

**Massachusetts Science Grades 9-12  
Learning Standards Mapping**

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<b>PHYSICS</b>	<b>Boardworks High School Physics Presentation</b>
<b>1. Motion and Forces</b> <b>Central Concept: Newton's laws of motion and gravitation describe and predict the motion of most objects.</b>	
1.1 Compare and contrast vector quantities (e.g. displacement, velocity, acceleration force, linear momentum) and scalar quantities (e.g. distance, speed, energy, mass, work).	Acceleration Momentum Speed and Velocity Vectors and Scalars
1.2 Distinguish between displacement, distance, velocity, speed, and acceleration. Solve problems involving displacement, distance, velocity, speed, and constant acceleration.	Acceleration Changes in Momentum Displacement, Velocity and Acceleration Momentum Speed and Velocity
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.	Displacement, Velocity and Acceleration
1.4 Interpret and apply Newton's three laws of motion.	Newton's First Law Newton's Second Law Newton's Third Law
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.	Free-Body Diagrams
1.6 <i>Distinguish qualitatively between static and kinetic friction, and describe their effects on the motion of objects.</i>	-
1.7 <i>Describe Newton's law of universal gravitation in terms of the attraction between two objects, their masses, and the distance between them.</i>	-
1.8 Describe conceptually the forces involved in circular motion.	Circular Motion
<b>2. Conservation of Energy and Momentum</b> <b>Central Concept: The laws of conservation of energy and momentum provide alternate approaches to predict and describe the movement of objects.</b>	
2.1 Interpret and provide examples that illustrate the law of conservation of energy.	Conservation of Energy

2.2 Interpret and provide examples of how energy can be converted from gravitational potential energy to kinetic energy and vice versa.	Gravitational and Potential Energy Kinetic Energy
2.3 Describe both qualitatively and quantitatively how work can be expressed as a change in mechanical energy.	Work
2.4 Describe both qualitatively and quantitatively the concept of power as work done per unit time.	Power
2.5 Provide and interpret examples showing 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.	Conservation of Momentum Changes in Momentum Momentum
<b>3. Heat and Heat Transfer</b> <b>Central Concept: Heat is energy that is transferred by the processes of convection, conduction, and radiation between objects or regions that are at different temperatures.</b>	
3.1 Explain how heat energy is transferred by convection, conduction, and radiation.	Conduction and Convection Radiation
3.2 <i>Explain how heat energy will move from a higher temperature to a lower temperature until equilibrium is reached.</i>	–
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 among evaporation, condensation, cooling, and warming.	Changing States Particles in Action
3.4 <i>Explain the relationships among temperature changes in a substance, the amount of heat transferred, the amount (mass) of the substance, and the specific heat of the substance.</i>	–
<b>4. Waves</b> <b>Central Concept: Waves carry energy from place to place without the transfer of matter.</b>	
4.1 Describe the measurable properties of waves (velocity, frequency, wavelength, amplitude, period) and explain the relationships among them. Recognize examples of simple harmonic motion.	Transverse Waves
4.2 Distinguish between mechanical and electromagnetic waves.	Electromagnetic Waves Longitudinal Waves Transverse Waves Waves
4.3 Distinguish between the two types of mechanical waves, transverse and longitudinal.	Longitudinal Waves Transverse Waves Waves

4.4 Describe qualitatively the basic principles of reflection and refraction of waves.	Reflection Refraction
4.5 <i>Recognize that mechanical waves generally move faster through a solid than through a liquid and faster through a liquid than through a gas.</i>	–
4.6 Describe the apparent change in frequency of waves due to the motion of a source or a receiver (the Doppler effect).	Doppler Effect
<b>5. Electromagnetism</b> <b>Central Concept: Stationary and moving charged particles result in the phenomena known as electricity and magnetism.</b>	
5.1 Recognize that an electric charge tends to be static on insulators and can move on and in conductors. Explain that energy can produce a separation of charges.	Static Electricity
5.2 Develop qualitative and quantitative understandings of current, voltage, resistance, and the connections among them (Ohm's law).	Calculating Resistance Current and Potential Difference Current, Voltage and Resistance
5.3 Analyze simple arrangements of electrical components in both series and parallel circuits. Recognize symbols and understand the functions of common circuit elements (battery, connecting wire, switch, fuse, resistance) in a schematic diagram.	Circuit Diagrams Series and Parallel Circuits
5.4 <i>Describe conceptually the attractive or repulsive forces between objects relative to their charges and the distance between them (Coulomb's law).</i>	–
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.	Current and Potential Difference Electrical Power
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.	Magnetism, Current and Forces Motors
<b>6. Electromagnetic Radiation</b> <b>Central Concept: Oscillating electric or magnetic fields can generate electromagnetic waves over a wide spectrum.</b>	
6.1 Recognize that electromagnetic waves are transverse waves and travel at the speed of light through a vacuum.	Electromagnetic Waves Transverse Waves
6.2 Describe the electromagnetic spectrum in terms of frequency and wavelength, and identify the locations 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.	Electromagnetic Waves