Physical Science

State Standard Number	State Standard Area / Description	Unit Name	Course Topic Description
PH.1	Newton's laws predict the motion of most objects. As a basis for understanding this concept:		
PH.1.a	Students know how to solve problems that involve constant speed and average speed.	Energy in Motion	Section A Speed
PH.1.b	Students know that when forces are balanced, no acceleration occurs; thus an object continues to move at a constant speed or stays at rest (Newton's first law).	Energy in Motion	Section C Newton's First Law of Motion
PH.1.c	Students know how to apply the law F = ma to solve one-dimensional motion problems that involve constant forces (Newton's second law).	Energy in Motion	Section C Newton's Second Law of Motion
PH.1.d	Students know that when one object exerts a force on a second object, the second object always exerts a force of equal magnitude and in the opposite direction (Newton's third law).	Energy in Motion	Section C Newton's Third Law of Motion
PH.1.e	Students know the relationship between the universal law of gravitation and the effect of gravity on an object at the surface of Earth.	Energy in Motion	Section B Gravity
PH.1.f	Students know applying a force to an object perpendicular to the direction of its motion causes the object to change direction but not speed (e.g., Earth's gravitational force causes a satellite in a circular orbit to change direction but not speed).		
PH.1.g	Students know circular motion requires the application of a constant force directed toward the center of the circle.		
PH.1.h	Students know Newton's laws are not exact but provide very good approximations unless an object is moving close to the speed of light or is small enough that quantum effects are important.		

Physical Science

PH.1.i	Students know how to solve two-dimensional trajectory problems.		
PH.1.j	Students know how to resolve two-dimensional vectors into their components and calculate the magnitude and direction of a vector from its components.	Energy in Motion	Section B Force Vectors
PH.1.k	Students know how to solve two-dimensional problems involving balanced forces (statics).	Energy in Motion	Section B Balanced and Unbalanced Forces
PH.1.l	Students know how to solve problems in circular motion by using the formula for centripetal acceleration in the following form: $a = v^2/r$.		
PH.1.m	Students know how to solve problems involving the forces between two electric charges at a distance (Coulomb's law) or the forces between two masses at a distance (universal gravitation).	Energy in Motion Electricity and Magnetism	Section B Gravity Section A Coulomb's Law
PH.2	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:		
PH.2.a	Students know how to calculate kinetic energy by using the formula $E = (1/2)mv^2$.		

Physical Science

PH.2.b	Students know how to calculate changes in gravitational potential energy near Earth by using the formula (change in potential energy) = mgh (h is the change in the elevation).		
PH.2.c	Students know how to solve problems involving conservation of energy in simple systems, such as falling objects.		
PH.2.d	Students know how to calculate momentum as the product mv.		
PH.2.e	Students know momentum is a separately conserved quantity different from energy.	Energy in Motion	Section C Inertia and Momentum
PH.2.f	Students know an unbalanced force on an object produces a change in its momentum.		
PH.2.g	Students know how to solve problems involving elastic and inelastic collisions in one dimension by using the principles of conservation of momentum and energy.		
PH.2.h	Students know how to solve problems involving conservation of energy in simple systems with various sources of potential energy, such as capacitors and springs.		
PH.3	Energy cannot be created or destroyed, although in many processes energy is transferred to the environment as heat. As a basis for understanding this concept:		
PH.3.a	Students know heat flow and work are two forms of energy transfer between	Matter, Energy and Change	Section C Forms of Energy

