CHAPTER 11 Vibrations and Waves

Chapter Opener

__ Tapping Prior Knowledge, TE Review previously learned concepts and check for preconceptions about the chapter content.

__ Discovery Lab, Pendulums and Spring Waves, ANC Students determine the factors that influence the time interval required for a pendulum to complete one full swing and investigate the nature of pendulum and wave motion. (BASIC)

__ Visual Concepts CD-ROM This CD-ROM consists of multimedia presentations of core physics concepts. (BASIC)

SECTION 1 Simple Harmonic Motion

PACING
Regular Schedule: with lab(s): N/A days without lab(s): 1 days
Block Schedule: with lab(s): N/A days without lab(s): 0.5 days

STATE OBJECTIVES

IV. Waves

A. Wave properties
   1. Conservation of energy
   2. Reflection
   3. Refraction
   4. Interference
   5. Diffraction

OBJECTIVES

1. Identify the conditions of simple harmonic motion.
2. Explain how force, velocity, and acceleration change as an object vibrates with simple harmonic motion.
3. Calculate the spring force using Hooke’s law.

NATIONAL SCIENCE EDUCATION STANDARDS

UCP 1: Systems, order, and organization
UCP 2: Evidence, models, and explanation
UCP 3: Change, consistency, and measurements
UCP 4: Evolution and equilibrium
UCP 5: Form and function
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SAI 1: Abilities to do scientific inquiry
SAI 2: Understanding about scientific inquiry
ST 1: Abilities of technological design
ST 2: Understanding about science and technology
HNS 3: History of science
SPSP 5: Science and technology in society

PS4a: Objects change their motion only when a net force is applied. Laws of motion are used to calculate precisely the effects of forces on the motion of objects. The magnitude of the change in motion can be calculated using the relationship \( F = ma \), which is independent of the nature of the force. Whenever one object exerts force on another, a force equal in magnitude and opposite in direction is exerted on the first object.

FOCUS (5 MINUTES)
__ Overview Review the objectives listed in the Student Edition. (GENERAL)

MOTIVATE (5 MINUTES)
__ Demonstration, A Vibrating Spring, TE This demonstration helps students see the changes in velocity and restoring force for a vibrating mass-spring system. (GENERAL)
__ Demonstration, An Oscillating Pendulum, TE This demonstration uses a pendulum bob attached to a ring stand to demonstrate the changes in velocity and restoring force for an oscillating pendulum. (GENERAL)
__ Demonstration, Hooke’s Law, TE Students use springs, ring stands, and weights to verify Hooke’s law experimentally. (GENERAL)

TEACH (25 MINUTES)
__ PowerNotes® Resources Use the customizable presentation to help students master the concepts in this section. (GENERAL)
__ Conceptual Challenge, p. 369, SE These conceptual questions challenge students to apply the section content to real-world applications. (GENERAL)
__ Sample Set A, Hooke’s Law, SE This sample and practice problem set covers Hooke’s law. (GENERAL)
__ Classroom Practice, Hooke’s Law, TE Use this problem as a teamwork exercise or for demonstration at the board or on an overhead projector. (GENERAL)
__ Visual Strategy, Figure 4, TE Students draw vectors for the forces in the figure. (GENERAL)
__ Quick Lab, Energy of a Pendulum, SE Students observe the motion of a toy car after it is struck by a pendulum bob with different starting angles. (GENERAL)
__ Datasheet, Energy of a Pendulum Students use the datasheet to complete the in-text QuickLab (GENERAL)
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__ Visual Strategy, Figure 5, TE Students decide whether the graph applies to a vibrating mass-spring system. (GENERAL)

__ Visual Strategy, Table 1, TE Students decide which system (or systems) the fourth column of the table refers to. (BASIC)

CLOSE (10 MINUTES)

__ Section Review, SE Students answer review questions, critical-thinking questions, and interpreting-graphics questions that assess their understanding of the section objectives. (GENERAL)

__ Study Guide, Simple Harmonic Motion, ANC Use this worksheet to review the main concepts presented in the section. (GENERAL)

__ Section Quiz, ANC Use this quiz to assess students' understanding of the section. (BASIC)

OTHER RESOURCE OPTIONS

__ Holt Online Learning Students can access interactive problem-solving help and active visual concept development with the Holt Physics Online Edition available at my.hrw.com.

