Physical Science CR

State Standard Number	State Standard Area / Description	Unit Name	Course Topic Description
P	Introductory Physics		
P.I	Content Standards		
P.I.1.1.A	Newton's laws of motion and gravitation describe and predict the motion of most objects.		
P.I.1.A.1.1	Compare and contrast vector quantities (such as, displacement, velocity, acceleration, force, and linear momentum) and scalar quantities (such as, distance, speed, energy, mass, and work).		
P.I.1.A.1.2	Distinguish between displacement, distance, velocity, speed, and acceleration. Solve problems involving displacement, distance, velocity, speed, and constant acceleration.		
P.I.1.A.1.3	Create and interpret graphs of 1-dimensional motion, such as position vs. time, distance vs. time, speed vs. time, velocity vs. time, and acceleration vs. time where acceleration is constant.	Energy in Motion	Using Graphs to Represent Speed Distance-Time Graphs Graphing Velocity and Acceleration
P.I.1.A.1.4	Interpret and apply Newton's three laws of motion.	Energy in Motion	Tutorial: Newton's Three Laws of Motion
P.I.1.A.1.5	Use a free-body force diagram to show forces acting on a system consisting of a pair of interacting objects. For a diagram with only co-linear forces, determine the net force acting on a system and between the objects.		
P.I.1.A.1.6	Distinguish qualitatively between static and kinetic friction, and describe their effects on the motion of objects.		

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P.I.1.A.1.7	Describe Newton's law of universal gravitation in terms of the attraction between two objects, their masses, and the distance between them.	Energy in Motion	Gravity, Mass and Weight
P.I.1.A.1.8	Describe conceptually the forces involved in circular motion.		
P.I.2.2.A	The laws of conservation of energy and momentum provide alternate approaches to predict and describe the movement of objects.		
P.I.2.A.2.1	Interpret and provide examples that illustrate the law of conservation of energy.	Matter, Energy and Change	The Law of Conservation of Energy
P.I.2.A.2.2	Interpret and provide examples of how energy can be converted from gravitational potential energy to kinetic energy and vice versa.	Matter, Energy and Change	Kinetic and Potential Energy
P.I.2.A.2.3	Describe both qualitatively and quantitatively how work can be expressed as a change in mechanical energy.		
P.I.2.A.2.4	Describe both qualitatively and quantitatively the concept of power as work done per unit time.	Machines	Tutorial: Work and Power
P.I.2.A.2.5	Interpret and provide examples that linear momentum is the product of mass and velocity and is always conserved (law of conservation of momentum). Calculate the momentum of an object.		

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P.I.3.3.A	Heat is energy that is transferred between objects or regions that are at different temperatures by the processes of convection, conduction, and radiation.		
P.I.3.A.3.1	Explain how heat energy is transferred by convection, conduction, and/or radiation.	Matter, Energy and Change	Heat Transfer
P.I.3.A.3.2	Explain how heat energy will move from a higher temperature to a lower temperature until equilibrium is reached.		
P.I.3.A.3.3	Describe the relationship between average molecular kinetic energy and temperature. Recognize that energy is absorbed when a substance changes from a solid to a liquid to a gas, and that energy is released when a substance changes from a gas to a liquid to a solid. Explain the relationships between evaporation, condensation, cooling, and warming.		
P.I.3.A.3.4	Explain the relationship among temperature change in a substance for a given amount of heat transferred, the amount (mass) of the substance, and the specific heat of the substance.		
P.I.4.4.A	Waves carry energy from place to place without the transfer of matter.		

