wind patterns result from combination of uneven heating of the earth, convection, and the Coriolis Effect.
i) I can describe the position and general direction of jet streams.
j) I can relate relative humidity with temperature and air density.
k) I can analyze cloud formation including concepts and relationships of existing lapse rate, dry adiabatic lapse rate, and moist lapse rate; stable and unstable air masses.
l) I can classify specific cloud types: cumulus, altocumulus, cirrocumulus, cumulonimbus, stratocumulus, stratus, altostratus, cirrostratus, nimbostratus, cirrus, and virga.
m) I can explain properties of atmospheric high and low pressure systems, including air density, temperature and relative humidity, surface and high altitude winds, and vertical airflow.
n) I can interpret weather maps.
o) I can locate and describe the major global air masses (e.g., polar continental, tropical maritime, etc) and their basic characteristics.
p) I can chart the geographical distribution of deserts.
q) I can describe the formation and the features of various types of severe weather.
r) I can relate atmospheric influences on direction of movement and hurricane prediction.
s) I can describe the properties of warm and cold fronts, including their different patterns of clouds, their formation, development, and dissipation in association with extratropical cyclones, and changes in barometric pressure, clouds, and wind direction associated with their approach and passage.
t) I can compare and contrast the properties of occluded fronts and stationary fronts.
u) I can construct explanations from evidence to describe how changes in the flow of energy through Earth's systems (e.g., volcanic eruptions, solar output, ocean circulation, surface temperatures, precipitation patterns, glacial ice volumes, sea levels, Coriolis effect) impact the climate.

Environmental Science

I. Population Ecology

1. Explain the concept of ecosystem function and balance.

a) I can define biodiversity.
b) I can calculate and measure the biodiversity of an ecosystem using the Simpson's index.
c) I can identify the critical role that keystone species play in an ecosystem.
d) I can describe the various land biomes in terms of climate, types of organisms and soil fertility.
e) I can create a food web that demonstrates the complex relationships within ecosystems.
f) I can construct a diagram analyzing the path and exchange of carbon through photosynthesis and cellular respiration.
g) I can construct a diagram that demonstrates how the different forms of nitrogen are exchanged through biogeochemical processes.
h) I can construct a diagram that demonstrates how phosphorus is exchanged through processes in the lithosphere and hydrosphere.
i) I can calculate the amount of energy transferred through an energy pyramid using the 10% Law.
j) I can compare and contrast between commensalism, mutualism, and parasitism.
k) I can define and analyze a carrying capacity graph.
l) I can apply the concept of carrying capacity to population sizes in an ecosystem.
m) I can analyze data to explain how the effects of population dispersion influence a species' chance of surviving and reproducing through multiple generations.

2. Engage in argument from evidence to evaluate how biological or physical changes within ecosystems affect the number and types of organisms, and that changing conditions may result in a new or altered ecosystem.

a) I can recognize exponential growth in human populations through the hunter-gatherer, agricultural, industrial and scientific revolutions.
b) I can explain carrying capacity in terms of human populations.
c) I can define land degradation.
d) I can identify the negative impact of human population growth on the environment in terms of increased natural resource use and land degradation.
e) I can analyze how land degradation can lead to ecological succession and predict how these changes can influence a change in biodiversity.
f) I can list examples of human activities that cause a loss of biodiversity locally, regionally and globally.
g) I can construct a watershed map of Alabama to differentiate aquatic and terrestrial physiographic regions.
h) I can evaluate and draw conclusions about Homewood's temperate deciduous forest preserve.
i) I can identify invasive species common in Alabama and observe their negative consequences.
j) I can obtain and evaluate geological and biological information to determine the types of major organisms that live in the predominate terrestrial biomes.
k) I can design and produce a biome model that represents the major topographical, geological, biodiversity and climate conditions of a specific biome.
l) I can identify an endangered and/or extinct species locally, regionally and globally.

m) I can apply the four provisions of the Endangered Species Act to the recovery of an endangered species.

II. Resource Utilization and Energy

3. Analyze cost-benefit ratios of competing solutions for developing, conserving, managing, recycling, and reusing energy and mineral resources to minimize impacts in natural systems (e.g., determining best practices for agricultural soil use, mining for coal, and exploring for petroleum and natural gas sources).

a) I can identify various ways land is managed, i.e. farmland, rangeland, forest land, parks and preserves.
b) I can distinguish between available resources within the various land types.
c) I can compare and contrast U.S. natural resources with natural resources in other regions of the world.
d) Analyze sustainable uses of natural resources.
e) I can define nonrenewable and renewable resources.
f) I can identify examples of nonrenewable and renewable resources.
g) I can describe uses of both renewable and nonrenewable resources.
h) I can relate the tragedy of the commons concept to natural resource management and conservation.
i) I can compare and contrast global geographical regions in which resource use is being managed both sustainably and non-sustainably.
j) I can predict potential economic and environmental consequences of unsustainable resource management.
k) I can identify ways that natural resources can be conserved.
l) I can apply the concept of reduce, reuse and recycle to all resources to minimize resource use and waste production.

