Cambridge Public Schools
Science Curriculum

Grade 9 Physics

Curriculum	Science Unit Description	Unit Understanding Goals and Related Massachusetts Science and Technology/Engineering Standards	Examples of Evidence of Student Learning
Physics of Driving Safety (Motion)	Students will study velocity, acceleration, Newton's Laws, and momentum based on the Active Physics™ Transportation unit. The culminating project requires students to create an ad campaign for a public service announcement about driving safety and write a paper explaining the physics behind their chosen safety measure.	• Students will understand that the motion of an object can be described by it's position, velocity, and acceleration, all of which can be represented graphically or numerically. • Students will understand that various factors that a driver can control, such as response time, initial velocity, or acceleration rate, affect a driver's ability to avoid collisions. • Students will understand that Newton's Laws and conservation of momentum can predict the motion of objects in a collision and the forces that act upon them. Students will represent the forces acting on an object using free-body diagrams and vectors. • Students will understand that Newton's Laws can help us determine how to safely stop someone during a collision. **State Standards for Introductory Physics: 1.1-1.8 (Motion and Forces), 2.5 (Conservation of Energy and Momentum)**	• Students brainstorming factors that might affect a person's response time and experimentally determining which of those factors significantly affect response time. • Students drawing and interpreting position vs. time and velocity vs. time graphs of objects moving slowly and quickly, moving forward and backward, speeding up, slowing down, and standing still. • Students using physics problem solving method (problem solving box) to solve problems involving velocity, acceleration, force and momentum. • Written lab reports discussing the effect of initial velocity on the braking distance of a cart. • Students connecting Newton's Laws to real-life scenarios. • Predict the motion of objects in a collision on an air track and collect data to determine if the prediction is correct or incorrect. • Student presentations of posters, pamphlets, or videos that promote a particular driving safety issue, and explanations of the physics that supports the public safety message.
Electricity in our Lives	Students will examine electricity, focusing on electric charge and electric circuits. In the culminating project students build a living unit wired for electricity.	• Students will understand what a charged object is on an atomic level, how a neutral object can become polarized and how objects can be charged (friction, conduction, induction). • Students will understand how charges and charged objects interact in cases of polarization, conduction, and induction. • Students will understand and be able to control the flow of electricity by arranging resistors in series or parallel and by using switches, resistors, and capacitors. • Students will understand current, voltage, and power and how to measure them. • Students will understand that current creates magnetic fields, and changing magnetic fields can exert force on charges. **State Standards for Introductory Physics: 5.1-5.6 (Electromagnetism)**	• Students using a battery, bulb and wire to build a complete circuit. • Students drawing models of neutral and charged atoms. • Students exploring how objects become charged, observing the interaction between charged objects, and explaining their behavior based on attraction and repulsion of charges. • Students observing and explaining Van de Graaff demonstrations. • Students participating in and analyzing a conceptual demonstration of Coulomb's Law. • Students building series and parallel circuits and observing the effect of removing and short-circuiting bulbs. • Students identifying and testing variables that influence circuit behavior and making measurements using ammeters and voltmeters. • Models of 'living units' wired with series and parallel circuits, including switches. • Students predicting and analyzing ways in which electricity creates magnetic fields and magnetic fields create current.

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Waves, Sound and Light as Entertainment	Students will study waves, sound and light with activities adapted from the Active Physics™ Communication unit. Students will conclude the unit with a culminating project requiring them to perform a sound and/or light demonstration and write a description of the physics concepts used in the demonstration.	• Students will understand that all waves share the same characteristics (frequency, wavelength, amplitude, speed) and how to measure and display those characteristics. • Students will understand that all waves demonstrate the same behaviors (reflection, refraction, interference, diffraction). • Students will understand how the human ear perceives sound (pitch, volume), how sound are produced and travel, and how to change the characteristics of a sound (frequency, amplitude, wavelength). • Students will understand that visible light is one region of the electromagnetic spectrum, how electromagnetic waves are produced, and how the characteristics (frequency, wavelength) of each region make them suited for particular applications. **State Standards for Introductory Physics: 4.1-4.6 (Waves), 6.1-6.2 (Electromagnetic Radiation)**	• Students measuring the frequency of a pendulum. • Students interpreting and drawing graphs of wave motion based on their frequency, period and amplitude. • Students drawing problem solving boxes to solve problems involving frequency, wavelength and wave speed. • Students modeling transverse and longitudinal waves with a slinky and determining which factors affect the speed of a slinky wave. • Students measuring the length of tube necessary to produce resonance in an air column at a particular frequency and writing reports analyzing the relationship between length and frequency. • Student drawings of the electromagnetic spectrum with frequency and wavelength. • Students comparing and contrasting sound and light waves. • Students designing and presenting a sound and/or light demonstration. Written papers detailing the physics concepts demonstrated.
Energy and Society	Students will study work, power, conservation of energy, and heat through a variety of experiments and activities. The unit will culminate with a project investigating and reporting about alternative energy resources	• Students will understand that there are many forms and sources of mechanical energy and that it can be transferred from one form to another. • Students will use the Law of Conservation and the concept of efficiency to explain why some energy is useable, some is not and that energy is never lost. • Students will understand that heat energy moves by convection, conduction and radiation, from a higher temperature to a lower temperature until thermal equilibrium is reached. • Students will understand that temperature is the average kinetic energy of an object's molecules. When an object changes temperature, it gains or loses heat energy and the amount of energy depends on the specific heat of the object. Heat energy is also gained or lost when an object changes phase. • Students will understand that useable energy sources are finite and they should make choices about which energy sources to use and how to efficiently use energy. These choices have both personal and societal consequences. **State Standards for Introductory Physics: 2.1-2.4 (Conservation of Energy and Momentum), 3.1-3.4 (Heat and Heat Transfer)**	• Students independently drawing problem solving boxes to solve problems involving work and power. • Written reports showing measurement and comparison of the power expended by students' bodies during various physics exercises. • Students calculating potential and kinetic energy relating concepts of energy conservation to a roller coaster. • Students determining the specific heat of metals experimentally. • Students making written observations of radiation, convection and conduction and collecting data to demonstrate heat transfer. • Students collecting and evaluating information about the benefits and drawbacks of using a particular energy resource. • Student presentations advocating for or against the use of energy resources.