High School Science Flipchart
Physical Science

▲ S.HS.1.1.2
The student actively engages in investigations, including developing questions, gathering and analyzing data, and designing and conducting research.

Official Test Specifications

- Multiple Choice
- Hypotheses in test questions should be written in "if/then" format.
- High Level Process Questions

Instructional Examples and/or Additional Specificity

- Formulate a testable hypothesis.
- Utilize variables, such as independent, dependent, and variables that need to be controlled.
- Use methods for gathering data that are observable, measurable, and replicable.
- Analyze and evaluate the results in order to clarify the questions and hypotheses, and to refine methods for further research.
- Given a data table, identify the question being investigated.
- Given a hypothesis, choose the graph that supports the hypothesis.
- Given a data table, identify the conclusion that supports the data.
- Identify the independent and dependent variable given an experimental procedure and resulting data.
- Explain the need to control a variable during the course of an experiment.

Item Specification

a. Distinguish between testable and untestable questions. Testable questions address phenomena that are measurable, repeatable, and can be proven or disproved using scientific methods. Untestable questions involve matters of opinion, preference, values, or religious or philosophical beliefs to which the scientific method cannot be applied.
b. Recognize that a scientific method of investigation is not a rigid, inflexible sequence of steps. An investigation may loop several times from data analysis back to hypothesis before reaching final conclusions.
c. Given a scenario with an unresolved problem, state a question that could be the basis of a scientific investigation to resolve the problem.
d. Design a procedure to investigate a stated question.
e. Given an experimental procedure, identify the question being tested.
f. Explain the relationship between the sample size or the number of trials during an investigation and the validity of results.
g. Explain the purpose of a control group in an experimental design and identify investigations where a control group is appropriate.
h. Choose an appropriate format (e.g., data table, diagrams, etc.) for collecting or recording data. Item ideas may include appropriate units of measure, column and row headings, appropriate table format, and adequate space to record data for all samples.

State Assessment Practice Item

Carla measured the fuel efficiency of three grades of gasoline with different octane ratings and recorded her results in the table below.

Fuel Efficiency of Three Grades of Gasoline

Gasoline Grade	Octane Rating	Fuel Efficiency (miles per gallon)	
Regular	87	Trial 1	22.5
		Trial 2	22.9
		Trial 3	21.9
Plus	89	Trial 1	22.8
		Trial 2	23.1
		Trial 3	23.5
Premium	92	Trial 1	24.6
		Trial 2	24.7
		Trial 3	24.6

Which conclusion is supported by Carla's data?

A) Cars are more fuel efficient when traveling at higher rates of speed.

B) A car running on high-octane gasoline travels faster than when running on low-octane gasoline.

C) Cars that use gasoline with a lower octane rating will run for a longer period of time.

D) X A car is more fuel-efficient when it runs on high-octane gasoline than when it runs on low-octane gasoline.

QuestionId: 32993, Standard 1 "Science As Inquiry", Benchmark 1 "1", Indicator "2", Sub Indicator "2"

▲ S.HS.1.1.3
The student actively engages in using technological tools and mathematics in their own scientific investigations.

Official Test Specifications
- Multiple Choice
- Mid Level Process Questions

Instructional Examples and/or Additional Specificity
- Describe the use of a variety of technologies, such as, measuring instruments, calculators, and computers as an integral component of scientific investigations.
- Use common mathematical functions (linear, exponential, comparison to mean value, etc.) to analyze and describe data. (e.g., mean, median, mode, deviation from the mean, unit conversions.)
- Use statistical and graphing data analysis techniques.
- Recognize that the accuracy and precision of the data, and therefore the quality of the investigation, depends on the instruments used.
- Use equipment properly and safely (i.e., heat sources, glassware, and electrical devices).
- Choose the instrument needed to determine a given property (e.g., mass, time intervals, density, emission spectrum, etc.).

Item Specification
a. Relate precision in measurement tools and in reporting measurements to the scale and units used.
b. Choose the most appropriate graphing format (including scale) to display and analyze data.
c. Identify and utilize appropriate units of measure for properties.
d. DO NOT assess use of equipment that is not common to most high school laboratories.