4. Explain the impact of climate on soil composition and examine the process of soil erosion and prevention.

a) I can define soil profile and soil sample.
b) I can identify the different soil types found in various climates.
c) I can construct a soil profile model.
d) I can identify the various processes and activities that promote soil formation.
e) I can recognize and evaluate agricultural and forestry activities from land use maps that degrade soil quality, cause soil loss and increase water runoff.
f) I can define soil erosion.
g) I can identify the various agents of soil erosion.
h) I can distinguish between natural and artificial agents of erosion.
i) I can describe various methods for preventing soil erosion.
j) I can explain the importance of fertile soil to land productivity.
k) I can design an urban land use plan that optimizes the use of vegetation to prevent soil loss and reduce water runoff.

5. Investigate and analyze the use of nonrenewable energy sources (e.g., fossil fuels, nuclear) and renewable energy sources (e.g., solar, wind, hydroelectric, geothermal) and propose solutions for their impact on the environment.

a) I can define fossil fuels.
b) I can compare and contrast the various fossil fuels types, their origin and characteristics.

c) I can distinguish between renewable and nonrenewable energy resources.
d) I can identify the by-products of the combustion of fossil fuels. (e.g. particulates, sulfur dioxide, nitrogen dioxide, arsenic, mercury, etc.)
e) I can describe and analyze the various effects on the environment from the combustion of fossil fuels. (e.g. smog, ozone depletion, acid deposition, climate change, etc.)
f) I can define nuclear fission and fusion.
g) I can compare and contrast nuclear fission reactions to fossil fuels used to produce energy.
h) I can analyze advantages and disadvantages of nuclear energy in terms of efficiency and waste production.
i) I can identify alternative and renewable forms of energy: solar, wind, biomass, hydro.
j) I can identify the application of each renewable form of energy to the production of energy for electricity and/or transportation.
k) I can apply the law of conservation of energy and the first and second laws of thermodynamics to the efficiency of energy resources.
l) I can evaluate the most efficient source of energy for transportation and electricity.

III. Air Pollution

6. Identify the cause and effect relationship of pollutants on the atmosphere.

a) I can define air pollution.
b) I can identify the different layers of the atmosphere and the chemical composition of each layer.
c) I can classify the formation of pollutants as primary, secondary, and indoor.
d) I can justify the banning of CFC's and the related social, political, economic, and environmental aspects.
e) I can describe the pollutants that are responsible for the formation of smog, thermal inversions, and ground level ozone.
f) I can apply solutions to air pollution as alleviation and/or remediation methods or strategies (e.g., carbon sequestration, scrubbers, catalytic converters, cap and trade).
g) I can analyze and graph the correlation of green houses to global temperature changes.
h) I can analyze data and climate models to predict potential changes to global precipitation patterns, sea level rise and ocean chemistry.
i) I can identify and investigate the effects of climate change patterns on human activity (e.g., political conflict, civil war, migration of environmental refugees).

IV. Water Resources

7. Engage in argument from evidence to defend how coastal, marine, and freshwater sources support biodiversity, economic stability and human recreation.

a) I can identify the various types of natural aquatic resources. (e.g. freshwater, marine, wetlands, estuaries, coral reefs, etc.)
b) I can compare and contrast various abiotic factors that are characteristic of natural aquatic resources and how these factors support biodiversity.
c) I can identify various fisheries as aquatic and economic resources.
d) I can compare and contrast the environmental functions and benefits of wetlands, estuaries, and coral reefs (e.g., nursery and breeding grounds, storm and flooding buffers, coastline protection).

e) I can identify the role of the open ocean in the water cycle, climate regulation and as a carbon sink.

8. Evaluate the quality of our local drinking water.

a) I can illustrate the parts of the water cycle.
b) I can distinguish between potable and nonpotable water.
c) I can categorize the local natural sources of drinking water. (e.g. lakes, reservoirs, rivers, aquifers, etc.)
d) I can apply chemical testing and bioassessment to the quality of water.
e) I can identify major consumers of water. (e.g. residential, industrial, agriculture, etc.)
f) I can identify ways that water can be conserved.
g) I can explain the process of water treatment.

9. Identify the cause(s) and effect(s) of pollutants on various water supplies.

a) I can describe the properties of water that make it a universal solvent.
b) I can identify water contaminants.
c) I can classify contaminants as point and nonpoint sources.
d) I can explain human activities that contribute to point and nonpoint sources (e.g., agriculture, forestry, feedlots).
e) I can describe the process of eutrophication from industrial effluents and agricultural runoff.
f) I can predict the negative effects of eutrophication on water chemistry and aquatic organisms.
g) I can perform water quality tests (e.g., bioassessment, chemical analysis) and use the results to determine the ecological health of a water source.
h) I can propose both alleviation and remediation strategies to reduce or prevent point and nonpoint sources of water pollution.

