

Physical Science HS

Indicators	Standards	Instructional Examples/ Additional Specificity	Month
actively engages in asking and evaluating research questions.	KS.1.1.1	Well-formed research questions drive scientific inquiry.	throughout year
▲ actively engages in investigations, including developing questions, gathering and analyzing data, and designing and conducting research	KS.1.1.2	The scientific investigations includes, when appropriate, a. formulating a testable hypothesis. b. identify and test variables (independent, dependent, and variables to be kept constant). c. using methods for gathering data that is observable, measurable, and replicable. d. analyzing and evaluating the results in order to clarify the questions and hypotheses, and to refine methods for further research.	throughout year
▲ actively engages in using technological tools and mathematics in their own scientific investigations.	KS.1.1.3	a. using a variety of technologies, such as hand tools, measuring instruments, calculators, and computers as an integral component of scientific investigations. b. using common mathematical functions to analyze and describe data. c. uses statistical and graphing data analysis techniques. d. recognizes that the accuracy and precision of the data, and therefore the quality of the investigation, depends on the instruments used. e. using equipment properly and safely.	throughout year
actively engages in conducting an inquiry, formulating and revising his or her scientific explanations and models (physical, conceptual, or mathematical) using logic and evidence, and recognizing that potential alternative explanations and models should be considered	KS.1.1.4	a. engages in discussions that result in the revision of his/her explanation. b. analyzes their explanation by reviewing current scientific understanding, weighing the evidence, and examining the logic so as to decide which explanations and models have the greatest explanatory power. c. evaluates personal preconceptions and biases with respect to his/her conclusions. d. based on their results, students consider modifications to their investigations.	throughout year
actively engages in communicating and defending the design, results, and conclusion of his/her investigation	KS.1.1.5	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.	throughout year

Physical Science HS

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<p>▲ understands 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.</p>	<p>KS2A.1.1</p>	<p>a. All atoms are identified by the number of protons in the nucleus, i.e. the atomic number. The protons have a positive charge and a mass of 1 amu. Protons and neutrons are found in the small, dense, nucleus.</p> <p>b. Neutrons have a neutral charge and a mass of 1 amu.</p> <p>c. The electrons have a negative charge and are found outside the nucleus in an electron cloud. The mass of an electron is approximately 2,000 times smaller than a proton. The electrons determine the size and chemical properties of the atom.</p> <p>a. The number of electrons is equal to the number of protons in a neutral atom. Ions have a different number of electrons than protons.</p>	<p>September</p>
<p>understands 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 decay, releasing radioactive energy.</p>	<p>KS2A.1.2</p>	<p>a. The periodic table reflects the average mass of the isotopes.</p> <p>b. Examples of released radioactivity are alpha, beta, and gamma radiation.</p> <p>c. Some isotopes spontaneously decay at a first order rate. There is a negative linear relationship between the log of the sample isotope concentration vs. time,</p> <p>d. To balance a nuclear equation, the sum of the atomic numbers and the sum of the mass numbers must be equal on both sides of the equation.</p>	<p>September October</p>
<p>▲ 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.</p>	<p>KS2A.2.1</p>	<p>a. Elements and molecules may exist as gases, liquids or solids. Ionic compounds most commonly exist as solids.</p> <p>b. 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.</p>	<p>October November</p>
<p>▲ understands the periodic table lists elements according to increasing atomic number.</p>	<p>KS2A.2.2</p>	<p>a. Elements in the same group have the same number of valence electrons and can be used to predict similar physical and</p>	<p>September</p>

