Grade 6

Physical Sciences

1. Matter is anything in the universe that has mass and takes up space. As a basis for understanding this concept, students know:
    a. the physical properties of matter, such as color, shape, and hardness, can be observed without changing the material
    b. density is the mass of a substance divided by its volume.
    c. matter has chemical properties that can be observed when a substance changes into a new substance.
2. Elements have distinct properties and atomic structure. Approximately 100 elements comprise all matter. As a basis for understanding this concept, students know:
    a. elements contain only one kind of atom.
    b. atoms are composed of protons-with positive charges, neutrons-with no charges, and electrons-with negative charges.
    c. particles in solids, liquids, and gases are in constant random motion.
    d. all matter, including any living cell, is composed of atoms.
3. Matter combines in different ways. As a basis for understanding this concept, students know:
    a. the electron structures of elements determine their chemical properties.
    b. elements are arranged in the periodic table according to repeating patterns of properties, as well as electron structures.
    c. many substances mix with water. Some form acids and bases in water that can neutralize each other.
    d. compounds are formed by combining two or more different elements. Compounds have properties that are different from the constituent elements.
    e. in chemical reactions, heat can be released or absorbed. Light or electrical energy can also be released or absorbed in reactions.
    f. matter isn't created or destroyed in chemical reactions.
    g. chemical equations are used to keep track of the quantities of substances involved in reactions.
    h. catalysts can initiate or accelerate certain reactions.
    i. the names and formulas of different compounds (NaCl, H2O, NaOH, CO2, CH4).

Life Sciences

4. Respiration, nutrition, and waste disposal systems in plants and animals transport substances essential for life and growth. As a basis for understanding this concept, students know:
    a. how sugar, water, and minerals are transported in a vascular plant.
    b. carbon dioxide (CO2) and energy from sunlight are used by plants to build molecules of sugar (releasing oxygen into the air) for growth and maintenance.
    c. plant and animal cells break down sugar to obtain energy, forming carbon dioxide (CO2) and water (respiration).

5. All populations living together and the physical factors with which they interact compose an ecosystem. As a basis for understanding this concept, students know:
    a. how to identify the biotic and abiotic components of various biomes.
    b. populations of organisms can be categorized by the functions they serve in an ecosystem.
    c. different kinds of organisms may play similar ecological roles in similar biomes.
    d. energy entering ecosystems as sunlight is transferred by producers into chemical energy through photosynthesis. That energy then passes from organism to organism in food webs.
    e. over time, matter is transferred from one organism to others in the food web, and between organisms and the physical environment.
    f. the number of organisms an ecosystem can support depends on the resources available and abiotic factors, such as quantity of light and water, range of temperatures, and soil composition.
6. Biological evolution accounts for the diversity of species developed through gradual processes over many generations. As a basis for understanding this concept, students know:
    a. how movements of the Earth's continental and oceanic plates through time, with associated changes in climate and geographical connections, have determined the past and present distribution of organisms.
    b. both genetic variation and environmental forces act to cause evolution and diversity of organisms over long periods of time.

Earth and Space Sciences

7. Topography is the result of competition between tectonic and depositional processes which build up the land, and erosional processes, which wear it down. As the basis for understanding this concept, students know:
    a. how topography is reshaped by weathering of rock and soil and by the transportation and deposition of sediment.
    b. the main agents of erosion are water, wind, ice, plants, and gravity and how the surface features of the Earth result from these agents.
    c. water running downhill is the dominant process in shaping the landscape and provide specific examples from different parts of California.
    d. rivers and streams are dynamic systems that erode and transport sediment, change their course, and flood their banks in natural and recurring patterns.
    e. beaches are dynamic systems in which sand is supplied by rivers and moved along the coast by wave action.
    f. natural hazards, including earthquakes, volcanic eruptions, landslides, and floods, change or destroy human and wildlife habitats, damage property, and harm or kill humans.
8. Evidence from rocks allow us to reconstruct the story of the Earth's past. As the basis for understanding this concept, students know:
    a. the solid Earth is layered with a lithosphere; a hot, convecting mantle; and a dense metallic core.
    b. how to relate sedimentary, igneous and metamorphic rock to the processes which formed them, including weathering, erosion, transportation, deposition, lithification, melting, crystallization, and metamorphism.