V. Sustainability

10. Evaluate land-use practices that promote sustainability and economic growth.

a) I can recognize methods of sustainable agriculture and forestry. (e.g. no-till planting, crop rotation, selective cutting, shelter wood cutting, etc.)
b) I can differentiate between unsustainable and sustainable methods of agriculture and forestry.
c) I can define integrated pest management.
d) I can apply the use of integrated pest management to agriculture and forestry practices.
e) I can develop a sustainable agricultural and forestry plan to maintain biodiversity.
f) I can categorize types of waste as organic, inorganic, biodegradable or nonbiodegradable.
g) I can identify ways to manage waste. (e.g. composting, recycling, reusing, reclaiming, etc.)
h) I can explain the relationship between waste management practices and economic growth.

VI. Culture, Society and Politics

11. Evaluate the environmental impact of population growth, political policy, and economics on developed and developing countries.

a) I can define demography.
b) I can list statistics associated with demographics. (e.g. infant mortality rate, birth rate, death rate, total fertility rate, life expectancy, etc.)
c) I can categorize countries as either developing or developed.
d) I can analyze population age diagrams.

e) I can predict the population growth of an individual country from a population age diagram.
f) I can identify diseases associated with developing and developed countries.
g) I can compare and contrast the public health issues of developing and developed countries.
h) I can identify environmental problems characteristic of both developing and developed countries.
i) I can differentiate between the rate of population growth in developing and developed countries.
j) I can predict the effects of urbanization on infrastructure.
k) I can evaluate the negative impact on natural resources and infrastructure caused by rapid population growth.
l) I can list strategies to reduce population growth in developing countries.
m) I can relate the level of affluence in developed countries to the size of their ecological footprint.
n) I can relate economics and political policy to population growth rates.
o) I can identify specific policies and legislation that are related to environmental protection.
p) I can apply specific environmental policies to improvements in sustainable development, climate and atmosphere, biological diversity, resource management and pollution prevention.

Chemistry

1. Obtain and communicate information from historical experiments (e.g., work by Mendeleev and Moseley, Rutherford's gold foil experiment, Thomson's cathode ray experiment, Millikan's oil drop experiment, Bohr's interpretation of bright line spectra) to determine the structure and function of an atom and to analyze the patterns represented in the periodic table.
a) I can identify the scientists and experiments credited with the subatomic particles.
b) I can predict an element's location on the periodic table based on their period and group numbers.
c) I can classify groups or families (alkali metals, alkaline earth metals, halogens, noble gases, rare earth metals, and transition metals) based on their characteristics and location on the periodic table.
d) I can predict the location of metals, nonmetals, and metalloids based on their periodic properties.
e) I can use Bohr's model to explain the relationship of wavelength, frequency and energy associated with electron transitions in an atom.
f) I can create electron configurations and orbital diagrams for neutral and excited atoms and ions using Bohr's model of the atom.
g) I can compare and contrast the modern periodic table to those developed by Mendeleev and Mosley.

2. Develop and use models of atomic nuclei to explain why the abundance-weighted average of isotopes of an element yields the published atomic mass.
a) I can explain the relationship of atomic number and mass number to elements and their isotopes.

b) I can analyze various isotopes and calculate the average atomic mass based on the percent abundance.
c) I can define nuclear radiation and nuclear decay.
d) I can define nuclide.
e) I can write nuclear symbols for protons, neutrons, electrons, positrons, alpha particles, beta particles, gamma radiation, and other nuclides.
f) I can balance nuclear equations using the Law of Conservation of Mass.
g) I can describe the processes of alpha decay, beta decay, positron emissions, electron capture, and gamma emissions.
h) I can create nuclear equations to represent alpha decay, beta decay, positron emissions, electron capture, and gamma emissions.
i) I can define radioactive half-life.
j) I can perform calculations using radioactive half-life.
k) I can explain the processes of nuclear fission and nuclear fusion.
l) I can identify common uses of nuclear radiation including carbon-14 dating.

3. Use the periodic table as a systematic representation to predict properties of elements based on their valence electron arrangement.

a) Analyze data such as physical properties to explain periodic trends of the elements, including metal/nonmetal/metalloid behavior, electrical/heat conductivity, electronegativity and electron affinity, ionization energy, and atomic-covalent/ionic radii, and how they relate to position in the periodic table.
b) I can describe the formation of both ions and ionic bonds using the terms valence electrons, cations, and anions.
c) I can compare and contrast the properties of ionic and covalent compounds in terms of bond strength, boiling and melting points, and conductivity.
d) I can indicate the number valence electrons and expected oxidation numbers for elements using electron configurations.
e) I can describe properties and formation of metallic bonds.
f) I can represent valence electrons in metallic atoms according the electron sea model.
g) I can classify bond types as ionic, polar covalent, and nonpolar covalent based on electro-negativity values or based on the elements involved in bonding.
h) I can describe the formation of covalent bonds using the terms bond length, potential energy, valence electrons.
i) I can create molecular models of molecules and polyatomic ions using VSEPR Theory.
j) I can illustrate Lewis structures for neutral molecules and polyatomic ions using valence electrons and the octet.
k) I can construct chemical formulas and names for ionic compounds using oxidation numbers for main group elements and the stock system for transition elements.
l) I can construct chemical formulas and names using appropriate prefixes for covalent compounds.
m) I can create formulas for common binary acids and oxyacids.