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P.I.4.A.4.1	Describe the measurable properties of waves (velocity, frequency, wavelength, amplitude, and period) and explain the relationships among them. Recognize examples of simple harmonic motion.		
P.I.4.A.4.2	Distinguish between mechanical and electromagnetic waves.	Waves	Tutorial: Electromagnetic and Mechanical Waves
P.I.4.A.4.3	Distinguish between the two types of mechanical waves, transverse and longitudinal.	Waves	Tutorial: Electromagnetic and Mechanical Waves
P.I.4.A.4.4	Describe qualitatively the basic principles of reflection and refraction of waves.	Waves	Reflection Refraction
P.I.4.A.4.5	Recognize that mechanical waves generally move faster through a solid than through a liquid and faster through a liquid than through a gas.	Waves	Tutorial: Understanding Sound
P.I.4.A.4.6	Describe the apparent change in frequency of waves due to the motion of a source or a receiver (the Doppler effect).	Waves	The Doppler Effect
P.I.5.5.A	Stationary and moving charged particles result in the phenomena known as electricity and magnetism.		

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P.I.5.A.5.1	Recognize that an electric charge tends to be static on insulators and can move on and in conductors, and explain that energy can produce a separation of charges.	Electricity and Magnetism	Electrical Charges Conductors and Insulators
P.I.5.A.5.2	Develop a qualitative and quantitative understanding of current, voltage, resistance, and the connection between them (Ohm's law).	Electricity and Magnetism	Tutorial: Understanding Ohm's Law, Currents and Circuits
P.I.5.A.5.3	Analyze simple arrangements of electrical components in both serial and parallel circuits. Recognize symbols and understand the functions of common circuit elements (battery, connecting wire, switch, fuse, and resistance) in a schematic diagram.	Electricity and Magnetism	Tutorial: Understanding Ohm's Law, Currents and Circuits
P.I.5.A.5.4	Describe conceptually the attractive or repulsive forces between objects relative to their charges and the distance between them (Coulomb's law).	Electricity and Magnetism	Coulomb's Law
P.I.5.A.5.5	Explain how electric current is a flow of charge caused by a potential difference (voltage) and how power is equal to current multiplied by voltage.		
P.I.5.A.5.6	Recognize that moving electric charges produce magnetic forces and moving magnets produce electric forces. Recognize that the interplay of electric and magnetic forces is the basis for electric motors, generators, and other technologies.	Electricity and Magnetism	Tutorial: Electromagnetic Induction

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P.I.6.6.A	Oscillating electric or magnetic fields can generate electromagnetic waves over a wide spectrum.		
P.I.6.A.6.1	Recognize that electromagnetic waves are transverse waves and travel at the speed of light through a vacuum.		
P.I.6.A.6.2	Describe the electromagnetic spectrum in terms of frequency and wavelength and identify the location of radio waves, microwaves, infrared radiation, visible light (red, orange, yellow, green, blue, indigo, and violet), ultraviolet rays, x-rays, and gamma rays on the spectrum.	Electricity and Magnetism	The Electromagnetic Spectrum
P.II	Scientific Inquiry Skills Standards		
P.II.SIS1	Make observations, raise questions, and formulate hypotheses.		
P.II.SIS1.1	Observe the world around them from a scientific perspective.	Scientific Nature	Tutorial: What is Science?

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P.II.SIS1.2	Pose questions and form hypotheses based on personal observations, scientific articles, experiments, and knowledge.	Scientific Nature	Tutorial: Hypothesis, Observations and Data
P.II.SIS1.3	Read, interpret, and examine the credibility and validity of scientific claims in different sources of information, such as scientific articles, advertisements, or media stories.		
P.II.SIS2	Design and conduct scientific investigations.		
P.II.SIS2.1	Articulate and explain the major concepts being investigated and the purpose of an investigation.	Scientific Nature	Scientific Method Case Study: Acid Rain's Effects on Forests
P.II.SIS2.2	Select required materials, equipment, and conditions for conducting an experiment.		
P.II.SIS2.3	Identify independent and dependent variables.	Scientific Inquiry	Tutorial: Variables
P.II.SIS2.4	Write procedures that are clear and replicable.		