State Assessment Practice Item
Which instrument would be best to use to measure 212 milliliters of a liquid?

A) beaker
B) test tube
C) Erlenmeyer flask
D) X graduated cylinder

QuestionId: 33010, Standard 1 "Science As Inquiry", Benchmark 1 "1", Indicator "3", Sub Indicator "3"

▲ S.HS.2A.1.1
The student understands that atoms, the fundamental organizational unit of matter, are composed of subatomic particles. Chemists are primarily interested in the protons, electrons, and neutrons found in the atom.

Official Test Specifications
- Multiple Choice
- Diagram
- Low Level Knowledge Questions

Instructional Examples and/or Additional Specificity

Not available at this time.

Item Specification
a. Identify the relative masses, charges, and locations of electrons, protons, and neutrons in an atom.
b. Know that the number of electrons equals the number of protons in a neutral atom and that the number of neutrons is not necessarily the same.
c. Understand that materials made of one kind of atom are elements.
d. Understand that the total size of an atom is determined by the number of electrons and by the strength of their electrostatic attraction to the nucleus.
e. Describe the Bohr model of the atom and relate the model to the energy levels of the electrons.
f. Understand that the electron clouds of the current atomic model represent the probabilities of finding electrons in various locations.

State Assessment Practice Item
A neutral atom of gold (Au) has a mass number of 197 and has 118 neutrons. How many electrons does this gold atom have?

A) X 79 electrons
B) 118 electrons
C) 197 electrons
D) 315 electrons

QuestionId: 33047, Standard 0 "Chemistry", Benchmark 1 "1", Indicator "1", Sub Indicator "1"

▲ S.HS.2A.2.1

The student understands chemists use kinetic and potential energy to explain the physical and chemical properties of matter on earth that may exist in any of these three states: solids, liquids, and gases.

Official Test Specifications

- Multiple Choice
- Diagram
- Knowledge Questions

Instructional Examples and/or Additional Specificity

- Elements and molecules may exist as gases, liquids or solids. Ionic compounds most commonly exist as solids.
- Intermolecular attraction (attraction between molecules) determines the state of the molecule. Examples of intermolecular attraction include hydrogen bonding, permanent dipole interaction, and induced dipole interaction. Gases have the weakest and solids have the greatest intermolecular attraction. The hydrogen bond is an intermolecular attraction responsible for the properties of water and many biological molecules.

Item Specification

a. Know that particles in all states of matter are in motion (even particles in a solid).
b. Relate models showing motion, spacing, and/or arrangement of particles to the physical state of a material.
c. Understand that temperature is a measure of the average kinetic energy of the particles of a material.
d. Understand that the strength of the forces between particles is related to the state of matter.
e. Understand that energy is absorbed or released during phase changes.
f. Understand that the polarity of water molecules is responsible for hydrogen bonding between molecules.
g. Understand that the unique properties of water are based on the molecular polarity of the water molecules (e.g. water is less dense as a solid than as a liquid, water is most dense at 4^{o} C)
h. Know that chemical potential energy is stored in chemical bonds.
i. The attractive forces in ionic bonds and in intermolecular bonds are related to the energy needed to change states of matter (e.g., relatively more energy is needed to boil water due to its molecules' polarity; more energy is needed to melt ionic solids due to the strong attraction between the ionic charges).
j. DO NOT address intramolecular forces.

State Assessment Practice Item

***This indicator is new or has been altered to warrant writing new assessment questions. A released sample item will be added to this flipchart when available.*

▲ S.HS.2A.2.2

The student understands the periodic table lists elements according to increasing atomic number. This table organizes physical and chemical trends by groups, periods, and sub-categories.

Official Test Specifications

- Multiple Choice
- Periodic Table
- Mid Level Knowledge Questions

Instructional Examples and/or Additional Specificity

- Elements in the same group share similar chemical properties because they have the same number of valence electrons.
- Periods indicate the energy level of the outermost (valence) electrons.
- Identify the regions of the periodic table occupied by metals, non-metals, noble gases, and transition elements.
- Describe the arrangement of elements in the periodic table.
- Recognize which elements have similar chemical properties.
- All questions MUST reference the periodic table OR electron configuration.