Physical Science HS

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<p>This table organizes physical and chemical trends by groups, periods, and sub-categories</p>		<p>chemical properties. Elements are grouped by similar ground state valence electron configurations.</p> <p>b. As periods increase, the principle energy levels of the outermost (<i>valence</i>) electrons increase. 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. When there is color, there are electrons changing energy levels.</p> <p>c. Sub-categories are regions such as metals, non-metals, and transition elements Nonmetals have different physical and chemical properties than metals. For example, nonmetals have lower melting points, lower density, and are poorer conductors of electricity and heat. Chemical properties depend on the subshell of the valence electrons which are different for metals and non-metals.</p>	
<p>▲ 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.</p>	<p>KS2A.2.3</p>	<p>a. Valence electron configurations determine whether an atom gains, loses, or shares electrons to achieve a more stable electron configuration similar to the noble gases.</p> <p>b. Positively charged ions are called cations, and negatively charged ions are called anions. Cations are attracted to anions (opposite charges attract). Most cations are metals; most anions are nonmetals. In stable ionic compounds, the sum of the charges is zero.</p> <p>c. Covalent bonds form when two or more atoms share one or more pairs of electrons to achieve a more stable electron configuration. The two classifications of covalent bonds are nonpolar and polar. The greater the electronegativity difference between atoms involved in the bond, the more polar the bond.</p> <p>d. The energy required to break ionic bonds is greater than the energy required to break covalent bonds. 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.</p> <p>e. Carbon atoms can bond to each other</p>	<p>November</p>

Physical Science HS

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		<p>in chains, rings, and branching networks to form a variety of molecular structures including relatively large molecules essential to life. Diamonds, a 3-dimensional branching of carbon atoms and quartz, a repeated 3-dimensional branching of silicon dioxide molecules, are further examples of network solids. Unique properties of network solids include hardness, high melting points, poor conductors - indicative of covalent bonding and stable geometry.</p> <p>f. Metallic bonding is defined as free roaming electrons forming a negative sea of electrons surrounding the positive metal ions.</p>	
<p>▲ 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.</p>	<p>KS2A.3.1</p>	<p>a. Chemical reactions are written as balanced chemical equations. In ordinary chemical reactions, the number and kind of atoms must be conserved.</p> <p>b. Examples of chemical reactions are synthesis, decomposition, combustion, single and double replacement, acid/base, and oxidation/reduction.</p> <p>c. Two or more of the following may often identify chemical reactions: physical property change, effervescence, mass change, precipitation, light emission, and heat exchange.</p> <p>d. The rate (speed) of a chemical reaction depends on such parameters as temperature, concentration, catalysts, inhibitors, surface area, and reaction type.</p>	<p>November</p>
<p>understands how to perform mathematical calculations regarding the Law of Conservation of Matter, i.e., through stoichiometric relationships.</p>	<p>KS2A.3.2</p>	<p>a. Reaction stoichiometry involves understanding the use of coefficients (moles) to balance equations and solve for a variety of relationships using the molar mass of the substances. Examples of these types of relationships include mole/mole, mole/mass, mole/volume, mass/volume, mass/mass, etc.</p>	<p>November</p>
<p>understands the differences and reactions between acids, bases, and salts. Perform calculations to determine the concentration of ions in solutions.</p>	<p>KS2A.3.3</p>	<p>a. Acids react with bases to produce water and salt.</p> <p>b. pH is a logarithmic function of hydronium ion concentration. pH decreases as the hydronium ion concentration increases. pOH and hydroxide concentrations are found in a</p>	<p>December</p>

Physical Science HS

Indicators	Standards	Instructional Examples/ Additional Specificity	Month
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<p>▲ Understands Newton's Laws and the variables of time, position, velocity, and acceleration can be used to describe the position and motion of particles.</p>	<p>KS 2B.1.1</p>	<p>a. The kinematic (motion) variables: position, velocity, and acceleration can most concisely be described as vectors.</p> <p>b. Velocity describes how position changes and acceleration describes how velocity changes.</p> <p>c. From the definitions of velocity and acceleration, one can derive equations that relate the kinematic variables.</p> <p>d. 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 is constant, and is related to the speed of the object and the radius of the circle.</p> <p>e. In the absence of a net force, an object's velocity will not change.</p> <p>f. In the presence of a net force, an object will experience an acceleration which is modeled mathematically by Newton's second law.</p> <p>g. 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.</p>	<p>January</p>
<p>Understands physicists use conservation laws to analyze the motion of objects.</p>	<p>KS 2B.1.2</p>	<p>a. Mechanical energy is conserved when no non-conservative forces (such as friction) do work.</p> <p>b. The momentum of an object is a product of its mass and velocity. Momentum is conserved when there are no external forces on the system.</p> <p>c. There are situations in which momentum is conserved but mechanical energy is not. Forces internal to a system can cause a loss of mechanical energy, but only external forces can change the system's momentum.</p> <p>d. Angular momentum is conserved when</p>	<p>February</p>