c. rocks are continually recycled into new rocks in the processes of the rock cycle.
d. slow geologic processes have very large effects over long periods of time.
e. evidence from geologic layers and radioactive dating that the Earth is about 4.6 billion years old.
f. the Earth's history is influenced by occasional catastrophic events, such as the impact of an asteroid or comet.

9. Plate tectonics explains important features of the Earth's surface and major geologic events. As the basis for understanding this concept, students know:
    a. lithospheric plates on the scales of continents and oceans move at rates of centimeters per year in response to movements in the mantle.
    b. earthquakes are sudden motions along breaks in the crust called faults, and volcanoes/fissures are locations where magma reaches the surface.
    c. major geologic events, such as earthquakes, volcanic eruptions, and mountain building result from plate motions.
    d. how to explain major features of California geology in terms of plate tectonics (including mountains, faults, volcanoes,etc.).
    e. how to prepare for, and what to do during and after earthquakes.
10. The sun is the major source of energy for phenomena on the Earth's surface. As a basis for understanding this concept, students know:
    a. energy from the sun powers winds, ocean currents, and the water cycle.
    b. seasons result from variations in the amount of sun's energy hitting the surface, due to the tilt of the Earth's rotation on its axis.
    c. how the tilt of the Earth's rotation on its axis is related to changes in the length of the day over the course of a year.
    d. how changes in the angle of incidence of the sun's rays result in differences in the temperature of the seasons.
11. Energy from the sun creates areas of uneven heating on the earth, causing air movements resulting in changing weather patterns. As a basis for understanding this concept, students know:
    a. uneven heating of the Earth causes air movements (convection currents).
    b. the influence of the ocean on weather, and the role of the water cycle in weather.
    c. causes and effects of different types of severe weather.
    d. how to use weather maps and weather forecasts to predict local weather, and that prediction depends on many changing variables.
    e. the Earth's atmosphere exerts a pressure that decreases with distance above the Earth's surface, and is the same in all directions.

Investigation and Experimentation

12. In the context of investigations designed to develop understanding, students will:
    a. utilize a variety of print and electronic resources (including the World Wide Web and CD-ROMs) to collect information
    b. classify objects (e.g. rocks, plants, leaves) based on appropriate criteria.
    c. develop a hypothesis.
    d. select and use appropriate tools and technology (including calculators, computers, balances, spring scales, microscopes, and binoculars) to perform tests, collect data, and display data.

e. construct appropriate graphs from data and develop qualitative statements about the relationships between variables.
f. communicate the steps and results from an investigation in written reports and verbal presentations.
g. use triangulation to determine the position of a point from data.
h. read a topographic map and a geologic map for evidence provided on the maps.
i. interpret events by sequence and time from natural phenomena (e.g. relative ages of rocks and intrusions).
j. identify changes in natural phenomena over time without manipulating the phenomena (e.g. a tree limb, a grove of trees, a stream, a hillslope).

Grade 7

Physical Sciences

1. Elements have distinct properties and atomic structure. Approximately 100 elements comprise all matter. As a basis for understanding this concept, students know:
    a. compounds are formed by combining two or more different elements. Compounds have properties that are different from the constituent elements.
    b. the names and formulas of different compounds (NaOH, HCl, CH4 and CaCO3)
    c. all matter, including any living cell, is composed of atoms.
2. Chemical reactions are processes in which atoms are rearranged into different combinations of molecules. As a basis for understanding this concept, students know:
    a. chemical compounds (the reactants) interact to form products with different chemical properties.
    b. the idea of atoms explains the conservation of matter: in chemical reactions the number of atoms stays the same no matter how they are arranged, so their total mass stays the same.
3. Light behaves in predictable ways and thus can be manipulated by lenses, prisms, and mirrors for a variety of purposes. As a basis for understanding this concept, students know:
    a. for an object to be seen, light emitted by it or scattered from it must enter the eye.
    b. how simple lenses are used in a magnifying glass, the eye, camera, telescope, and microscope.