Item Specification

a. Know that the first periodic table was arranged to illustrate that properties of elements form a repeating (periodic) pattern as the atomic number of elements increases, and understand that it was later discovered that this pattern is explained by a repeating pattern of electron configurations.
b. Relate the information for an element in the periodic table to its atomic number, atomic mass, electron configuration, and the numbers of electrons, protons, and neutrons.

State Assessment Practice Item

Which trend is observed when moving from left to right in the second row of the periodic table, beginning with lithium (Li) and ending with neon (Ne)?

A) The atomic mass increases by one with each element.
B) The number of energy levels increases by one with each element.
C) The atomic radius increases by one with each element.
D) X The number of electrons in the outer shell increases by one with each element.

QuestionId: 33053, Standard 0 "Chemistry", Benchmark 2 "2", Indicator "2", Sub Indicator "2"

▲ S.HS.2A.2.3

The student understands chemical bonds result when valence electrons are transferred or shared between atoms. Breaking a chemical bond requires energy. Formation of a chemical bond releases energy. Ionic compounds result from atoms transferring electrons. Molecular compounds result from atoms sharing electrons.
For example, carbon atoms can bond to each other in chains, rings, and branching networks. Branched network and metallic solids also result from bonding.

Official Test Specifications

- Multiple Choice
- Diagram
- Knowledge Questions

Instructional Examples and/or Additional Specificity

- Valence electrons (those farthest from the nucleus or highest energy electrons) determine the chemistry of the atom.
- Ionic compounds are composed of positively charged ions called cations and negatively charged ions called anions. Most cations are metals; most anions are non-metals.
- Molecules results when two or more nonmetals form covalent bonds by sharing one or more pairs of electrons.
- Identify groups of elements most likely to form ionic compounds.
- Identify elements most likely to form cations and elements most likely to form anions.

Item Specification

a. Predict bond type and ionic charge based on electron configuration, position in the periodic table, or metallic/nonmetallic character.
b. Predict and diagram bond type, bond order, and chemical formula by applying the octet rule.
c. Construct and interpret electron dot-diagrams (Lewis structures).
d. Understand that polar bonds result from unequal sharing of electrons between bonded atoms.
e. Predict properties based on bond polarity (e.g., solubility, boiling point).
f. Reactions may absorb energy if the bonds formed in a reaction have greater potential energy than the bonds that were broken (endothermic reactions)
g. Reactions may release energy if the bonds formed in a reaction have less potential energy than the bonds that were broken (exothermic reactions). For example, respiration in biology
h. Energy may be needed to start a reaction; this energy is used to break bonds (activation energy)
i. A catalyst may increase the rate of a chemical reaction by reducing the activation energy.

DO NOT USE ΔH

State Assessment Practice Item
Based on its position in the periodic table, which element is **most likely** to form a negatively charged ion?

A) gold (Au)
B) neon (Ne)
C) barium (Ba)
D) X chlorine (Cl)

QuestionId: 33068, Standard 0 "Chemistry", Benchmark 2 "2", Indicator "3", Sub Indicator "3"

▲ S.HS.2A.3.1

The student understands a chemical reaction occurs when one or more substances (reactants) react to form a different chemical substance(s) (products). There are different types of chemical reactions all of which demonstrate the Law of Conservation of Matter and Energy.

Official Test Specifications

- Multiple Choice
- Equations or equivalent provided
- Mid Level Knowledge Questions

Instructional Examples and/or Additional Specificity

- Chemical reactions are written as chemical equations, which demonstrate the Law of Conservation of Mass through stoichiometric relationships.

Item Specification

a. Identify the products and reactants of a reaction.
b. Identify a balanced chemical equation, and provide ONE missing coefficient to balance a simple chemical equation.
c. Determine proportionate amounts of reactants required or products produced from chemical equations by applying relationships expressed by a balanced chemical equation.
d. Describe chemical processes at the molecular level (e.g., forming and breaking bonds).
e. Recognize that coefficients in chemical equations represent ratios of atoms (as opposed to masses of materials).
f. DO NOT assess identification of specific types of reactions (i.e., synthesis, decomposition, combustion, single and double replacement, acid/base, and oxidation/reduction).