Physical Science HS

Indicators	Standards	Instructional Examples/ Additional Specificity	Month
		there is no external torques on the system.	
<p>Understands matter has energy. Mass and energy can be interchanged. The total energy in the universe is constant, but the type of energy may vary.</p>	KS 2B.2.1	<p>a. The amount of energy in a given amount of mass at rest is given by $E = mc^2$.</p> <p>b. 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.</p> <p>c. Two light nuclei that merge into a larger nucleus emit energy. This is known as fusion.</p> <p>d. A massive nucleus that splits apart into two medium mass nuclei emit energy. This is known as fission.</p>	February
<p>▲ 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.</p>	KS 2B.2.2	<p>a. 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.</p> <p>b. Heat is an exchange of internal (kinetic and/or potential) energy between systems due to a temperature difference. 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. A heat engine can convert heat to work, but some heat will always be lost in the process. Examples of heat transport include radiation from the sun, convection of hydrosphere/atmosphere/mantle, and conduction between water/land/air.</p> <p>c. 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 it.</p> <p>d. There is a relationship between energy</p>	March

Physical Science HS

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		and power. Power is the rate at which work is done, or the rate at which the energy of some system changes.	
<p>▲ Understands waves have energy and can transfer energy when they interact with matter.</p>	KS 2B.3.2	<p>a. 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.</p> <p>b. 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.</p> <p>c. 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. Difference wavelengths of visible light correspond to different colors.</p>	April
<p>The student understand interference – how waves interact with other waves.</p>	KS 2B.3.3	<p>a. Most common types of waves obey the principle of linear superposition. When two waves meet, they superimpose. At points where the crests (or troughs) of two waves meet there is constructive interference. At points where the crest of one wave meets the through of another, there is destructive interference. Beats are heard when two sound waves with slightly different frequencies interfere. Two waves traveling in opposite directions can combine to produce a standing wave.</p> <p>b. Diffraction is the bending of a wave around an obstacle or an edge. When this happens, different intensities of the wave are observed downstream due to the wave interfering with itself.</p>	April

Physical Science HS

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The student will understand the principles of reflection and refraction.	KS 2B.3.4	a. 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 in a manner given by Snell's law. One can trace rays to predict the properties of images produced by mirrors. One can trace rays to predict the properties of images produced by lenses.	April/May
▲ Understands electromagnetic waves result when a charged particle is accelerated or decelerated.	KS 2B.3.5	a. 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.**	April/May
The student understands basic electrostatics and circuits.	KS 2B.3.5	<p>a. There is a potential energy associated with the electric force. This is most commonly dealt with in the related quantity electric potential. The electric potential energy of a particle is its charge times the electric potential at the particle's location.</p> <p>b. Knowledge of electric force and potential allows for the analysis of simple DC circuits. Batteries increase the electric potential energy of electrons. Although it is electrons that flow in a circuit, we analyze circuits as if positive charges are flowing in the other direction. Current is the rate at which charges are flowing in a circuit. The electric potential in a conductor has the same value everywhere in that conductor. Positive charges flowing through a resistor experience a drop in electric potential given by Ohm's law. Charges flowing through a resistor lose energy at a rate that depends on the current and on the resistance of the resistor. The resistance of resistors in series or in parallel can be computed, given the resistances of each individual resistor.</p>	May

Physical Science HS

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