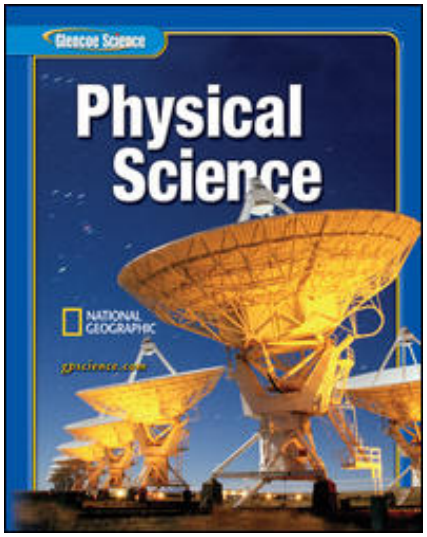
Introductory Physics
High School Standards

Massachusetts



Physical Science

	STANDARDS	PAGE REFERENCES
	I. Content Standards	
	1. Motion and Forces	
	Broad Concept: Newton's laws of motion and gravitation describe and predict the motion of most objects.	
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).	**Student Edition:** 38-39, 44, 47-50 *LAB* 57 *MiniLAB* 42 *National Geographic* 49 **Teacher Wraparound Edition:** A 44; D 48; FYI 45; IM 39; RC 39; SJ 44; VA 49
1.2	Distinguish between displacement, distance, velocity, speed, and acceleration. Solve problems involving displacement, distance, velocity, speed, and constant acceleration.	**Student Edition:** 39, 44, 47-49 *Applying Math* 86 *Design Your Own LAB* 58-59 *MiniLAB* 129 *National Geographic* 49 **Teacher Wraparound Edition:** A 44, 46; D 44, 48; DI 45; IM 39; RC 39, 44

Codes used for Teacher Wraparound Edition pages are the initial caps of headings on that page.

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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.	**Student Edition:** 22-24, 41-43, 50 *Applying Math* 63 *Design Your Own LAB* 58-59 *National Geographic* 49 **Teacher Wraparound Edition:** A 23, 46; D 23; DI 49; IM 43; LD 50; VL 23, 43
1.4	Interpret and apply Newton's three laws of motion.	**Student Edition:** 54-56, 68-70, 83-85 *Applying Math* 69, 86 *LAB* 90-91 *MiniLAB* 54, 81 *National Geographic* 85 **Teacher Wraparound Edition:** A 55; FF 55, 85; FYI 69; QD 69, 84; SJ 84
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.	**Student Edition:** 52-53, 70-74, 82-83, 88 *LAB* 89, 90-91 *MiniLAB* 71 **Teacher Wraparound Edition:** A 56, 79; DI 54, 88; IM 53; QD 53, 87; VL 87
1.6	Distinguish qualitatively between static and kinetic friction, and describe their effects on the motion of objects.	**Student Edition:** 70-74, 112, 136 *Applying Math* 74 *MiniLAB* 74 **Teacher Wraparound Edition:** A 73; D 73; DI 71; DIn74; FF 73; IM 70; LD 70; VL 72
1.7	Describe Newton's law of universal gravitation in terms of the attraction between two objects, their masses, and the distance between them.	**Student Edition:** 75-79 *Integrate Earth Science* 79 *Launch LAB* 67 *Science and History* 92 *Science Online* 76 **Teacher Wraparound Edition:** A 79; D 78; FF 76; FYI 78; QD 78

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1.8	Describe conceptually the forces involved in circular motion.	**Student Edition:** 44, 48, 81-82 *MiniLAB* 81 **Teacher Wraparound Edition:** A 81; CA 81; DI 81; QD 78; USW 81
	2. Conservation of Energy and Momentum	
	Broad Concept: The laws of conservation of energy and momentum provide alternate approaches to predict and describe the movement of objects.	
2.1	Interpret and provide examples that illustrate the law of conservation of energy.	**Student Edition:** 107-113 *Design Your Own LAB* 116-117 *Integrate Environment* 11 *Integrate Health* 115 *MiniLAB* 112 *Science and History* 118 **Teacher Wraparound Edition:** A 110; CB 118; DI 108; HCB 118; HS 118; LD 110
2.2	Interpret and provide examples of how energy can be converted from gravitational potential energy to kinetic energy and vice versa.	**Student Edition:** 103, 108-109 *Applying Math* 104 *LAB* 106 *National Geographic* 110 **Teacher Wraparound Edition:** A 105; CC 109; FYI 109; ILA 104; QD 104; RC 109
2.3	Describe both qualitatively and quantitatively how work can be expressed as a change in mechanical energy.	**Student Edition:** 126-129, 132-133 *Applying Math* 128, 131, 153 *LAB* 148-149 *MiniLAB* 129 **Teacher Wraparound Edition:** A 127; D 128, 130; DI 133; DIn131, 137; QD 128; VL 129
2.4	Describe both qualitatively and quantitatively the concept of power as work done per unit time.	**Student Edition:** 129-131 *Applying Math* 130, 131, 153 *MiniLAB* 129 **Teacher Wraparound Edition:** A 131; CC 130; D 130; DI 127; DIn131; FYI 129; RC 129