State Assessment Practice Item

The chemical equation below shows the decomposition of sodium nitrate ($NaNO_3$) into sodium nitrite ($NaNO_2$) and oxygen gas (O_2).

$$2NaNO_3 \rightarrow 2NaNO_2 + O_2$$

One mole of O_2 has a mass of 32 g. If 1.0 mole of $NaNO_3$ decomposes completely, how many **grams** of O_2 are produced?

A) 0.5 g
B) 1.0 g
C) X 16.0 g
D) 32.0 g

QuestionId: 33094, Standard 0 "Chemistry", Benchmark 3 "3", Indicator "1", Sub Indicator "1"

▲ S.HS.2B.1.1

The student understands Newton's Laws and variables of time, position, velocity, and acceleration can be used to describe the position and motion of particles.

Official Test Specifications

- Multiple Choice
- Mid Level Knowledge Questions

Instructional Examples and/or Additional Specificity

- The kinematic variables of position, velocity, and acceleration can most concisely be described as vectors.
- Velocity describes how position changes and acceleration describes how velocity changes.
- From the definitions of velocity and acceleration, one can derive equations that relate the kinematic variables.
- Acceleration occurs when there is either a change in speed or a change in direction. In the case of uniform circular motion, the acceleration points towards the center of the circle. The magnitude of this acceleration can be constant, and is related to the speed of the object and the radius of the circle.
- In the absence of a net force, an object's velocity will not change.
- In the presence of a net force, an object will experience an acceleration, which is modeled mathematically by Newton's second law.
- The force that one object exerts on a second object has the same magnitude but opposite direction as the force that the second object exerts on the first.
- Identify speed and direction as the quantities that determine velocity.
- Given the forces acting on an object, qualitatively describe its motion (single object, could be multiple forces). Predict the general direction of motion (e.g., north, northeast…), but DO NOT require calculation of exact angles by vector analysis.

Item Specification

a. Recognize that gravity is the force that accelerates falling objects.
b. Know that gravitational force between two objects increases with the masses of the objects and decreases with the distance between the objects. DO NOT assess quantitative calculations.
c. Describe weight as the measurement of the gravitational force between objects.
d. Describe mass as the measurement of the amount of matter in an object and the source of an object's inertia.
e. Understand that an object's mass is constant but its weight may change depending on location.
f. Identify friction and air resistance as the cause of apparent deviations from the first law of motion when observing the motion of objects on Earth.
g. Interpret graphs of distance vs. time and velocity vs. time (e.g., What does the slope represent? When was the velocity constant?).
h. Predict the change in motion of an object acted on by an unbalanced force.
i. Given one force of an action-reaction pair, identify the other.
j. DO NOT assess identification of laws of motion by name or label.
k. DO NOT distinguish between speed and velocity or use together.

State Assessment Practice Item
An object is pushed with a force and begins to move across a frictionless surface. Which **best** describes the object's motion after the force stops acting?

A) X constant velocity
B) increasing velocity
C) variable acceleration
D) decreasing acceleration

QuestionId: 33103, Standard 0 "Physics", Benchmark 1 "1", Indicator "1", Sub Indicator "1"

▲ S.HS.2B.2.2

The student understands the first law of thermodynamics states the total internal energy of a substance (the sum of all the kinetic and potential energies of its constituent molecules) will change only if heat is exchanged with the environment or work is done on or by the substance. In any physical interaction, the total energy in the universe is conserved.

