

Physical Science

STANDARD 1: SCIENCE AS INQUIRY

Benchmark 1: Students will demonstrate the abilities necessary to do scientific inquiry.

Indicators:

1. develops an understanding of the natural world through experience in order to ask and evaluate research questions.
 - a. *Read scientific information.*
 - b. *Know that science changes -*
 - c. *To develop these skills, students might be involved in such activities as: investigating mass, length, volume, and density; neutralizing acids/bases; simulating half-lives of radioactive isotopes; investigating velocity and acceleration with paper airplanes; developing student-build models for friction and motion; investigating models that demonstrate knowledge of Newton's laws of motion.*

2. ▲ identifies and utilizes concepts that guide scientific investigations, including developing questions, gathering data, and design and conducting research
 - a. *Understand and use the scientific method (1. state the problem; 2. research; 3. form a hypothesis; 4. gather materials; 5. carry, out a procedure; 6. gather data; 7. form conclusions and report).*
 - b. *Design and conduct investigations*
 - c. *Analyze and explain data; then modify the procedure to get better results (e.g. the scientific method is not always a linear process)*
 - d. *Utilize variables, such as independent, dependent, and controls.*
 - e. *Determine methods for gathering data that is observable, measurable and replicable.*

3. ▲ uses technological tools and mathematics in scientific investigations.
 - a. *Interpret and communicate scientific results using mathematics and technology.*
 - b. *Choose appropriate tools for measurement; measure accurately with proper metric units.*
 - c. *Investigate phenomena using technology appropriately and safely (such as balance scales, spring scales, thermometers,*

stopwatches, graduated cylinders, beakers, flasks and other glassware)

- d. uses common mathematical functions (linear, exponential, etc.) to analyze and describe data.
 - e. recognizes that the accuracy and precision of the data, and therefore the quality of the investigation, depends on the instruments used.
4. ▲ as part of conducting an inquiry, formulates and revises his or her scientific explanations and models (physical, conceptual, or mathematical) using logic and evidence, recognizing that potential alternative explanations and models should be considered.
- a. evaluates personal preconceptions and biases with respect to his/her conclusions.
5. communicates and defends the design, results, and conclusion of his/her investigation.
- a. *Writes procedures, expresses concepts reviews information, summarizes data, and uses language appropriately.*
 - b. *Develops diagrams and charts to summarize and analyze data.*
 - c. *Presents information clearly and logically, both orally and in writing.*
 - d. *Constructs reasoned arguments.*
 - e. *Responds appropriately to critical comments.*
 - f. *Apply concepts and skills to everyday experiences.*

STANDARD 2A: CHEMISTRY

As a result of their activities in grades 9-12, all students will develop an understanding of the structure of atoms, *compounds*, chemical reactions, and the interactions of energy and matter.

Benchmark 1: The student will understand the structure of the atom.

Indicators:

1. ▲ Atoms, the fundamental organizational unit of matter, are composed of subatomic particles, organized in a small, dense, positively charged nucleus (containing protons and neutrons which determines the atomic mass) and surrounded by a negatively charged electron cloud (containing electrons, which determines the size of the atom). .

- a. ▲ *describe the structure and size of an atom and its properties according to modern atomic theory*
 - b. *diagram a simple atom for each of the first twenty elements*
 - c. *name the common elements, give their chemical symbols and state their common oxidation numbers*
2. Isotopes are atoms with the same atomic number (same number of protons) but different numbers of neutrons. The nuclei of some atoms are radioactive isotopes that spontaneously release radioactive energy
- a. *identify isotopes as atoms with the same number of protons but differing numbers of neutrons*
 - b. *discuss ways in which radioactive substances can be used.*
 - c. *compare the three types of nuclear radiation (alpha, beta, and gamma)*
 - d. *describe the process and products of radioactive decay*
 - e. ▲ *describe the effect of radioactivity on the environment and how to safely handle radioisotopes*

Benchmark 2: The students will understand the states and properties of matter.