Life Sciences

4. Plants and animals at all levels of organization demonstrate the complementary nature of structure and function. As a basis for understanding this concept, students know:
    a. plants and animals have levels of organization for structure and function, including cells, tissues, organs, organ systems, and the whole organism.
    b. organ systems function because of the contributions of individual organs, tissues, and cells. The failure of any part can affect the entire system.
    c. relate the structures of sense organs (including the eye and ear), to their functions.
    d. that contractions of the heart generate blood pressure, and that heart valves prevent backflow of blood in the circulatory system.
    e. how the food moves through the digestive system, and is broken down into smaller molecules.
    g. the individual functions and sites of secretion of digestive enzymes, stomach acid, and bile organs.
5. The body mounts many types of defenses to protect itself from infections disease. As a basis for understanding this concept, students know:
    a. the role of antibodies in the body's response to infection.
    b. why vaccinations protect an individual from an infectious disease.
    c. that viruses must enter a cell and use the biochemical machinery in order to be propagated.

6. All living things are composed of cells, from just one to many trillions, whose details usually are visible only through a microscope. As a basis for understanding this concept, students know:
    a. the way in which cells function is similar in all living organisms.
    b. the characteristics that distinguish plant cells from animal cells, including chloroplasts, and cell walls.
    c. how prokaryotic and eukaryotic cells differ in complexity.
    d. a cell is defined by an enclosing membrane that is semi-permeable.
    e. the nucleus is the repository for genetic information in plant and animal cells.
    f. mitochondria provide energy for the work that cells do by breaking down organic molecules into carbon dioxide.
    g. chloroplasts capture sunlight energy for photosynthesis, and synthesize sugar from carbon dioxide.
    h. the role of cytoplasm as a site for protein synthesis by ribosomes.
    i. cells divide to increase their numbers through a process of mitosis, which results in two daughter cells with identical sets of chromosomes. As multi-cellular organisms develop, their cells differentiate.
7. A typical cell of any organism contains genetic instructions that specify its traits. Those traits may be modified by environmental influences. As a basis for understanding this concept, students know:
    a. DNA is the genetic material of living organisms, and is located in the chromosomes of each cell.
    b. how to compare the life cycles and reproduction of sexual and asexual organisms, and that sexual reproduction produces offspring that typically contain half of their genes from each parent.
    c. plant and animal cells contain many thousands of different genes, and typically have two copies of every gene. The two copies (or alleles) of the gene may or may not be identical, and one may be dominant in determining the phenotype while the other is recessive.
8. Meiosis is a process of random segregation of chromosomes -- the gametes produced contain only one of each of the types of chromosomes in the original cell. As a basis for understanding this concept, students know:
    a. that only certain cells in a multi-cellular organism undergo meiosis.
    b. that genetic variation results from both sexual reproduction and from mutation.
    c. how random chromosome segregation explains the probability that a particular allele will be in a gamete.
9. A new combination of alleles may be generated in a zygote through fusion of male and female gametes (fertilization). As a basis for understanding this concept, students know:
    a. why approximately half of an individual's DNA sequence comes from each parent.
    b. the role of sex chromosomes in determining gender in humans.
    c. how to predict the probable outcome of a phenotype in a genetic cross, given the genotypes of the parents and mode of inheritance (autosomal or X-linked, dominant or recessive).
10. Biological evolution accounts for the diversity of species developed through gradual processes over many generations. As a basis for understanding this concept, students know:

a. both genetic variation and environmental forces act to cause evolution and diversity of organisms.
b. the reasoning used by Darwin in his conclusions that natural selection is the mechanism of evolution.
c. how natural selection determines the differential survival of groups of organisms.

