MASSACHUSETTS
Science and Technology/Engineering Curriculum Framework
Physics, Grade 9 or 10
Physics: Principles and Problems © 2005

LEARNING STANDARDS	PAGE REFERENCES
STRAND 3: PHYSICAL SCIENCES (CHEMISTRY AND PHYSICS) **Learning Standards for a Full First-Year Course**	
1. Motion and Forces *Broad Concept:* Newton's laws of motion and gravitation describe and predict the motion of most objects.	
1.1 Distinguish between vector quantities (velocity, acceleration, and force) and scalar quantities (speed and mass).	SE: 35 TWE: CU 37 RE 35
1.2 Illustrate how to represent vectors graphically and be able to add them graphically.	SE: 120, 122-123 TWE: HSS 121 IM 122 RE 123
1.3 Distinguish between, and solve problems involving, velocity, speed, and constant acceleration.	SE: 43-47, 58-59, 62-63, 65-70 *Internet Physics Lab* 20-21 *Launch Lab* 57 TWE: BA 43 CT 59 CU 47 QD 44
1.4 Create and interpret graphs of motion (position vs. time, speed vs. time, velocity vs. time, constant acceleration vs. time).	SE: 38-42, 58-59, 61-63, 65-68 *Launch Lab* 57 TWE: CD 38 CT 59 IM 39 TPK 57, 65
1.5 Explain the relationship between mass and inertia.*	SE: 95, 183-184 TWE: QD 94, 183
1.6 Interpret and apply Newton's first law of motion.*	SE: 90-92, 94-95, 100-101, 131-132 *Problem-Solving Strategies* 98 TWE: CB 92 CU 101 IM 90 QD 94, 100
1.7 Interpret and apply Newton's second law of motion to show how an object's motion will change only when a net force is applied.*	SE: 93, 96-99, 154-155 *Internet Physics Lab* 108-109 TWE: CH 97 CU 156 D 96 IM 98 PP 99

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1.8 Use a free body force diagram with only co-linear forces to show forces acting on an object, and determine the net force on it.	SE: 89, 96-101, 105-106 TWE: CU 95, 101 D 96 HSS 89 IM 98
1.9 Qualitatively distinguish between static and kinetic friction, what they depend on and their effects on the motion of objects.	SE: 126-130, 132-135 *Physics Lab* 136 TWE: BA 126 CT 127 D 134 QD 128 RE 129 RT 130
1.10 Interpret and apply Newton's third law of motion.	SE: 102-103, 105, 107 *How It Works* 110 *Internet Physics Lab* 108-109 TWE: CU 107 HSS 104 TPK 102 UA 105 UM 103
1.11 Understand conceptually Newton's law of universal gravitation.*	SE: 175-178, 179-184 TWE: CD 176, 177 CT 175, 184 CU 178, 185 IM 182 TPK 179
1.12 Identify appropriate standard international units of measurement for force, mass, distance, speed, acceleration, and time, and explain how they are measured.	SE: 5-7, 11-14, 43, 91, 183-184 *Math Handbook* 846-847 *Tables* 911-912 TWE: D 6 HSS 44 UA 62
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.*	SE: 293-294, 301 *Physics Lab* 302-303 *Problem-Solving Strategies* 295 TWE: BA 293 CB 298 CD 294 QD 295
2.2 Provide examples of how energy can be transformed from kinetic to potential and vice versa.	SE: 289, 294-295 *Launch Lab* 285 TWE: BA 293 CD 258 HSS 296

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2.3 Apply quantitatively the law of conservation of mechanical energy to simple systems.	SE: 293-295 TWE: AML 295 BA 293 CD 294 CHP 380
2.4 Describe the relationship among energy, work, and power both conceptually and quantitatively.	SE: 257-265, 286-288 TWE: CD 258 CU 265 ICE 262, 264 IM 263 RLP 260
2.5 Interpret the law of conservation of momentum and provide examples that illustrate it. Calculate the momentum of an object.	SE: 230-232, 236-237 *Internet Physics Lab* 246-247 TWE: CU 245 TPK 236
2.6 Identify appropriate standard international units of measurement for energy, work, power, and momentum.	SE: 258-259, 263-265 *Tables* 911-912 TWE: CU 265 D 260 ICE 264
3. Heat and Heat Transfer *Broad Concept:* Heat is energy that is transferred between bodies that are at different temperatures by the processes of convection, conduction, and/or radiation.	
3.1 Relate thermal energy to molecular motion.*	SE: 314-315, 317, 323-325, 347-348 TWE: QD 315 TPK 314, 349, 359
3.2 Differentiate between specific heat and heat capacity.	SE: 317-321 TWE: CB 318
3.3 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.	SE: 317-321 TWE: CB 318 HSS 320
3.4 Recognize that matter exists in four phases, and explain what happens during a phase change.	SE: 323-325, 342-348, 350-351, 359-363 TWE: CD 360 CT 326 TPK 349, 359 UM 324
4. Waves *Broad Concept:* Waves carry energy from place to place without the transfer of matter.	
4.1 Differentiate between wave motion (simple harmonic nonlinear motion) and the motion of objects (nonharmonic).*	SE: 375-379, 381-385 *Design Your Own Physics Lab* 392-393 TWE: BA 375 CT 378 EX 380 IM 376 TPK 381