Indicators:

1. 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.
 - a. Elements and molecules may exist as gasses, liquids or solids; Ionic compounds most commonly exist as solids.
 1. *relate phase changes to changes in heat energy*
 - b. Intermolecular attraction (attraction between molecules) determines the state of the molecule. 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.
2. ▲ The periodic table lists elements according to increasing atomic number. This table organizes physical and chemical trends by groups, periods, and categories.
 - a. 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. Some categories are regions such as metals, non-metals, and transition elements.

1. ▲ *organize elements according to similar physical and chemical properties by groups (families), periods (series), and categories*
2. ▲ *describe some differences between metals and nonmetals*
- b. There are discrete energy levels for electrons in an atom.
Electrons changing from one energy level to another may result in the emission or absorption of various forms of electromagnetic radiation, including the range of colors that form visible light.
3. ▲ Chemical bonds result when valence electrons are transferred or shared between atoms. Ionic compounds result from atoms transferring electrons. Molecular compounds result from atoms sharing electrons.
 - a. Valence electrons (those farthest from the nucleus or highest energy electrons) determine the chemistry of the atom.
 - b. Ionic compounds are composed of (positively charged) metal cations and (negatively charged) nonmetal anions
 1. ▲ *describe the formation of ions and ionic bonds*
 - c. Molecules result when two or more nonmetals share electrons (form a covalent bond).
 1. ▲ *describe the formation of covalent bonds and draw the electron dot structure of covalently bonded substances*
 - d. Carbon atoms can bond to each other in chains, rings, and branching networks to form a variety of molecular structures including relatively large molecules essential to life.
4. *identify and explain the general characteristics of matter i.e. density, volume and mass*
 - a. *determine the volume, density and mass of a given object*
 - b. *determine whether a given object will float in a given fluid*

Benchmark 3: The students will gain a basic concept of chemical reactions.

Indicators:

1. ▲ 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 that demonstrate the Law of Conservation of Mass i.e., synthesis, decomposition, combustion, single and double replacement, acid/base, and oxidation/reduction.

- a. Chemical reactions are written as chemical equations, which demonstrate the Law of Conservation of Mass through stoichiometric relationships.
 1. *balance chemical equations*
- b. Two or more of the following may often identify chemical reactions: physical property change, effervescence, mass change, precipitation, light emission, and heat exchange.
 1. *describe the formation of salts*
- c. Heat exchange during a chemical reaction is often easily noticed: a reaction that absorbs heat will feel colder; a reaction that releases heat will feel warmer.
- d. The tendency of nature to occupy the greatest number of different states, called entropy, is ultimately the driving force behind chemical reactions.
- e. The rate (speed) of a chemical reaction depends on such parameters as temperature, concentration, catalysts, and reaction type.
- f. **▲** *understand the relationship of elements to compounds*
- g. *describe properties and uses of acids and bases .*
- h. *relate pH number to acid/base strength*

STANDARD 2B: PHYSICS

As a result of their activities in grades 9-12, all students will develop an understanding of the structure of atoms, *compounds*, chemical reactions, and the interactions of energy and matter.

Benchmark 1: The student will understand the relationships between force and motion.

Indicators:

3. **▲** Newton's Laws and the kinematic variables of time, position, velocity, and acceleration can be used to describe the position and motion of all particles.
 - a. *apply Newton's three laws of motion to physical science*
 - b. In the absence of a net force, an object's velocity will not change.

- c. *demonstrate and mathematically communicate that unbalanced forces will cause changes in the speed or direction of an object's motion*
4. There are four fundamental forces in nature: strong nuclear force, weak nuclear force, electromagnetic force, and gravitational force.
 - a. A strong nuclear force keeps particles together in atomic nuclei.
 - b. The weak nuclear force plays a role in the radioactive disintegration of certain nuclei.
 - c. The electromagnetic force is the force that charged particles exert on one another. The electric force between any two charged particles is given by Coulomb's law, which states that the force is inversely proportional to the square of the distance between the charges.
 3. The gravitational force is the attractive force that objects exert on one another due to their mass. The gravitational force between any two points or spherically symmetric masses is given by Newton's law of universal gravitation, which states that the force is inversely proportional to the square of the distance between the masses. Near the surface of the Earth, the acceleration of an object due to gravity is a constant.
 - a. *explain the relationship between gravity and weight*

Benchmark 2: The student will understand the conservation of mass and energy, and the First and Second Laws of Thermodynamics.