Investigation and Experimentation

11. In the context of investigations designed to develop understanding, students will:
    a. develop a hypothesis.
    b. plan and conduct a scientific investigation to test a hypothesis.
    c. select and use appropriate tools and technology (including calculators, computers, balances, spring scales, microscopes, and binoculars) to perform tests, collect data, and display data.
    d. utilize a variety of print sources to collect information as evidence as part of a research project.
    e. communicate the logical connection among hypothesis, science concepts, tests conducted, data collected, and conclusions drawn from the scientific evidence.
    f. construct scale models, maps and appropriate labeled diagrams to describe scientific knowledge (e.g. motion of Earth's plates and cell structure).
    g. communicate the steps and results from an investigation in written reports and verbal presentations.
    h. apply simple mathematical relationships to determine one quantity given the other two (including speed = distance/time, density = mass/volume, force = pressure x area, volume = area x height).
    i. construct appropriate graphs from data and develop qualitative statements about the relationships between variables.
    j. interpret events by sequence and time from natural phenomena.
    k. identify changes in natural phenomena over time without manipulating the phenomena (e.g., a tree limb, a grove of trees, a stream, a hillslope).
    l. distinguish between variable and controlled parameters in a test.
    m. recognize whether evidence is consistent with a proposed explanation.

Grade 8

Physical Sciences

1. The motion of an object is the rate of change of its position. As a basis for understanding this concept, students know:
    a. position is defined relative to some choice of standard reference point and a set of reference directions.
    b. average speed is the total distance traveled divided by the total time elapsed. The speed of an object along the path traveled can vary.
    c. how to solve problems involving distance, time, and average speed.
    d. that to describe the motion of an object one must specify both direction and speed.
    e. changes in motion can be changes in speed, direction or both.
    f. how to interpret graphs of distance or position versus time (velocity graphs) and graphs of velocity versus time for motion in a single direction (acceleration graphs).
    g. how to solve problems involving falling objects using acceleration due to gravity. ($v = g * t$)
2. Unbalanced forces cause changes in motion. As a basis for understanding this concept, students know:
    a. a force has both direction and magnitude.
    b. when an object is subject to two or more forces at once the resulting effect is the cumulative effect of all the forces.
    c. when the forces on an object are balanced the motion of the object does not change.
    d. how to identify separately two or more forces acting on a single static object, including gravity, elastic forces due to tension or compression in matter, and friction.
    e. when the forces on an object are unbalanced the object will change its motion (that is, it will speed up, slow down, or change direction).
3. The motion of objects is generally predictable using Newton's laws. As a basis for understanding this concept students know:
    a. how to solve problems involving constant speed and average speed.
    b. an object continues to move at a constant speed or stays at rest unless a net force acts on it .(inertia) (Newton's First Law).
    c. how to apply the law $F = m * a$ to solve one-dimensional motion problems involving constant force. The greater the mass of an object the more force is needed to achieve the same change in motion. (Newton's Second Law)
    d. for every action force there is an equal and opposite reaction force (Newton's Third Law).
4. Energy can move from one place to another and be transformed from one form to another. As a basis for understanding this concept, students know:
    a. energy can be stored in many forms, such as a weight raised to a height, a stretched rubber band; stored energy is called potential energy.

b. moving objects have energy, called kinetic energy; kinetic energy increases with the mass of the object and, more rapidly, with the speed of the object.
c. energy can be carried from one place to another by electric current, by moving objects, by waves including water waves, sound, light and other electromagnetic radiation (such as radio waves, microwaves, or infrared).
d. heat is produced by friction in mechanical and electrical machines and any time one thing rubs against another.