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P.II.SIS2.5	Employ appropriate methods for accurately and consistently	Scientific Inquiry	Measurement Errors
P.II.SIS2.5.	making observations;	Scientific Nature	Good Observations
P.II.SIS2.5.	making and recording measurements at an appropriate level of precision and;	Scientific Inquiry	Measurement Errors
P.II.SIS2.5.	collecting data or evidence in an organized way.	Scientific Inquiry	The Importance of Organizing Data
P.II.SIS2.6	Properly use instruments, equipment, and materials (such as scales, probeware, meter sticks, microscopes, computers, etc.) including: set-up, calibration (if required), technique, maintenance, and storage.		
P.II.SIS2.7	Follow safety guidelines.	Scientific Inquiry	Safety During Investigations
P.II.SIS3	Analyze and interpret results of scientific investigations.		

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P.II.SIS3.A	Present relationships between variables in appropriate forms.	Scientific Inquiry	Tutorial: Trends in Data
P.II.SIS3.A.	Represent data and relationships between variables in charts and graphs.	Scientific Inquiry	Classifying Data Tutorial: Graphs
P.II.SIS3.A.	Use appropriate technology (such as graphing software, etc.) and other tools.		
P.II.SIS3.1	Use mathematical operations to analyze and interpret data results.	Scientific Nature	Mathematics: The Language of Science Scientific Notation
P.II.SIS3.2	Identify reasons for inconsistent results, such as sources of error or uncontrolled conditions, and assess the reliability of data.	Scientific Inquiry	Measurement Errors Evaluating and Experimenting Data
P.II.SIS3.3	Use results of an experiment to develop a conclusion to an investigation that addresses the initial questions and supports or refutes the stated hypothesis.	Scientific Inquiry	Making Conclusions from Data
P.II.SIS3.4	State questions raised by an experiment that may require further investigation.	Scientific Inquiry	Evaluation Check List

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P.II.SIS4	Communicate and apply the results of scientific investigations.	Scientific Inquiry	Communicating Results
P.II.SIS4.1	Develop descriptions and explanations of scientific concepts that an investigation focused on.	Scientific Nature	Scientific Method Case Study: Acid Rain's Effects on Forests
P.II.SIS4.2	Review information, explain statistical analysis, and summarize data collected and analyzed from an investigation.		
P.II.SIS4.3	Explain diagrams and charts that represent relationships of variables.		
P.II.SIS4.4	Construct a reasoned argument and respond appropriately to critical comments and questions.		
P.II.SIS4.5	Use language and vocabulary appropriately, speak clearly and logically, and use appropriate technology (such as presentation software, etc.) and other tools to present findings.		
P.II.SIS4.6	Use and refine scientific models that simulate physical processes or phenomena.	Scientific Nature	Models

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P.III	Mathematical Skills		
0	Students are expected to know the content of the Massachusetts Mathematics Curriculum Framework, through grade 8. Below are some specific skills from the Mathematics Framework that students in this course should have the opportunity to apply:		
P.III.1	Construct and use tables and graphs to interpret data sets.	Scientific Inquiry	Classifying Data Tutorial: Graphs
P.III.2	Solve simple algebraic expressions.		
P.III.3	Perform basic statistical procedures to analyze the center and spread of data.		
P.III.4	Measure with accuracy and precision (length, volume, mass, temperature, time, etc.)		
P.III.5	Convert within a unit (such as, centimeters to meters).		

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P.III.6	Use common prefixes such as milli-, centi-, and kilo-.	Scientific Nature	Unit Conversions
P.III.7	Use scientific notation, where appropriate. Use ratio and proportion in the solution of problems.	Scientific Nature	Scientific Notation Models
P.III.8	The following skills are not detailed in the Mathematics Framework, but are necessary for a solid understanding in this course:		
P.III.8.1	Determine the correct number of significant figures.		
P.III.8.2	Determine percent error from experimental and accepted values.		
P.III.8.3	Use appropriate metric/standard international (SI) units of measurement for mass (kg); length (m); time (s); force (N); speed (m/s); acceleration (m*s-2); frequency (Hz); work and energy (J); power (W); momentum (kg*m/s); electric current (A); electric potential difference/voltage (V); and electric resistance (omega).	Covered throughout the course	

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P.III.8.4	Use Celsius and Kelvin scales.		