4. Plan and conduct investigations to demonstrate different types of simple chemical reactions based on valence electron arrangements of the reactants and determine the quantity of products and reactants.

a) I can justify the balancing of equations based on the Law of Conservation of Mass.
b) I can draw particule diagrams given an amount of reactants in order to verify the conservation of mass.
c) I can design an experiment to illustrate that the mass of reactants and the mass of the products of a chemical reaction are conserved.
d) I can create word equations given formula equations, and vice versa.
e) I can classify the five types of chemical reactions (i.e. synthesis, decomposition, single replacement, double replacement, and combustion) based on definitions and on balanced chemical reactions.
f) I can predict products of the five types of chemical reactions given the reactants of the reaction.
g) I can create a balanced chemical equation that describes a chemical reaction given the reactants.
h) I can predict the equilibrium position for a given reaction based on LeChâtelier's principle when outside stresses of temperature, concentration and pressure are applied.
i) I can predict the formation of a precipitate based on solubility rules and create total ionic and net ionic equations.
j) I can identify the mole ratio relating to two substances in a chemical equation.
k) I can apply the mole ratio in stoichiometric calculations.
l) I can analyze stoichiometric relationships involving mole-mole, mole-mass, mass-mole, mass-mass, and volume (gases) conversions.
m) I can evaluate a reaction in terms of limiting and excess reactants.
n) I can distinguish among theoretical yield, actual yield, and percent yield for a chemical reaction.
o) I can determine the limiting reactant and calculate the theoretical yield for a given reaction.
p) I can draw particle diagrams representing the products of a chemical reaction including excess reactants.

5. Use mathematics and computational thinking to express the concentrations of solutions quantitatively using molarity.

a) I can solve molarity and molality calculations based on properties of a solution.
b) I can calculate freezing point depression, boiling point elevation, changes in osmotic pressure and solution molality of nonelectrolyte solutes.
c) I can perform calculations involving the expected changes in freezing point, boiling point, and osmotic pressure of an electrolyte solution.
d) I can design and create particle models to represent water dissolving ionic solutes.
e) I can construct particle diagrams illustrating the miscibility of two liquids based on polarity.
f) I can explain how temperature, surface area, and increased interaction between solute and solvent affect the solubility of a solid solute in a liquid solvent.
g) I can compare the effects of temperature and pressure on the solubility of gases in liquids versus solids in liquids.
h) I can represent solution equilibrium by creating saturated, unsaturated, and supersaturated solutions.
i) I can demonstrate the proper use a conductivity probe to measure the conductivity of solutions.

j) I can plan an investigation testing the conductivity of solutions resulting from compounds that dissociate to produce different number of ions as well as substances that do not dissociate into ions.
k) I can collect voltage data for a variety of ionic and covalent solutions and explain why solutions are classified as electrolytes and nonelectrolytes.
l) I can prove that voltage is a function of amount of solute in solution.
m) I can list the general properties of aqueous acids and bases.
n) I can differentiate between strong and weak acids and bases.
o) I can model various acids and bases according to Arrhenius and Brønsted-Lowry theories.
p) I can perform calculations involving pH, pOH and molar concentrations of the hydronium and hydroxide ions.
q) I can explain how the pH scale is used for measuring solution acidity and alkalinity.

6. Plan and carry out investigations to explain the behavior of ideal gases in terms of pressure, volume, temperature, and number of particles.
a) I can convert units of pressure measurements.
b) I can apply the various gas laws (Boyle's, Charles's, Gay-Lussac's, Combined, Dalton's) to describe the relationships among pressure, volume, and temperature.
c) I can analyze rates of effusion and diffusion of gases using Graham's Law.
d) I can apply the ideal gas law to calculate pressure, volume, temperature, and amount of gas under a set of known circumstances.
e) I can apply standard molar volume to calculate gas masses and volumes.
f) I can evaluate stoichiometric relationships between volume and molar quantities of gases.

7. Analyze and interpret data (e.g., melting point, boiling point, solubility, phase-change diagrams) to compare the strength of intermolecular forces and how these forces affect physical properties and changes.
a) I can describe the six changes in state.
b) I can distinguish between crystalline and amorphous solids.
c) I can interpret and create phase diagrams and heating/cooling curves given normal boiling point, normal freezing point, and triple point for various substances.
d) I can describe the intermolecular forces (London Dispersion forces, dipole-dipole, and hydrogen bonding) and their relative strengths.
e) I can create particulate diagrams depicting intermolecular forces that must be overcome during phase changes.
f) I can interpret solubility curves and interpret the effects of temperature on Solubility.
g) I can represent solution equilibrium by creating saturated, unsaturated, and supersaturated solutions.
h) I can plan and conduct an investigation to classify properties of matter as intensive (e.g., density, viscosity, specific heat, melting point, boiling point) or extensive (e.g., mass, volume, heat) and demonstrate how intensive properties can be used to identify a compound.