Official Test Specifications

- Multiple Choice
- Diagram
- Mid Level Knowledge Questions

Instructional Examples and/or Additional Specificity

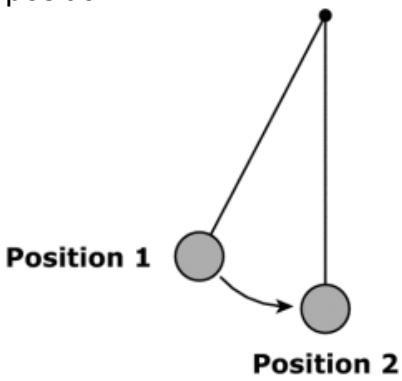
- There are different manifestations of energy. Kinetic energy is the energy an object possesses due to its motion. Gravitational potential energy is the energy due to the separation of masses. Electric potential energy is the energy due to the separation of charges. Kinetic and potential energy combined are known as mechanical energy.
- Heat is an exchange of internal (kinetic and/or potential) energy between systems due to a temperature difference. Examples of heat transfer include radiation from the sun, convection of hydrosphere/atmosphere/mantle, and conduction between water/land/air.
- A force that has a component parallel to the direction of motion of an object is said to do work on that object. The work done on an object may be positive or negative. When positive work is done on an object, it increases the object's energy. Negative work decreases the object's energy.
- There is a relationship between energy and power. Power is the rate at which work is done, or the rate at which the energy of some system changes.
- Recognize kinetic and potential energy.
- EXCLUDE questions about heat unless focused on convection, conduction, and radiation.
- Emphasize conceptual understanding instead of calculations.

Item Specification

a. Identify the form of energy in an example as being mechanical (potential and kinetic), heat, light, sound, chemical, electrical, or nuclear.
b. Trace energy transfers and transformations through a system (e.g., trace energy from a commercial power source to a household appliance).
c. Distinguish between heat and temperature in terms of particle motion (i.e., heat is the total kinetic energy of the particles; temperature, in Kelvins, is proportional to the average kinetic energy of the particles).
d. Understand that energy is conserved in a closed system and that energy transfers and transformations do not change the amount of energy.
e. Compare quantities of work done, given force and distance data.
f. Compare quantities of power generated, given time and work or time, distance, and force data.

State Assessment Practice Item

The diagram below shows a pendulum at two different positions in its path. The pendulum started from rest in position 1.



Which **best** describes the energy change as the pendulum moves from position 1 to position 2?

A) The total energy is decreasing.

B) X The kinetic energy is increasing.

C) The thermal energy is decreasing.

D) The potential energy is increasing.

QuestionId: 33118, Standard 0 "Physics", Benchmark 2 "2", Indicator "2", Sub Indicator "2"

▲ S.HS.2B.3.2
The student understands waves have energy and can transfer energy when they interact with matter.

Official Test Specifications
- Multiple Choice
- Diagram of waves
- Mid Level Knowledge Questions

Instructional Examples and/or Additional Specificity
- Waves are traveling disturbances, which transport energy without the bulk motion of matter. In transverse waves, the disturbance is perpendicular to the direction of travel. In longitudinal waves, the disturbance is parallel to the direction of travel.
- There are many different types of waves. Examples are water waves, sound waves, and electromagnetic waves. Visible light, radio waves, and X-rays are all examples of electromagnetic waves. Periodic waves can also be described in terms of their wavelength, frequency, period, and amplitude.
- All waves can be described in terms of their velocities. The velocity of most types of waves depends on the medium in which they are traveling. There is a relationship between the speed, wavelength, and frequency of a periodic wave. The frequency of sound waves is related to the pitch we perceive. Different wavelengths of visible light correspond to different colors.
- Understand that waves can exhibit constructive and destructive interference.
- Diffraction is the bending of a wave around an obstacle or an edge. When this happens, different intensities (i.e., diffraction patterns) of the wave are observed due to the wave interfering with itself.
- When light reflects from a surface, the angle of incidence is equal to the angle of reflection. When light propagates from one transparent medium to another, it bends (refracts) at the interface. Predict the path of rays passing through concave and convex lenses and reflected from concave and convex mirrors.

Item Specification
a. Explain the Doppler Effect and predict the difference between the pitch emitted and the pitch perceived when the source and observer are in motion relative to one another.
b. Predict the relative speed of light and sound through various media.
c. DO NOT assess refraction quantitatively (as calculated by Snell's Law).

State Assessment Practice Item
Which lists the colors of visible light in order from **shortest** wavelength to **longest** wavelength?

