Appendix A: Selected Massachusetts Curriculum Frameworks

Physical Sciences (Chemistry and Physics)

The physical sciences (chemistry and physics) examine the physical world around us. Using the methods of the physical sciences, students learn about the composition, structure, properties, and reactions of matter, and the relationships between matter and energy.

Students are best able to build understanding of the physical sciences through hands-on exploration of the physical world. This *Framework* encourages repeated and increasingly sophisticated experiences that help students understand properties of matter, chemical reactions, forces and motion, and energy. The links between these concrete experiences and more abstract knowledge and representations are forged gradually. Over the course of their schooling, students develop more inclusive and generalizable explanations about physical and chemical interactions.

Tools play a key role in the study of the physical world, helping students to detect physical phenomena that are beyond the range of their senses. By using well-designed instruments and computer-based technologies, students can better explore physical phenomena in ways that support greater conceptual understanding.

- In **grades PreK–2**, students' curiosity is engaged when they observe physical processes and sort objects by different criteria. During these activities, students learn basic concepts about how things are alike or different. As they push, pull, and transform objects by acting upon them, the students see the results of their actions and begin to understand how part of their world works. They continue to build understanding by telling stories about what they did and what they found out.

  Learning standards for PreK–2 fall under the following three subtopics: *Observable Properties of Objects; States of Matter;* and *Position and Motion of Objects.*

- In **grades 3–5**, students' growth in their understanding of ordinary things allows them to make the intellectual connections necessary to understand how the physical world works. Students are able to design simple comparative tests, carry out the tests, collect and record data, analyze results, and communicate their findings to others.

  Learning standards for grades 3–5 fall under the following three subtopics: *Properties of Objects and Materials; States of Matter;* and *Forms of Energy* (including electrical, magnetic, sound, and light).

- In **grades 6–8**, students still need concrete, physical-world experiences to help them develop concepts associated with motion, mass, volume, and energy. As they learn to make accurate measurements using a variety of instruments, their experiments become more quantitative and their physical models more precise. Students in these grades are able to graph one measurement in relation to another, such as temperature change over time. They may collect data by using microcomputer- or calculator-based laboratories (MBL or CBL), and can learn to make sense immediately of graphical and other abstract representations essential to scientific understanding.

  Learning standards for grades 6–8 fall under the following five subtopics: *Properties of Matter; Elements, Compounds, and Mixtures; Motion of Objects; Forms of Energy;* and *Heat Energy.*

- In **high school Chemistry**, students learn about the properties of matter and how these properties help to organize elements on the periodic table. Students develop a better understanding of the structure of the atom. Students develop an understanding of chemical reactions, including the involvement of energy and sub-atomic particles, to better understand the nature of chemical changes. Students learn about chemical reactions that occur around us everyday as they learn about chemical reactions such as oxidation-reduction, combustion, and decomposition. Students also gain a deeper understanding of acids and bases, rates of reactions, and factors that affect those rates. From calculating stoichiometry problems and molar concentrations, students learn about proportionality and strengthen their mathematical skills.

  Learning standards for high school Chemistry fall under the following eight subtopics: *Properties of Matter; Atomic Structure and Nuclear Chemistry; Periodicity; Chemical Bonding; Chemical Reactions and Stoichiometry; States of Matter, Kinetic Molecular Theory, and Thermochemistry; Solutions, Rates of Reaction, and Equilibrium;* and *Acids and Bases and Oxidation-Reduction Reactions.*

- In **high school Introductory Physics**, students recognize the nature and scope of physics, including its relationship to the other sciences. Students learn about basic topics such as motion, forces, energy, heat, waves, electricity, and magnetism. They learn about natural phenomena by using physical laws to calculate quantities such as velocity, acceleration, momentum, and energy.

  Students of introductory physics learn about the relationships between motion and forces through Newton's laws of motion. They study the difference between vector and scalar quantities and learn how to solve basic problems involving these quantities. Students learn about conservation of energy and momentum and how these are applied to everyday situations. They learn about heat and how thermal energy is transferred throughout the different phases of matter. Students extend their knowledge of waves and how they carry energy. Students gain a better understanding of electric current, voltage, and resistance by learning about Ohm's law. They also gain knowledge about the electromagnetic spectrum in terms of wavelength and frequency.

  Learning standards for high school Introductory Physics fall under the following six subtopics: *Motion and Forces; Conservation of Energy and Momentum; Heat and Heat Transfer; Waves; Electromagnetism;* and *Electromagnetic Radiation.*

Physical Science learning standards are also grouped under Broad Topics in Appendix I, which highlights the relationships of standards among grade spans.