__ Problem Workbook, Sample Set A: Hooke’s Law, ANC This worksheet provides an additional example problem and several practice problems that cover Hooke’s law. (GENERAL)

__ Problem Bank, Sample Set A: Hooke’s Law, OSP This worksheet provides a third example problem and several practice problems that cover Hooke’s law. (GENERAL)

__ SciLinks, Online Students can visit www.scilinks.org to find internet resources related to the chapter content. Topic: Hooke’s Law SciLinks Code: HF60756

__ SciLinks, Online Students can visit www.scilinks.org to find internet resources related to the chapter content. Topic: Pendulums SciLinks Code: HF61121
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SECTION 2 Measuring Simple Harmonic Motion

PACING
Regular Schedule: with lab(s): 2 days without lab(s): 1 days
Block Schedule: with lab(s): 1 days without lab(s): 0.5 days

STATE OBJECTIVES
IV. Waves
   A. Wave properties
      1. Conservation of energy
      2. Reflection
      3. Refraction
      4. Interference
      5. Diffraction

OBJECTIVES
1. Identify the amplitude of vibration.
2. Recognize the relationship between period and frequency.
3. Calculate the period and frequency of an object vibrating with simple harmonic motion.

NATIONAL SCIENCE EDUCATION STANDARDS
UCP 1: Systems, order, and organization
UCP 2: Evidence, models, and explanation
UCP 3: Change, consistency, and measurements
UCP 4: Evolution and equilibrium
SAI 1: Abilities to do scientific inquiry
SAI 2: Understanding about scientific inquiry
ST 2: Understanding about science and technology
HNS 1: Science as a human endeavor
HNS 2: Nature of science
SPSP 2: Populations, resources, and environments
SPSP 5: Science and technology in society

FOCUS (5 MINUTES)
   __ Overview Review the objectives listed in the Student Edition. (GENERAL)
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MOTIVATE (5 MINUTES)

__ Demonstration, Period and Frequency, TE This demonstration uses a pendulum bob attached to a ring stand to help students understand the concepts of period and frequency, as the relationship between the two. (GENERAL)

__ Demonstration, Relationship Between the Length and the Period of a Pendulum, TE This demonstration uses a pendulum bob attached to a ring stand to verify the equation for a pendulum’s period experimentally. (GENERAL)

TEACH (70 MINUTES)

__ PowerNotes® Resources Use the customizable presentation to help students master the concepts in this section. (GENERAL)

__ Sample Set B, Simple Harmonic Motion of a Simple Pendulum, SE This sample and practice problem set covers simple harmonic motion of a simple pendulum. (GENERAL)

__ Classroom Practice, Simple Harmonic Motion of a Simple Pendulum, SE Use this problem as a teamwork exercise or for demonstration at the board or on an overhead projector. (GENERAL)

__ Conceptual Challenge, p. 379, SE These conceptual questions challenge students to apply the section content to real-world applications. (GENERAL)

__ Sample Set C, Simple Harmonic Motion of a Mass-Spring System, SE This sample and practice problem set covers simple harmonic motion of a mass-spring system. (GENERAL)

__ Classroom Practice, Simple Harmonic Motion of a Mass-Spring System, SE Use this problem as a teamwork exercise or for demonstration at the board or on an overhead projector. (GENERAL)

__ Inquiry Lab, Simple Harmonic Motion of a Pendulum, SE Students construct simple pendulums, find the periods of the pendulums, and examine the relationships between length, mass, and period. (GENERAL)

__ Datasheet, Simple Harmonic Motion of a Pendulum, ANC Students use the datasheet to complete the in-text lab. (GENERAL)

CLOSE (10 MINUTES)

__ Section Review, SE Students answer review questions, critical-thinking questions, and interpreting-graphics questions that assess their understanding of the section objectives. (GENERAL)

__ Study Guide, Measuring Simple Harmonic Motion, ANC Use this worksheet to review the main concepts presented in the section. (GENERAL)

__ Section Quiz, ANC Use this quiz to assess students' understanding of the section. (BASIC)

OTHER RESOURCE OPTIONS

__ Holt Online Learning Students can access interactive problem-solving help and active
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visual concept development with the Holt Physics Online Edition available at my.hrw.com.