A) blue, green, red, yellow
B) red, yellow, green, blue
C) X blue, green, yellow, red
D) yellow, red, green, blue

QuestionId: 33131, Standard 0 "Physics", Benchmark 3 "3", Indicator "2", Sub Indicator "2"

▲ S.HS.2B.3.5
The student understands electromagnetic waves result when a charged particle is accelerated or decelerated.

Official Test Specifications
- Multiple Choice
- Diagram of the electromagnetic spectrum
- Mid Level Knowledge Questions

Instructional Examples and/or Additional Specificity
- Electromagnetic waves include radio waves, microwaves, infrared radiation, visible light, ultraviolet radiation, X-rays, and gamma rays. The energy of electromagnetic waves is carried in packets and has a magnitude that is inversely proportional to the wavelength.
- Understand that an accelerating charged particle produces an electromagnetic wave.
- Some particles, such as protons and electrons, have a physical property known as charge. There are two types of charge, positive and negative. Two charged particles or objects exert a force on each other, which is attractive between unlike charges and repulsive between like charges.
- This force increases with the magnitude of the charges and decreases with the distance between the charges.

Item Specification
a. Understand that moving charges generate magnetic fields.
b. Understand that the relative motion of a magnetic field to an electrical conductor induces an electric current in the conductor.

State Assessment Practice Item
Stars emit wave energy as electromagnetic radiation. Which statement **best** explains the origin of these waves?

A) X Accelerated electrons give off energy of various wavelengths.
B) Electrons that maintain constant kinetic energy give off waves with constant wavelengths.
C) Accelerated neutrons give off energy at constant wavelengths.
D) Neutrons that maintain maximum kinetic energy give off waves with maximum wavelengths.

QuestionId: 33148, Standard 0 "Physics", Benchmark 3 "3", Indicator "3", Sub Indicator "3"

▲ S.HS.4.1.2
The student understands the theory of Plate Tectonics explains that internal energy drives the Earth's ever changing structure.

Official Test Specifications
- Multiple Choice
- Mid Level Knowledge Questions

Instructional Examples and/or Additional Specificity
- Movable continental and oceanic plates make up Earth's surface; the hot, convecting mantle is the energy source for plate movement.
- Convection circulation in the mantle is driven by the outward transfer of Earth's internal heat.
- Identify convection currents in the mantle as the cause of movement in Earth's tectonic plates.

Item Specification
a. Describe evidence supporting the theory of continental drift (e.g., jigsaw puzzle fit of continents and matching rock formations, locating similar fossils where coastlines appear to have drifted apart, magnetic striping of ocean floors at mid-oceanic ridges).
b. Explain volcanic and seismic activity in terms of plate boundaries. Interpret a map showing plate boundaries and volcanoes and earthquakes.
c. Identify the three kinds of plate boundaries and match each to the resulting landforms (i.e., mid-ocean ridges and rift valleys at divergent plate boundaries; mountains at convergent plate boundaries—note differences depending on whether the plates are both continental or one is oceanic and one continental; slip [transform] boundaries displace surface features).

State Assessment Practice Item
Each type of tectonic plate movement causes characteristic land forms. Which type of plate movement can form a rift valley?

A) collision of two tectonic plates
B) X divergence of two tectonic plates
C) two plates slipping past each other
D) subduction of one plate under another

QuestionId: 33322, Standard 4 "Earth and Space Science", Benchmark 1 "1", Indicator "2", Sub Indicator "2"

▲ S.HS.4.3.2
The student understands the relationship between the earth, moon, and sun explains the seasons, tides, and moon phases.

Official Test Specifications
- Multiple Choice
- Mid Level Knowledge Questions

Instructional Examples and/or Additional Specificity
- The angle of incidence of solar energy striking Earth's surface affects the amount of heat energy absorbed at Earth's surface.
- The gravitational relationship between Earth, the moon, and the sun causes tides.
- Identify the moon as having the greatest effect on the tides of Earth's oceans.
- Explain why the lunar eclipses occur only at the time of a full moon and solar eclipses only occur at the time of a new moon.