8. Plan and conduct experiments that demonstrate how changes in a system (e.g., phase changes, pressure of a gas) validate the kinetic molecular theory.
a) I can state the Kinetic Molecular Theory.

b) I can list the five assumptions set forth by the the Kinetic Molecular Theory of Gases.
c) I can explain how the characteristics of gases (low density, high compressibility, etc.) relate to the assumptions of the Kinetic Molecular Theory of Gases.
d) I can differentiate between real gases and ideal gases.
e) I can identify the environmental factors that cause deviation of a real gas from its "ideal" behavior.
f) I can distinguish between effusion and diffusion of gases.
g) I can distinguish among the states of matter based on particle motion.
h) I can compare and contrast the properties of solids, liquids, and gases according to the Kinetic Molecular Theory.
i) I can construct particle diagrams depicting the average kinetic energy of particles at various temperatures.
j) I can illustrate characteristics of matter (density, compressibility, etc) using particle diagrams.
k) I can develop a model to explain the relationship between the average kinetic energy of the particles in a substance and the temperature of the substance (e.g., no kinetic energy equaling absolute zero [0K or -273.15^{o}C]).

9. Construct an explanation that describes how the release or absorption of energy from a system depends upon changes in the components of the system.
a) I can perform calculations involving the relationships of heat energy, heat of vaporization/fusion, and amount of substance when a substance undergoes a series of phase changes.
b) I can evaluate chemical systems as being exothermic or endothermic processes.
c) I can construct and experiment to evaluate how mass and specific heat affect magnitude of the change in temperature of a system.
d) I can create a model to draw qualitative and quantitative connections between the reaction enthalpy and the energies involved in the breaking and formation of chemical bonds.
e) I can analyze the relationship between bond energies and bond length.
f) I can compare the bond energies of a chemical reaction to bond strength.
g) I can design and interpret the results of an experiment in which calorimetry is used to
h) determine the change in enthalpy a chemical process (heating/cooling, phase transition, or chemical reaction) at constant pressure.
i) I can predict the identity of an unknown metal based on its specific heat capacity determined from data obtained through calorimetry.
j) I can analyze the impact of specific heat on heat transferred from one object to another.

Physical Science

Matter and Its Interactions

1. Use the periodic table as a model to predict the relative properties and trends (e.g. reactivity of metals; types of bonds formed, including ionic, covalent, and polar covalent;

numbers of bonds formed; reactions with oxygen) of main group elements based on the patterns of valence electrons in atoms.

a) I can explain the significance of the placement of elements on the periodic table.
b) I can classify elements as metals, nonmetals, Alkali metals, Alkaline earth metals, transition metals, metalloids, halogens, and noble gases.
c) I can determine the placement of an unknown element on the periodic table based on its physical and chemical properties.
d) I can build models that show the atomic structure of different isotopes and the formation of ions.
e) I can illustrate the difference in the roles of valence electrons in ionic compounds, polar covalent compounds, and nonpolar covalent compounds.
f) I can design a lab activity that will determine if a substance is an ionic, polar covalent, or nonpolar covalent compound.
g) I can name and write chemical formulas for ionic and covalent compounds formed from main group elements.
h) I can assemble models that will show the structure of both ionic and covalent compounds formed from main group elements.

2. Plan and carry out investigations (e.g. squeezing a balloon, placing a balloon on ice) to identify the relationships that exist among the pressure, volume, density, and temperature of a confined gas.

a) I can illustrate the movement and arrangement of gas molecules in a sealed container.
b) I can design an experiment to show the relationship between pressure and volume of a gas.
c) I can create a particulate diagram to show how changes in pressure, volume, density and temperature affect gas molecules in a sealed container.
d) I can perform gas law calculations involving the pressure, volume, density and temperature of a gas in a sealed container.

3. Analyze and interpret data from simple chemical reactions or combustion reactions involving main group elements.

a) I can distinguish between a physical change and a chemical change/reaction.
b) I can use the signs of a chemical reaction to determine if one has taken place.
c) I can distinguish among the five basic types of chemical reactions (i.e. synthesis, decomposition, single replacement, double replacement, combustion).
d) I can predict the products of a basic chemical reaction when given the reactants.
e) I can perform an experiment demonstrating each of the five basic types of chemical reactions.
f) I can model a basic chemical reaction using particle diagrams.
g) I can investigate how changing different factors affects the rate of a chemical reaction.

4. Analyze and interpret data using acid-base indicators (e.g. color-changing marker, pH paper) to distinguish between acids and bases, including comparisons between strong and weak acids and bases.

a) I can classify a solution as acidic, basic, or neutral based on its pH.
b) I can discuss the relative acidity/basicity (strength) of a substance based on its pH value.
c) I can describe how the hydrogen ion concentration affects the pH of a solution.

d) I can design a lab activity using indicators to determine if a substance is an acid, base, or neutral.
e) I can perform an experiment using acid-base indicators to determine the relative strength of acids and bases.