Indicators:

1. Physicists view matter as equivalent to energy. Matter and energy cannot be created or destroyed, but they can be interchanged. The total energy and matter in the universe is constant.
 - a. The amount of energy in a given amount of mass is given by $E = mc^2$.
 - b. ▲ *recognize that matter and energy cannot be destroyed, only interchanged*
 - c. The amount of energy that would be required to completely dissociate a nucleus into its constituent protons and neutrons, divided by the number of protons and neutrons, is known as the "binding energy per nucleon" of the nucleus.
 - d. *compare the nuclear fission and nuclear fusion*

2. ▲ The first Law of Thermodynamics states the total energy of a substance is the sum of all the kinetic and potential energies of its constituent molecules. In any physical interaction, the total energy in the universe is conserved.
- a. *identify forms of energy (potential, kinetic, gravitational potential, electrical, electrical potential, chemical and chemical potential energies).*
 - b. *describe the forces that exist between the charged particles*
 - c. *understand that a force like gravity or friction is a push or a pull and investigate force variables*
 - d. *identify different types of friction*
 - e. *show how simple machines are related to complex machines*
 - f. *describe motion, speed, velocity, acceleration and displacement*
 - g. *calculate scientific measurements based on given formulas (such as speed, velocity, acceleration, work, energy, power, and density)*
 - h. *relate force, work, distance, and power*
 - i. *describe the role of machines in doing work*
 - j. *explain how a hydraulic device operates*
 - k. *calculate pressure*
 - l. *examine the effect of fluid pressure on various phenomena*
 - m. *demonstrate an understanding of buoyancy*
 - n. *demonstrate an understanding of phase changes and be able to calculate energy gained or lost in phase changes or in change of temperature*
 - o. *be able to calculate thermal expansion and practical application of thermal expansion*
3. The Second Law of Thermodynamics states the universe tends to become less organized and more disordered with every chemical and physical change.
- a. Heat flows spontaneously from hot objects to cooler ones. It does not flow spontaneously in the other direction. Heat can be made to flow from cooler objects to warmer ones if one does work.
 - b. *explain how insulation prevents heat loss*
 - c. *identify types of heat energy transfer and explain how heat energy is transferred*

Benchmark 3: The students will understand the nature of the fundamental interactions of matter and energy.

Indicators:

1. ▲ Waves have energy and can transfer energy when they interact with matter. All waves can be described in terms of their velocities. Periodic waves can also be described in terms of their wavelength, frequency, period, and amplitude.

2. ▲ Electromagnetic waves result when a charged particle is accelerated or decelerated. Charged particles experience a force given by Coulomb's law.
 - a. Electromagnetic waves include radio waves, microwaves, infrared radiation, visible light, ultraviolet radiation, X-rays, and gamma rays.
 - b. Some particles, such as protons and electrons, have a physical property known as charge. There are two types of charge, known as positive and negative.
 - c. *describe the nature of current electricity*
 - d. *identify the parts of an electric circuit*
 - e. *do calculations using Ohm's law, electrical power and electrical cost*
 - f. *identify conductors, semiconductors, and insulators*
 - g. *identify various sources of electricity*
 - h. *describe the nature of static electricity*
 - i. *distinguish between parallel and series circuits*

USD 312 Benchmark 4: Magnetism

Indicators

1. *have a basic understanding of magnetism.*
 - a. *describe magnetism and the behavior of magnetic poles*
 - b. *describe the Earth's magnetic properties*
 - c. *explain how a compass works*