5. The laws of conservation of energy and momentum provide a way to predict and describe the movement of objects. As a basis for understanding this concept students know:
   a. how to calculate momentum as product mv and that momentum is conserved.
   b. an unbalanced force or net force applied to an object produces a change in its momentum.
6. Light behaves in predictable ways and thus can be manipulated by lenses, prisms, and mirrors for a variety of purposes. As a basis for understanding this concept, students know:
   a. light interacts with matter by transmission (including refraction), absorption, or scattering (including reflection).
   b. the angle of reflection of a light beam is equal to the angle of incidence.
   c. white light is composed of many colors and different colors are refracted at different angles.
   d. that light travels in straight lines except when the medium it travels through changes.
7. Waves have characteristic properties that do not depend on the type of wave. As a basis for understanding this concept, students know:
   a. waves carry energy from one place to another.
   b. how to solve problems involving wavelength, frequency, and wave speed. (velocity = wavelength x frequency).
   c. sound is a wave whose speed depends on the properties of the medium in which it propagates.
   d. radio waves, light and X-rays are electromagnetic waves whose speed in vacuum is 300,000,000 m/s.
8. An object will float when it has displaced a weight of fluid equal to its own weight. A less dense substance will float when placed in a more dense fluid. As a basis for understanding this concept, students know:
   a. that density is the mass of a substance per unit volume
   b. how to calculate the density of substances (regular and irregular solids, and liquids) from measurements of mass and volume. (density = mass/volume
   c. that the buoyant force on an object in a fluid is equal to the weight of the displaced fluid, and know how to apply this principle to predict whether an object will float or sink.
   d. how to apply their knowledge of buoyant forces to calculate the densities of solids and liquids from appropriate measurements.
9. Elements have distinct properties and atomic structure. All matter is comprised of one or more of approximately 100 elements. As a basis for understanding this concept, students know:
   a. compounds are formed by combining two or more different elements. Compounds have properties that are different from the constituent elements.

b. the names and formulas of different compounds (NaOH, HCl, and CO2)
c. all matter is composed of atoms.
d. the structure of the atom, and its components: protons, neutrons and electrons.
e. atoms and molecules form solids by building up repeating patterns such as the crystal structure of NaCl or long chain polymers.
f. in solids the atoms are closely locked in position and can only vibrate, in liquids the atoms and molecules are more loosely connected and can only slide past one another, and in gases the atoms or molecules are free to move independently, colliding occasionally.

10. Chemical reactions are processes in which atoms are rearranged into different combinations of molecules. As a basis for understanding this concept, students know:
    a. chemical compounds (the reactants) interact to form products with chemical properties different from those of the reactants.
    b. the idea of atoms explains the conservation of matter: in chemical reactions the number of atoms stays the same no matter how they are arranged, so their total mass stays the same.
    c. chemical reactions usually liberate or absorb heat.
    d. physical processes include freezing and boiling, in which a material changes form with **no** chemical reaction.
    e. that energy is released when a material condenses or freezes and that energy must be provided to achieve a change of phase in the opposite direction (melting or evaporating).
11. The Periodic Table provides a way to display and organize the elements of matter. As a basis for understanding this concept, students know:
    a. the Periodic Table organizes groups of elements by their chemical properties. These groups include highly reactive metals, less reactive metals, highly reactive non-metals, and some almost non-reactive gases.
    b. elements are defined by the number of protons in the nucleus, which is called the atomic number. Different isotopes of an element have a different number of neutrons in the nucleus.
    c. substances can be classified by their physical properties, including melting temperature, density, hardness, and conductivity of heat and electricity.
    d. how to relate the position of an element in the periodic table to its atomic structure.
    e. that molecules are formed by electrical attraction between atoms which occurs because they can share (covalent bond) or exchange (ionic bond) electrons.

Investigation and Experimentation

12. In the context of investigations designed to develop understanding, students will:
    a. distinguish between variable and controlled parameters in a test.
    b. recognize whether evidence is consistent with a proposed explanation.
    c. construct appropriate graphs from data and develop quantitative statements about the relationships between variables.
    d. evaluate the accuracy and reproducibility of data.

e. apply simple mathematical relationships to determine one quantity given the other two (including: speed = distance/time, density = mass/volume, force = mass x acceleration, acceleration = change in velocity/change in time).

f. recognize the slope of the linear graph as the constant in the relationship y = k * x and apply this to interpret graphs constructed from data.