5. Use mathematical representations to support and verify the claim that atoms, and therefore mass, are conserved during a simple chemical reaction.
a) I can write a balanced chemical equation to describe a chemical reaction.
b) I can describe the law of conservation of mass.
c) I can relate the law of conservation of mass to a balanced chemical equation.
d) I can perform a lab experiment that demonstrates the conservation of mass during a chemical reaction.
e) I can model the conservation of mass by using a particulate diagram.

6. Develop models to illustrate the concept of half-life for radioactive decay.
a) I can use the concept of radioactive half-life to determine the amount of decay and the amount of original remaining when given the half-life period and total decay time.
b) I can research and communicate information about types of naturally occurring radiation and their properties.
c) I can design an activity that shows the process of the different types of decay using everyday materials.
d) I can develop arguments for and against nuclear power generation compared to other types of power generation.

Motion and Stability: Forces and Interactions

7. Analyze and interpret data for one- and two-dimensional motion applying basic concepts of distance, displacement, speed, velocity, and acceleration (e.g., velocity versus time graphs, displacement versus time graphs, acceleration versus time graphs).
a) I can differentiate between an object's distance traveled and its displacement given its motion.
b) I can perform calculations using the relationships that exist among distance, displacement, speed, velocity, and acceleration.
c) I can construct a displacement vs. time graph and a velocity vs. time graph when given a description of an object's motion.
d) I can analyze a displacement vs. time, velocity vs. time, and acceleration vs. time graph.
e) I can physically model the motion represented by a displacement vs. time graph using motion detectors.
f) I can differentiate between the components of one-dimensional and two-dimensional motion.
g) I can explain the relationship between gravity and two-dimensional, projectile, motion.

8. Apply Newton's laws to predict the motion of a system by constructing force diagrams that identify the external forces acting on the system, including friction (e.g., a book on a table, an object being pushed across a floor, an accelerating car).
a) I can explain each of Newton's laws of motion using real world examples.

b) I can relate the mass of an object to its inertia.
c) I can mathematically determine the net force acting on an object.
d) I can differentiate between the effects of balanced and unbalanced forces acting on an object's motion.
e) I can identify the external forces acting upon a stationary object and an object that is in motion.
f) I can construct a force diagram using vectors in order to determine the resultant force acting on an object.
g) I can create a lab investigation to determine the relationship among net force, mass, and acceleration (Newton's second law).

9. Use mathematical equations (e.g., (m1v1 + m2v2) before = (m1v1 + m2v2) after) and diagrams to explain that the total momentum of a system of objects is conserved when there is no net external force on the system.
a) I can describe a one-dimensional elastic collision.
b) I can calculate the momentum of an object in motion and an object at rest.
c) I can explain the laws of conservation of energy and conservation of momentum.
d) I can predict the results of a one-dimensional elastic collision using the law of conservation of momentum.
e) I can experimentally prove the law of conservation of momentum by using objects to demonstrate a one-dimensional elastic collision.

10. Construct simple series and parallel circuits containing resistors and batteries and apply Ohm's law to solve typical problems demonstrating the effect of changing values of resistors and voltages.
a) I can identify the basic components in an electrical circuit.
b) I can differentiate between a series and parallel circuit.
c) I can illustrate both a series and parallel circuit by using a schematic diagram.
d) I can construct both a series and parallel circuit using resistors, batteries, bulbs, etc.
e) I can predict whether a bulb will light based on the wiring of a circuit.
f) I can carry out lab investigations to determine the effects of changing voltage and resistance in circuit.
g) I can predict the changes in the brightness of a bulb in a circuit using the relationship between voltage, current, and resistance.
h) I can perform calculations involving Ohm's law.

Energy

11. Design and conduct investigations to verify the law of conservation of energy, including transformations of potential energy, kinetic energy, thermal energy, and the effect of any work performed on or by the system.
a) I can differentiate between potential and kinetic energy.
b) I can perform calculations involving mechanical, potential, and kinetic energy.
c) I can investigate the conservation of mechanical energy by using computer simulations.
d) I can explain what happens to energy that appears to be "lost" during a process.

e) I can explore the various ways that energy is transferred and transformed during energy production in different types of power plants.

12. Design, build, and test the ability of a device to convert one form of energy into another form of energy.

a) I can determine the work input and work output of both a simple machine and a complex machine.
b) I can calculate the efficiency of a machine.
c) I can research different methods of energy conversion and transformation.
d) I can design and build a device that will convert one form of energy into another.
e) I can estimate the efficiency of the built device to determine its ability to convert energy.