Item Specification
a. Explain that seasonal temperature variation at a given latitude results from Earth's axis being tilted with respect to the plane of its orbit, and that this relationship is the result of three factors:
   i. Changes in the angle of incidence changes the area over which the rays are spread.
   ii. Changes in the angle of incidence changes the amount of energy-absorbing atmosphere through which the rays must pass.
   iii. Changes in the inclination of a hemisphere toward or away from the sun changes the hours of sunlight per day.
b. Recognize that distance from the sun is NOT a factor in the cycle of seasons.
c. Understand that the gravitational attraction of the moon and, to a lesser extent, the sun cause ocean tides, and be able to locate areas of high and low tides on an Earth-moon-sun diagram.
d. Arrange phases of the moon in the order of occurrence.
e. Given an Earth-moon-sun diagram, identify the phase of the moon.
f. Given a phase of the moon, identify the Earth-moon-sun diagram that would result in that phase.

State Assessment Practice Item
Which contributes **most** to cooler winter temperatures in the northern hemisphere?

A) Earth is at its greatest distance from the sun.
B) X Incoming solar radiation is spread over a larger surface area.
C) The northern hemisphere is tilted toward the sun.
D) More solar radiation is reflected by Earth's upper atmosphere.

QuestionId: 33351, Standard 4 "Earth and Space Science", Benchmark 3 "3", Indicator "2", Sub Indicator "2"

▲ S.HS.4.4.1
The student understands stellar evolution.

Official Test Specifications
- Multiple Choice
- Mid Level Knowledge Questions

Instructional Examples and/or Additional Specificity
- Condensation of gases, due to gravity, is a foundation for the formation of stars.
- The life cycle of the star begins with the nebula, which contains mostly hydrogen and helium. Heavier elements were, and continue to be, made by the nuclear fusion reactions in stars or formed during supernovae.
- The Hertzsprung-Russell (H-R) diagram is one method used to classify stars. The Sun is a main sequence star.
- Stars are classified by their color, temperature, age, apparent brightness, and distance from Earth.
- Understand that star color is related to star temperature (i.e., long wavelength [red] are cooler; short wavelength [blue] are hotter).

Item Specification
a. Understand that atoms of elements more massive than hydrogen are formed by fusion reactions in stars or during supernovae of stars.
b. Understand that fusion reactions in stars release large amounts of energy, including solar energy striking Earth.
c. Explain that changes during the evolution of a star are caused by shifts in the balance between gravitational collapse and nuclear fusion.
d. Explain that increasing gravitational forces, caused by the increasing density of stellar matter, can cause stars to collapse to form neutron stars or black holes.
e. Given a Hertzsprung-Russell diagram:
    i. Supply missing axis labels (i.e., temperature, luminosity).
    ii. Indicate the group to which Earth's sun belongs.
f. Locate and describe the basic characteristics of the main sequence group, giants, and dwarfs.

State Assessment Practice Item
Which stellar object has the **greatest** density?

A) red giant
B) supernova
C) white dwarf
D) X neutron star

QuestionId: 33357, Standard 4 "Earth and Space Science", Benchmark 4 "4", Indicator "1", Sub Indicator "1"

▲ S.HS.5.1.1
The student understands technology is the application of scientific knowledge for functional purposes.

Official Test Specifications
- Multiple Choice
- Low Level Knowledge Questions

Instructional Examples and/or Additional Specificity
- Technology is driven by the need to meet human needs and solve human problems.
- Engineering is the practical application of science to commerce or industry.
- Medicine is a practical application of science to human health.
- All technological advances contain a potential for both gains and risks for society.
- Technology is the application of science knowledge to meet human needs.

Item Specification
a. Given a group of human endeavors, select the one that is best classified as technology, as opposed to science, art, philosophy, etc.
b. Given a field of science, identify a common technological application resulting from discoveries in that field.
c. Given a field of technological application, identify the scientific discoveries that made it possible.
d. Given a technological advance, identify related benefits and hazards or risks.

State Assessment Practice Item
All of the following technological advances resulted from discoveries in the field of biology **except**

A) vaccines.
B) antibiotics.
C) X x-ray imaging.
D) genetic sequencing.

QuestionId: 33389, Standard 5 "Science and Technology", Benchmark 1 "1", Indicator "1", Sub Indicator "1"