Physical Science

	systems.		
PH.3.b	Students know that the work done by a heat engine that is working in a cycle is the difference between the heat flow into the engine at high temperature and the heat flow out at a lower temperature (first law of thermodynamics) and that this is an example of the law of conservation of energy.	Matter, Energy and Change	Section D Case Studies: Energy Transformations in a Car
PH.3.c	Students know the internal energy of an object includes the energy of random motion of the object's atoms and molecules, often referred to as thermal energy. The greater the temperature of the object, the greater the energy of motion of the atoms and molecules that make up the object.	Matter, Energy and Change	Section B Kinetic Theory of Matter
PH.3.d	Students know that most processes tend to decrease the order of a system over time and that energy levels are eventually distributed uniformly.		
PH.3.e	Students know that entropy is a quantity that measures the order or disorder of a system and that this quantity is larger for a more disordered system.		
PH.3.f	Students know the statement "Entropy tends to increase" is a law of statistical probability that governs all closed systems (second law of thermodynamics).		
PH.3.g	Students know how to solve problems involving heat flow, work, and efficiency in a heat engine and know that all real engines lose some heat to their surroundings.	Matter, Energy and Change	Section D Case Studies: Energy Transformations in a Car
PH.4	Waves have characteristic properties that do not depend on the type of wave. As a basis for understanding this concept:		
PH.4.a	Students know waves carry energy from one place to another.	Waves	Section A What is a Wave?
PH.4.b	Students know how to identify transverse and longitudinal waves in mechanical media, such as springs and ropes, and on the earth (seismic	Waves	Section A Categories of Waves

Physical Science

	waves).		
PH.4.c	Students know how to solve problems involving wavelength, frequency, and wave speed.	Waves	Section A Wave Speed
PH.4.d	Students know sound is a longitudinal wave whose speed depends on the properties of the medium in which it propagates.	Waves	Section C The Origin of Sound
PH.4.e	Students know radio waves, light, and X-rays are different wavelength bands in the spectrum of electromagnetic waves whose speed in a vacuum is approximately 3 x 10 to the 8th power m/s (186,000 miles/second).	Waves	Section D The Electromagnetic Spectrum
PH.4.f	Students know how to identify the characteristic properties of waves: interference (beats), diffraction, refraction, Doppler effect, and polarization.	Waves	Sections B, C and D Throughout
PH.5	Electric and magnetic phenomena are related and have many practical applications. As a basis for understanding this concept:		
PH.5.a	Students know how to predict the voltage or current in simple direct current (DC) electric circuits constructed from batteries, wires, resistors, and capacitors.	Electricity and Magnetism	Section B Direct Current and Alternating Current
PH.5.b	Students know how to solve problems involving Ohm's law.	Electricity and Magnetism	Section B Ohm’s Law
PH.5.c	Students know any resistive element in a DC circuit dissipates energy, which heats the resistor. Students can calculate the power (rate of energy dissipation) in any resistive circuit element by using the formula Power = IR (potential difference) x I (current) = 1^2 R.		
PH.5.d	Students know the properties of transistors and the role of transistors in electric circuits.		
PH.5.e	Students know charged particles are sources of electric fields and are subject to the forces of the electric fields from other charges.	Electricity and Magnetism	Section B Electric Potential

Physical Science

PH.5.f	Students know magnetic materials and electric currents (moving electric charges) are sources of magnetic fields and are subject to forces arising from the magnetic fields of other sources.	Electricity and Magnetism	Section C Magnetic Fields
PH.5.g	Students know how to determine the direction of a magnetic field produced by a current flowing in a straight wire or in a coil.	Electricity and Magnetism	Section C Magnetic Fields
PH.5.h	Students know changing magnetic fields produce electric fields, thereby inducing currents in nearby conductors.		
PH.5.i	Students know plasmas, the fourth state of matter, contain ions or free electrons or both and conduct electricity.		
PH.5.j	Students know electric and magnetic fields contain energy and act as vector force fields.		
PH.5.k	Students know the force on a charged particle in an electric field is qE, where E is the electric field at the position of the particle and q is the charge of the particle.		
PH.5.l	Students know how to calculate the electric field resulting from a point charge.		
PH.5.m	Students know static electric fields have as their source some arrangement of electric charges.	Electricity and Magnetism	Section A Static Electricity
PH.5.n	Students know the magnitude of the force on a moving particle (with charge q) in a magnetic field is qvB sin(a), where a is the angle between v and B (v and B are the magnitudes of vectors v and B, respectively), and students use the right-hand rule to find the direction of this force.		
PH.5.o	Students know how to apply the concepts of electrical and gravitational potential energy to solve problems involving conservation of energy.		