_ Integrating Technology, Bicycle Design and Shock Absorption, Online_ Students can visit my.hrw.com and enter the keyword HF6VIBX to find this activity. Teacher resources can be found by entering the keyword HF6VIBXT. (GENERAL)

_ Problem Workbook, Sample Set B: Simple Harmonic Motion of a Simple Pendulum, ANC_ This worksheet provides an additional example problem and several practice problems that cover simple harmonic motion of a simple pendulum. (GENERAL)

_ Problem Bank, Sample Set B: Simple Harmonic Motion of a Simple Pendulum, OSP_ This worksheet provides a third example problem and several practice problems that cover simple harmonic motion of a simple pendulum. (GENERAL)

_ Problem Workbook, Sample Set C: Simple Harmonic Motion of a Mass-Spring System, ANC_ This worksheet provides an additional example problem and several practice problems that cover simple harmonic motion of a mass-spring system. (GENERAL)

_ Problem Bank, Sample Set C: Simple Harmonic Motion of a Mass-Spring System, OSP_ This worksheet provides a third example problem and several practice problems that cover simple harmonic motion of a mass-spring system. (GENERAL)

_ Invention Lab, Tensile Strength and Hooke’s Law, ANC_ Students hang various masses from both a spring and from a rubber band and graph the data to find the spring constant of each. (ADVANCED)

_ CBLTM Experiment, Pendulum Periods, ANC_ In this scenario-based CBL lab, students use CBLs and sensors to develop a set of models that will help them determine the effects of amplitude, length, and mass on the period of a pendulum. Students will use their models to aid in the replacement of a pendulum missing from an antique clock. (ADVANCED)
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SECTION 3 Properties of Waves

PACING
Regular Schedule: with lab(s): N/A days without lab(s): 2 days
Block Schedule: with lab(s): N/A days without lab(s): 1 days

STATE OBJECTIVES
IV. Waves
  A. Wave properties
     1. Conservation of energy
     2. Reflection
     3. Refraction
     4. Interference
     5. Diffraction

OBJECTIVES
1. Distinguish local particle vibrations from overall wave motion.
2. Differentiate between pulse waves and periodic waves.
3. Interpret waveforms of transverse and longitudinal waves.
4. Apply the relationship among wave speed, frequency, and wavelength to solve problems.
5. Relate energy and amplitude.

NATIONAL SCIENCE EDUCATION STANDARDS
UCP 1: Systems, order, and organization
UCP 2: Evidence, models, and explanation
UCP 3: Change, consistency, and measurements
PS6a: Waves, including sound and seismic waves, waves on water, and light waves, have energy and can transfer energy when they interact with matter.
PS6b: Electromagnetic waves result when a charged object is accelerated or decelerated. Electromagnetic waves include radio waves (the longest wavelength), microwaves, infrared radiation (radiant heat), visible light, ultraviolet radiation, x-rays, and gamma rays. The energy of electromagnetic waves is carried in packets whose magnitude is inversely proportional to the wavelength.

FOCUS (5 MINUTES)
__ Overview Review the objectives listed in the Student Edition. (GENERAL)

MOTIVATE (5 MINUTES)
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Demonstration, Wave Motion, TE This demonstration uses a spring to help students distinguish between wave motion and particle motion. (BASIC)

Demonstration, Transverse Waves, TE This demonstration uses a spring to demonstrate that, in a transverse pulse, particle vibration and wave motion are perpendicular to each other. (GENERAL)

TEACH (70 MINUTES)

PowerNotes® Resources Use the customizable presentation to help students master the concepts in this section. (GENERAL)

Visual Strategy, Figure 10, TE Students look at the figure and identify different parts of the cycle shown. (BASIC)

Visual Strategy, Figure 11, TE Students sketch graphs describing the waves produced by a hand shaking a rope in specific ways. (GENERAL)