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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.	**Student Edition:** 86-88 *Applying Math* 86, 88, 95 *LAB* 90-91 **Teacher Wraparound Edition:** A 88, 91; AIL 90; D 86, 87; DI 86; QD 87; VL 87; VLbs 86
	3. Heat and Heat Transfer	
	Broad Concept: Heat is energy that is transferred between objects or regions that are at different temperatures by the processes of convection, conduction, and radiation.	
3.1	Explain how heat energy is transferred by convection, conduction, and/or radiation.	**Student Edition:** 164-167, 173-175, 180-181 *LAB* 171, 180-181 *MiniLAB* 168 *National Geographic* 166 **Teacher Wraparound Edition:** CC 167; LD 165; QD 173
3.2	Explain how heat energy will move from a higher temperature to a lower temperature until equilibrium is reached.	**Student Edition:** 165, 168-170, 172-175, 179, 185 #16, #21 *Integrated Earth Science* 176 *LAB* 180-181 **Teacher Wraparound Edition:** A 179, 181; AIL 180; FYI 178; RC 175
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.	**Student Edition:** 158-160, 178-179, 476-484 *Applying Math* 483 *LAB* 484 *Launch LAB* 157, 475 *MiniLAB* 494 **Teacher Wraparound Edition:** CA 478; DIn495; FYI 178; IM 478; SJ 482; TPK 476
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.	**Student Edition:** 160-163 *Applying Math* 162, 163, 185 *LAB* 180-181 *MiniLAB* 168 **Teacher Wraparound Edition:** A 163; CC 167; D 161; DI 161; DIn 163; QD 161

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	4. Waves	
	Broad Concept: Waves carry energy from place to place without the transfer of matter.	
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.	**Student Edition:** 296-301, 327-330, 357-358, 367-368, 398 *Applying Math* 299 *LAB* 302, 312-313 *MiniLAB* 297 *Use the Internet LAB* 374-375 **Teacher Wraparound Edition:** AP 301; CC 299; DI 301; IM 291; LD 291; QD 291
4.2	Distinguish between mechanical and electromagnetic waves.	**Student Edition:** 291-295, 352-575 *Inquiry LAB* 364 *LAB* 312-313, 375 *Launch LAB* 289, 353 *MiniLAB* 356 **Teacher Wraparound Edition:** A 359; DIn359; FYI 358; VL 356
4.3	Distinguish between the two types of mechanical waves, transverse and longitudinal.	**Student Edition:** 291-293, 296, 300-301 *LAB* 302, 312-313 **Teacher Wraparound Edition:** A 292, 313; DI 292; DIn 295; FYI 292, 294; LD 291; QD 291, 357; SJ 293; USW 292; VL 298
4.4	Describe qualitatively the basic principles of reflection and refraction of waves.	**Student Edition:** 303-306, 339-343 *Applying Math* 342, 343 *National Geographic* 340 *Science and History* 314 **Teacher Wraparound Edition:** CB 314; DI 305, 340; FYI 305, 342; SJ 304; USW 304; VL 341
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.	**Student Edition:** 289-299, 304-305, 323-324 *LAB* 302 *MiniLAB* 323 **Teacher Wraparound Edition:** A 302; CA 324; D 298; DI 305; DIn 326; FYI 305; RC 323

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4.6	Describe the apparent change in frequency of waves due to the motion of a source or a receiver (the Doppler effect).	**Student Edition:** 320, 331-332 *Integrate Astronomy* 331 *Integrate Health* 343 **Teacher Wraparound Edition:** AP 320; CC 331; DIn 332; IH 343; QD 331; RC 331; VL 331
	5. Electromagnetism	
	Broad Concept: Stationary and moving charged particles result in the phenomena known as electricity and magnetism.	
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.	**Student Edition:** 193-195**,** 198-199 *LAB* 206 *MiniLAB* 198 *National Geographic* 197 **Teacher Wraparound Edition:** A 206; CU 199; D 194, 196; DI 195; FYI 195; SJ 193
5.2	Develop a qualitative and quantitative understanding of current, voltage, resistance, and the connection between them (Ohm's law).	**Student Edition:** 200-205 *Applying Math* 205 *Integrate Health* 205 *LAB* 214-215 *MiniLAB* 202 **Teacher Wraparound Edition:** A 205; AIL 214; D 203; DIn 205; IM 201, 203; QD 201; UA 203; VL 204
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.	**Student Edition:** 207-210 *Integrate Physics* 216 *LAB* 214-215 *Launch LAB* 191 **Teacher Wraparound Edition:** A 208, 209; FYI 209; IM 217; LD 208; MM 210; QD 209; TPK 207; VL 209