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4.2 Recognize the measurable properties of waves (e.g., velocity, frequency, wavelength) and explain the relationships among them.*	SE: 381-384, 404-407, 445, 705-708 *Physics Lab* 420-421 TWE: CT 383 QD 382 RE 384, 706 RT 386
4.3 Distinguish between transverse and longitudinal waves.	SE: 381, 384, 404-405, 412-415, 705-708 *Technology and Society* 394 TWE: BA 705 D 385 QD 383 RE 405 UM 381
4.4 Distinguish between mechanical and electromagnetic waves.*	SE: 381-384, 404-405, 705-708 *Design Your Own Physics Lab* 392-393 TWE: BA 705 CD 706 RE 384
4.5 Interpret and be able to apply the laws of reflection and refraction (qualitatively) to all waves.	SE: 388-391, 457-473, 485-503 *Physics Lab* 474-475, 504-505 TWE: CT 461 CU 391 IM 387 PP 388 UM 458
4.6 Recognize the effects of polarization, wave interaction, and the Doppler effect.	SE: 388, 407-410, 443-444, 446-447 *MiniLAB* 389 *Physics Lab* 448-449 TWE: AML 437 CD 407 D 410 RE 446
4.7 Explain, graph, and interpret graphs of constructive and destructive interference of waves.	SE: 389, 390-391, 412-415, 418-419, 516-523, 761-763 TWE: CT 390, 760 EX 391 IM 762
4.8 Explain the relationship between the speed of a wave (e.g., sound) and the medium it travels through.	SE: 382, 391, 404-405, 486, 488-489 TWE: CB 385 CT 416 RE 390
4.9 Recognize the characteristics of a standing wave and explain the conditions under which two waves on a string or in a pipe can interfere to produce a standing wave.	SE: 388-389, 412-415 *Physics Lab* 420 TWE: CD 413 CU 419 CT 414 IM 412 RE 415

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5. Electromagnetism *Broad Concept:* Stationary and moving charge particles result in the phenomenon known as electricity and magnetism.	
5.1 Recognize the characteristics of static charge, and explain how a static charge is generated.	SE: 541-545, 547-548, 575-579 *Design Your Own Physics Lab* 554-555 *Launch Lab* 541 TWE: CB 548 CT 547 CU 545 IM 542 UA 544
5.2 Interpret and apply Coulomb's law.	SE: 549-552, 564-566 TWE: ICE 551, 566 IM 552 RE 550 TPK 546, 563
5.3 Explain the difference in concept between electric forces and electric fields.	SE: 546-553, 563-568, 576-577 TWE: CD 564 EX 553, 568 IM 552, 567 RE 550 TPK 546
5.4 Develop a qualitative and quantitative understanding of current, voltage, resistance, and the connection between them.	SE: 592-593, 595-597 *MiniLAB* 599 *Physics Lab* 606-607 TWE: CD 593 IM 594 QD 597 RLP 596 UA 592
5.5 Identify appropriate units of measurement for current, voltage, and resistance, and explain how they are measured.	SE: 570, 593, 595-597, 631 *MiniLAB* 623 *Physics Lab* 606-607, 632-633 TWE: AML 598, 625 IM 592
5.6 Analyze circuits (find the current at any point and the potential difference between any two points in the circuit) using Kirchoff's and Ohm's laws.	SE: 617-620, 623-626, 629-631 *Launch Lab* 591 *Physics Lab* 632-633 TWE: BA 617 CU 600 ICE 625 IM 618 RE 596
6. Electromagnetic Radiation *Broad Concept:* Oscillating electric or magnetic fields can generate electromagnetic waves over a wide spectrum of energies.	
6.1 Describe the electromagnetic spectrum in terms of wavelength and energy, and be able to identify specific regions such as visible light.*	SE: 440, 705-709, 712-713 TWE: RE 706

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6.2	**Explain how the various wavelengths in the electromagnetic spectrum have many useful applications such as radio, television, microwave appliances, and cellular telephones.**	SE: 708, 713 *Applying Physics* 710 *Technology and Society* 716 TWE: CB 710 CT 708 PP 711 RE 713 RLP 725
6.3	Calculate the frequency and energy of an electromagnetic wave from the wavelength.	SE: 706, 708, 712, 725, 727-728 TWE: CD 729 RE 706
6.4	Recognize and explain the ways in which the direction of visible light can be changed.	SE: 458-459, 485-489, 493-499 *Extreme Physics* 506 *How It Works* 534 TWE: CD 488, 494 D 460 UM 458

Codes Used for TWE Pages

AML	Additional MiniLab
BA	Bellringer Activity
CB	Content Background
CD	Concept Development
CH	Challenge
CHP	Challenge Problem
CT	Critical Thinking
CU	Check for Understanding
D	Discussion
EX	Extension
HSS	Helping Struggling Students
ICE	In-Class Example
IM	Identifying Misconceptions
QD	Quick Demo
PP	Physics Project
RE	Reinforcement
RLP	Real Life Physics
RT	Reteach
TPK	Tie to Prior Knowledge
UA	Using an Analogy
UM	Using Models