Waves and Their Applications in Technologies for Information Transfer

13. Use mathematical representations to demonstrate the relationships among wavelength, frequency, and speed of waves (e.g., the relation $v = \lambda f$) traveling in various media (e.g., electromagnetic radiation traveling in a vacuum and glass, sound waves traveling through air and water, seismic waves traveling through Earth).

a) I can differentiate between electromagnetic and mechanical waves.
b) I can interpret a diagram of the electromagnetic spectrum.
c) I can compare and contrast the characteristics of the different types of waves.
d) I can develop a lab activity that will show the relationships among wave speed, period, frequency, and wavelength.
e) I can perform calculations involving the frequency, wavelength, period and speed of a wave.
f) I can model the effects that the type of medium has on the speed of the wave (e.g. refraction).
g) I can propose and defend a hypothesis based on information gathered from published materials for and against the various claims for the safety of electromagnetic radiation.
h) I can obtain and communicate information from published materials to explain how transmitting and receiving devices (e.g. cell phones, medical-imaging technology, solar cells, wireless Internet, etc.) us the principles of wave behavior and interactions with matter to transmit and capture information and energy.

General Physics

Kinematics

1. Investigate and analyze, based on evidence obtained through observation / experimentation about the general relationships among position, velocity, and acceleration.

a) I can create graphical representations of kinematic quantities as functions of time.
b) I can design and investigate the relationships of position, velocity and accelerations through experimental data collection.
c) I can determine the net displacement of an object through calculation or experimentation.
d) I can perform kinematics calculations involving position, velocity, and acceleration.

e) I can create and analyze distance-time, velocity-time, and acceleration-time graphs of objects with constant acceleration.

2. **Use the kinematic equations to analyze one-dimensional and two-dimensional motion with constant acceleration.**

a) I can differentiate between a vector and scalar value and use them appropriately in different scenarios.
b) I can evaluate the magnitude and direction of a vector quantity..
c) I can design a laboratory investigation that will determine the resultant and equilibrant for a given set of vectors using both graphical and mathematical methods.
d) I can apply and construct models for the horizontal and vertical components of position, velocity, and acceleration for two-dimensional motion to solve kinematics calculations using experimental data.
e) I can plan and carry out investigations relating the vertical and horizontal components of projectile motion.
f) I can construct models and solve problems that describe projectile motion.
g) I can demonstrate that the horizontal and vertical components of projectile motion are independent of one another.

Newton's Laws of Motion

3. Correlate the interaction of forces on an object with that object's subsequent motion.

a. I can develop a logical argument to explain the effects of inertia.
b. I can model and calculate the change in velocity that results when a constant force acts over a specified time period.
c. I can cite evidence for the acceleration of a system by using the magnitude and direction of the interactions within the system.
d. I can carry out investigations for an object's acceleration by examining the net force on that object.
e. I can model, in the form of a free-body diagram, all forces acting upon a given object.
f. I can interpret a free-body diagram to illustrate Newton's 2^{nd} Law.
g. I can investigate the relationship between normal and frictional forces on an object mathematically and experimentally.
h. I can describe and construct models for free fall motion.
i. I can carry out investigations on acceleration due to gravity by putting an object into free fall.
j. I can distinguish force pairs and the objects on which they act (Newton's 3^{rd} Law).
k. I can derive a complex system of equations involving unknown forces or accelerations.
l. I can analyze the components of velocity and acceleration vectors for an object experiencing uniform circular motion.
m. I can construct models illustrating the differences in the motion of an object traveling with and without the effects of gravitational forces.
n. I can carry out investigations comparing the velocity, period of revolution, and centripetal acceleration of a body in relation to the radius of its orbit.
o. I can analyze mathematical relationships to draw conclusions that mass does not affect the motion of an object in a circular orbit.

Work, Power, Energy and Momentum

4. Analyze the concepts of conservation of energy and momentum, work and power, and linear collisions.

a) I can differentiate and classify mechanical, kinetic, and gravitational potential energies in a system.
b) I can construct and evaluate systems involving elastic potential energy including spring mass systems.
c) I can cite evidence for the Law of Conservation of Energy.
d) I can design labs for the demonstration of the conservation of mechanical energy.
e) I can draw conclusions when mechanical energy is or is not conserved and communicate the mechanism by which energy is lost.
f) I can develop a logical argument for the Work-Energy Theorem.
g) I can investigate problems dealing with the relationships among work, energy, force, mass, displacement, power and time.
h) I can relate impulse and time of collision, both graphically and mathematically, to the change in linear momentum for a moving object.
i) I can synthesize and construct models for situations in which linear momentum is or is not conserved.
j) I can compare and contrast elastic and inelastic collisions.
k) I can apply the conservation of linear momentum to elastic and inelastic collisions.
l) I can develop a model for collisions to find the changes in kinetic energy.

Rotational

5. Examine the concept of uniform circular motion.

a) I can construct models that assess an object's rotational inertia.
b) I can carry out investigations and design labs that draw conclusions for the factors that contribute to an object’s rotational inertia.
c) I can identify and analyze torque and it’s effects on rotational motion.

