Physics HS

Indicators (▲ are tested)	Standards	Instructional Examples/ Additional Specificity	Month
▲Understands Newton's Laws and the variables of time, position, velocity, and acceleration can be used to describe the position and motion of particles.	KS 2B.1.1	a. The kinematic (motion) variables: position, velocity, and acceleration can most concisely be described as vectors. b. Velocity describes how position changes and acceleration describes how velocity changes. c. From the definitions of velocity and acceleration, one can derive equations that relate the kinematic variables. 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. e. In the absence of a net force, an object's velocity will not change. f. In the presence of a net force, an object will experience an acceleration which is modeled mathematically by Newton's second law. 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.	September

Physics HS

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Understands physicists use conservation laws to analyze the motion of objects.	KS 2B.1.2	a. Mechanical energy is conserved when no non-conservative forces (such as friction) do work. 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. 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. d. Angular momentum is conserved when there is no external torques on the system.	October
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.	KS 2B.2.1	a. The amount of energy in a given amount of mass at rest is given by $E = mc^2$. 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. c. Two light nuclei that merge into a larger nucleus emit energy. This is known as fusion. d. A massive nucleus that splits apart into two medium mass nuclei emit energy. This is known as fission.	January

Physics HS

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▲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.	KS 2B.2.2	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. 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. 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. d. 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.	February

Physics HS

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Understands the second law of thermodynamics that states the entropy of the universe is increasing.	KS 2B.2.3	a. Entropy is a state function that describes a system. In some cases, it can be thought of as a measure of disorder. A system will not spontaneously undergo a process that decreases its entropy. b. A discretely defined system; a collection of objects or particles interacting via forces or processes that are internal to the system, remains the same or become more disordered (i.e. losing heat across the boundary of the system) over time.	November
There are four fundamental forces in nature: strong nuclear force, weak nuclear force, electromagnetic force, and gravitational force.	KS 2B.3.1	a. The 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 strong and weak nuclear forces act on quarks and leptons, subatomic particles. d. 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 state that the force is inversely proportional to the square of the distance between the charges. The magnetic force occurs between any two charged particles moving relative to each other. e. The gravitational force is the attractive force that objects exert on one another due to their mass. The gravitational force between any two 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. This explains the motion of planets. Near the surface of the Earth, the acceleration of an object due to gravity is independent of the mass of the object and therefore constant.	October, March, and May
▲Understands waves have	KS 2B.3.2	a. Waves are traveling disturbances	March

Physics HS

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energy and can transfer energy when they interact with matter. Understands waves have energy and can transfer energy when they interact with matter.		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. 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. 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.	
The student understand interference – how waves interact with other waves.	KS 2B.3.3	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. 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.	March

Physics 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.	March
▲ 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. 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. Charged particles experience a force given by Coulomb's law. Coulomb's law indicates that the electric force between two charges is attractive if the charges have opposite sign, and repulsive if they have the same sign. The force between charges is inversely proportional to the square of the distance between them. d. The magnitude of the magnetic force on a particle in a magnetic field is proportional to the particle's charge and speed, and to the magnitude of the magnetic field. The direction of the force is perpendicular to both the particle's velocity and the magnetic field. If the particle's velocity is parallel to the magnetic field, the force vanishes.	March
The student understands basic electrostatics and circuits.	KS 2B.3.5	a. There is a potential energy associated with the electric force. This is most commonly dealt with in the related	April

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		quantity electric potential. The electric potential energy of a particle is its charge times the electric potential at the particle's location. 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.	