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5.4	Describe conceptually the attractive or repulsive forces between objects relative to their charges and the distance between them (Coulomb's law).	**Student Edition:** 192-199 *MiniLAB* 198 *National Geographic* 197 **Teacher Wraparound Edition:** A 193; CU 199; IM 196; RC 193; SJ 193; VL 194, 198
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.	**Student Edition:** 131, 194, 200, 205, 210-211 *Applying Math* 131, 205, 211 *National Geographic* 197 **Teacher Wraparound Edition:** AIL 214; SJ 211
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.	**Student Edition:** 231-240 *Design Your Own LAB* 246-247 *LAB* 245 *National Geographic* 241 *Science and History* 248 **Teacher Wraparound Edition:** AIL 246; CC 233; D 232; IL 234; QD 233, 240
	6. Electromagnetic Radiation	
	Broad Concept: Oscillating electric or magnetic fields can generate electromagnetic waves over a wide spectrum.	
6.1	Recognize that electromagnetic waves are transverse waves and travel at the speed of light through a vacuum.	**Student Edition:** 354, 356, 358, 367-368 *MiniLAB* 356 *National Geographic* 369 **Teacher Wraparound Edition:** A 358; CC 368; QD 357; VL 356
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.	**Student Edition:** 360-365, 367-368 *Applying Math* 365 *National Geographic* 369 **Teacher Wraparound Edition:** A 359; D 365; DI 361; DIn 359, 365; IM 368; QD 362

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II. Scientific Inquiry Skills Standards	
Scientific literacy can be achieved by supporting students to inquire about the physical world. Engaging students in scientific inquiry allows them to develop conceptual understandings and scientific skills that are necessary to be informed decision-makers. The science curriculum should include substantial hands-on laboratory and field experiences, as appropriate, for students to develop and use these skills in an Introductory Physics course.	
SIS1. Make observations, raise questions, and formulate hypotheses. *Students will be able to:* Observe the world around them from a scientific perspective. Pose questions and form hypotheses based on personal observations, scientific articles, experiments, and knowledge. Read, interpret, and examine the credibility and validity of scientific claims in different sources of information, such as scientific articles, advertisements, or media stories.	**Student Edition:** 6-10, 38-39 *Design Your Own LAB* 28-29, 716-717 *Integrate Astronomy* 76 *Integrate Earth Science* 45-46 *LAB* 171, 302, 777 *MiniLAB* 19 *National Geographic* 110 *Science and Language Arts* 30 *Science Skill Handbook* 788-796 *Use the Internet LAB* 278-279, 374-375, 652-653 **Teacher Wraparound Edition:** A 23, 45; AIL 28, 278; CC 10
SIS2. Design and conduct scientific investigations. *Students will be able to:* Articulate and explain the major concepts being investigated and the purpose of an investigation. Select required materials, equipment, and conditions for conducting an experiment. Identify independent and dependent variables. Write procedures that are clear and replicable. Employ appropriate methods for accurately and consistently O making observations; O making and recording measurements at an appropriate level of precision; and O collecting data or evidence in an organized way. 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. Follow safety guidelines.	**Student Edition:** 6-10 *Design Your Own LAB* 58-59, 214-215 *LAB* 312-313 *Launch LAB* 157, 191, 601 *MiniLAB* 71, 202, 486 *Model and Invent LAB* 148-149 *Science Skills Handbook* 797-799 *Use the Internet LAB* 374-375 **Teacher Wraparound Edition:** AIL 28, 58, 116; IL 80, 174; LD 70

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SIS3. Analyze and interpret results of scientific investigations. *Students will be able to:* Present relationships between variables in appropriate forms. O Represent data and relationships between variables in charts and graphs. O Use appropriate technology (such as graphing software, etc.) and other tools. Use mathematical operations to analyze and interpret data results. Identify reasons for inconsistent results, such as sources of error or uncontrolled conditions, and assess the reliability of data. Use results of an experiment to develop a conclusion to an investigation that addresses the initial questions and supports or refutes the stated hypothesis. State questions raised by an experiment that may require further investigation.	**Student Edition:** 14-21 *Applying Math* 24 *Design Your Own LAB* 28-29 *LAB* 312-313 *Launch LAB* 505 *MiniLAB* 25, 259 *Model and Invent LAB* 148-149 *Science Skills Handbook* 795-796 **Teacher Wraparound Edition:** A 29, 149, 505; AIL 28; D 23; FYI 24; LD 25, 70; QD 24
SIS4. Communicate and apply the results of scientific investigations. *Students will be able to:* Develop descriptions and explanations of scientific concepts that an investigation focused on. Review information, explain statistical analysis, and summarize data collected and analyzed from an investigation. Explain diagrams and charts that represent relationships of variables. Construct a reasoned argument and respond appropriately to critical comments and questions. Use language and vocabulary appropriately, speak clearly and logically, and use appropriate technology (such as presentation software, etc.) and other tools to present findings. Use and refine scientific models that simulate physical processes or phenomena.	**Student Edition:** 10-11, 22-26 *Applying Math* 24 *Design Your Own LAB* 28-29, 214-215 *Integrate Earth Science* 11 *MiniLAB* 25 *Science Skills Handbook* 796 **Teacher Wraparound Edition:** AIL 214, 246; CYD 89, 375; DI 23; IES 11; IL 260