Thermal Physics

6. Analyze heat transfers and thermodynamics.

a) I can compare heat and temperature and differentiate between the two..
b) I can investigate and draw conclusions about how much heat can be produced by the performance of a specified quantity of mechanical work.
c) I can prove there is an absolute zero temperature and show how it relates to thermal energy.
d) I can describe, both verbally and mathematically, the heat energy transfers that occur during changes in temperature and changes in state using specific heat, heat of fusion and heat of vaporization.
e) I can model and analyze the effects of conduction, radiation, and convection in thermal processes.
f) I can engage, in argument from evidence, the laws of thermodynamics to model the relationship among entropy, heat, and temperature for open and closed systems.
g) I can carry out investigations on the sign conventions of heat, internal energy and work that accompany the first law of thermodynamics.

Electricity and Magnetism

7. Use the principles of Ohm's and Kirchhoff's laws.

a) I can formulate the relationships among electric forces, charges and distance as it relates to Coulomb's law in one and two dimensions.
b) I can illustrate electric fields and relate them both graphically and mathematically to electric forces.
c) I can predict the motion of charged particles in an electric field.
d) I can analyze electric potential difference and it's relationship to work and energy.
e) I can describe and cite evidence for charge distribution on conductors.
f) I can identify and describe conditions that create current in an electric circuit.
g) I can verify through experimentation current, potential difference, and resistance.
h) I can relate graphically current and voltage for a resistor as it relates to Ohm's Law.
i) I can differentiate between resistors set up in parallel and in series and calculate the equivalent resistance of a network of resistors.
j) I can calculate the equivalent capacitance of a network of capacitors.
k) I can describe how stored charge is divided between capacitors connected in parallel and in series.
l) I can illustrate the electric field and potential inside and outside a charged conducting sphere.

8. Relate magnetism to electric charge and electricity.

a) I can develop a logical argument for magnetism and how it relates to electric charge.
b) I can model the motion of a particle under the influence of an electromagnetic force.
c) I can investigate the magnetic forces for the use of magnetic resonance imaging [MRI].
d) I can determine and model the magnitude and direction of the magnetic force on a charged particle in a magnetic field.
e) I can demonstrate the right-hand-rule to find the direction of current, magnetic field, force, or velocity of a particle.
f) I can design labs and synthesis scenarios where magnetic fields can generate electrical current.
g) I can carry out investigations on and experimentally verify the uses of solenoids with magnets.

Waves and Optics

9. Analyze changes in mechanical wave behavior.

a) I can differentiate between transverse and longitudinal waves.
b) I can relate frequency, wavelength, period to the speed of a wave.
c) I can draw conclusions for the speed of wave to the medium in which it travels.
d) I can differentiate between incident and reflected waves.
e) I can illustrate and describe the reflection of a wave as it relates to Sound Navigation and Ranging (SONAR).
f) I can relate the principle of superposition to the constructive and destructive interferences of a wave.

g) I can illustrate the resultant wave by applying the principle of superposition.
h) I can analyze and draw conclusions from the process of the production of a standing wave.
i) I can identify nodes, antinodes, wavelengths, areas of constructive interference and areas of destructive interference on a standing wave.

10. Describe sound in terms of wave properties and behavior.
a) I can relate the pitch of a sound to the frequency of the sound wave.
b) I can model and investigate shifts in pitch/frequency using the Doppler Effect.
c) I can assess the intensity of sound at a given distance from the sound source using the inverse-square law.
d) I can model the resonant frequencies that occur on a string, in an air column that is open at both ends, and in an air column that is closed at one end.
e) I can calculate and experimentally verify resonant lengths in open and closed pipes.
f) I can calculate the wavelengths and frequencies for a number of harmonics given the fundamental frequency and the length of the string or air column.

11. Analyze the wave nature of light.
a) I can compare and contrast the differences in electromagnetic waves and mechanical waves.
b) I can discuss the various forms of electromagnetic radiation in terms of their locations on the electromagnetic spectrum and potential danger to environments.
c) I can investigate the electromagnetic spectrum to determine the characteristics of electromagnetic radiation.
d) I can illustrate both the behaviors and particle-wave duality of electromagnetic waves.
e) I can formulate problems involving the speed of light.
f) I can differentiate among opaque, transparent, and translucent media.
g) I can discern whether a light source is luminous or illuminated.
h) I can predict the effect of combining colors of light and pigments.
i) I can model polarization and its usefulness in technology.
j) I can apply the law of reflection to determine the locations and properties of images produced by plane, concave, and convex mirrors.
k) I can differentiate and discuss the usefulness of real and virtual images in technology.
l) I can relate the index of refraction for a substance to the speed that light will travel in that substance.
m) I can experimentally apply Snell's law of refraction to determine the locations and properties of images produced by converging and diverging lenses.
n) I can illustrate using ray tracing to find the image of an object placed in front of a lens or mirror.
o) I can explain phenomena by using the lens/mirror equation to find quantities such as: object distance, image distance, or focal length of the lens.