A-1

Physical Sciences (Chemistry and Physics), Grades 6–8

Learning Standard	Ideas for Developing Investigations and Learning Experiences
Properties of Matter	
1. Differentiate between weight and mass, recognizing that weight is the amount of gravitational pull on an object.	Determine the weight of a dense object in air and in water. Explain how the results are related to the different definitions of mass and weight.
2. Differentiate between volume and mass. Define density.	
3. Recognize that the measurement of volume and mass requires understanding of the sensitivity of measurement tools (e.g., rulers, graduated cylinders, balances) and knowledge and appropriate use of significant digits.	Calculate the volumes of regular objects from linear measurements. Measure the volumes of the same objects by displacement of water. Use the metric system. Discuss the accuracy limits of these procedures and how these limits explain any observed differences between the calculated volumes and the measured volumes.
4. Explain and give examples of how mass is conserved in a closed system.	Melt, dissolve, and precipitate various substances to observe examples of the conservation of mass.
Elements, Compounds, and Mixtures	
5. Recognize that there are more than 100 elements that combine in a multitude of ways to produce compounds that make up all of the living and nonliving things that we encounter.	Demonstrate with atomic models (e.g., ball and stick) how atoms can combine in a large number of ways. Explain why the number of combinations is large, but still limited. Also use the models to demonstrate the conservation of mass in the modeled chemical reactions.
6. Differentiate between an atom (the smallest unit of an element that maintains the characteristics of that element) and a molecule (the smallest unit of a compound that maintains the characteristics of that compound).	Use atomic models (or Lego blocks, assigning colors to various atoms) to build molecules of water, sodium chloride, carbon dioxide, ammonia, etc.
7. Give basic examples of elements and compounds.	Heat sugar in a crucible with an inverted funnel over it. Observe carbon residue and water vapor in the funnel as evidence of the breakdown of components. Continue heating the carbon residue to show that carbon residue does not decompose. Safety note: sugar melts at a very high temperature and can cause serious burns.
8. Differentiate between mixtures and pure substances.	

Physical Sciences (Chemistry and Physics), Grades 6–8

Learning Standard	Ideas for Developing Investigations and Learning Experiences
Elements, Compounds, and Mixtures (cont.)	
9. Recognize that a substance (element or compound) has a melting point and a boiling point, both of which are independent of the amount of the sample.	
10. Differentiate between physical changes and chemical changes.	Demonstrate with molecular ball-and-stick models the physical change that converts liquid water into ice. Also demonstrate with molecular ball-and-stick models the chemical change that converts hydrogen peroxide into water and oxygen gas.
Motion of Objects	
11. Explain and give examples of how the motion of an object can be described by its position, direction of motion, and speed.	
12. Graph and interpret distance vs. time graphs for constant speed.	
Forms of Energy	
13. Differentiate between potential and kinetic energy. Identify situations where kinetic energy is transformed into potential energy and vice versa.	
Heat Energy	
14. Recognize that heat is a form of energy and that temperature change results from adding or taking away heat from a system.	
15. Explain the effect of heat on particle motion through a description of what happens to particles during a change in phase.	
16. Give examples of how heat moves in predictable ways, moving from warmer objects to cooler ones until they reach equilibrium.	Place a thermometer in a ball of clay and place this in an insulated cup filled with hot water. Record the temperature every minute. Then remove the thermometer and ball of clay and place them in an insulated cup of cold water that contains a second thermometer. Observe and record the changes in temperature on both thermometers. Explain the observations in terms of heat flow, including direction of heat flow and why it stops.

A-3

Appendix B: Sixth and Seventh Grade Curricula

12/14/07

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Course: Sixth Grade Science	Topic/Unit: Intro to Science	Month: September and October

Standards	Essential Concepts	Assessment Techniques	Instructional Strategies
Life Science LS 2, 3, 4, 13, 14, 15 Physical Science LS 1, 2, 3 Technology and Engineering LS 1, 8 Earth and Space LS 1	**Chapter One** **What is science?** **What are scientific models?** **Describe scientific tools and uses.** **Forests** **What is a forest?**	Chapter One Test Quizzes • Safety • Microscope • Forest Notebook—check class notes and grade Response Journal—Bellringer questions (access prior knowledge) Make predictions and confirmations Guided reading questions Vocabulary crossword puzzles/quiz Demonstrations Project—Safety Alert Poster (rubric) Labs Reports • Letterboxing: following clues, observing • Does It All Add Up? • Gumdrop Model Labs—Observations by teacher and students regarding teamwork Classroom discussion Demonstrate proper use of tools • Identify • Use • Name • Describe purposes Directed Reading Worksheets Section Review Use of graphic organizers as study guides Mnemonics Science World Magazine • Discussion • Written reports/short essays Classroom extension	**Interactive student handbook** **Chapter warm-up with overview transparency** **Warm-up activity** **Bellringer--answer questions in journal to assess prior knowledge and intro new topic** **Reading strategy--paired reading and summarizing** **Directed reading worksheets reinforce basic vocabulary and concepts with evidentiary support from the text** **Connection to ELA--write essays for open response questions** **Use color transparencies to focus attention and enhance learning** **Graphic organizers help organize notes and terms for each section** **Participate in labs and write reports** **Hands-on use of the microscope and various scientific lab tools** **Jeopardy review before the test**

SIXTH GRADE CURRICULUM

A-5