Demonstration, Longitudinal Waves, TE This demonstration uses a long, coiled spring to demonstrate that, in a longitudinal pulse, particle vibration and wave motion are parallel. (GENERAL)

Demonstration, Amplitude, Wavelength, and Wave Speed, TE This demonstration uses a long, coiled spring and a clock or stopwatch to show that wave speed is independent of amplitude and wavelength. (GENERAL)

Sample Set D, Wave Speed, SE This sample and practice problem set covers wave speed. (BASIC)

CLOSE (10 MINUTES)

Section Review, SE Students answer review questions, critical-thinking questions, and interpreting-graphics questions that assess their understanding of the section objectives. (GENERAL)

Study Guide, Properties of Waves, ANC Use this worksheet to review the main concepts presented in the section. (GENERAL)

Section Quiz, ANC Use this quiz to assess students' understanding of the section. (BASIC)

OTHER RESOURCE OPTIONS

Holt Online Learning Students can access interactive problem-solving help and active visual concept development with the Holt Physics Online Edition available at my.hrw.com.

Problem Workbook, Sample Set D: Wave Speed, ANC This worksheet provides an additional example problem and several practice problems cover wave speed. (GENERAL)

Problem Bank, Sample Set D: Wave Speed, OSP This worksheet provides a third example problem and several practice problems that cover wave speed. (GENERAL)

Integrating Earth Science, Earthquake Waves, Online Students can visit my.hrw.com
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and enter the keyword HF6VIBX to find this activity. Teacher resources can be found by entering the keyword HF6VIBXT.

SciLinks, Online Students can visit www.scilinks.org to find internet resources related to the chapter content. Topic: Wave Motion SciLinks Code: HF61639
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SECTION 4 Wave Interactions

PACING
Regular Schedule: with lab(s): N/A days without lab(s): 1 days
Block Schedule: with lab(s): N/A days without lab(s): 0.5 days

STATE OBJECTIVES
IV. Waves
   A. Wave properties
      1. Conservation of energy
      2. Reflection
      3. Refraction
      4. Interference
      5. Diffraction

OBJECTIVES
1. Apply the superposition principle. Differentiate between constructive and destructive interference.
2. Predict when a reflected wave will be inverted.
3. Predict whether specific traveling waves will produce a standing wave. Identify nodes and antinodes of a standing wave.

NATIONAL SCIENCE EDUCATION STANDARDS
UCP 1: Systems, order, and organization
UCP 2: Evidence, models, and explanation
UCP 3: Change, consistency, and measurements
UCP 4: Evolution and equilibrium
UCP 5: Form and function
ST 1: Abilities of technological design
ST 2: Understanding about science and technology
HNS 1: Science as a human endeavor
HNS 3: History of science
SPSP 1: Personal health
SPSP 5: Science and technology in society
PS6a: Waves, including sound and seismic waves, waves on water, and light waves, have energy and can transfer energy when they interact with matter.
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FOCUS (5 MINUTES)

__ Overview Review the objectives listed in the Student Edition. (GENERAL)

MOTIVATE (5 MINUTES)

__ Demonstration, Wave Superposition, TE This demonstration uses a spring to show that the amplitudes of traveling waves add as the waves cross one another. (GENERAL)
__ Demonstration, Waves Passing Each Other, TE This demonstration uses a spring to show that wave pulses are unaffected after they pass through one another. (BASIC)

TEACH (25 MINUTES)

__ PowerNotes® Resources Use the customizable presentation to help students master the concepts in this section. (GENERAL)
__ Appendix J: Advanced Topics, De Broglie Waves, SE This feature allows students to explore higher-level concepts related to the chapter. (ADVANCED)
__ Demonstration, Wave Reflection, TE Use a long spring to demonstrate that a wave reflected by a fixed boundary is inverted. (BASIC)
__ Visual Strategy, Figure 20, TE Students draw a schematic diagram for a wave shown in the photograph. (GENERAL)
__ Demonstration, Standing Waves, TE This demonstration shows longitudinal standing waves around a circle and that only certain frequencies produce standing waves. (GENERAL)

CLOSE (10 MINUTES)

__ Section Review, SE Students answer review questions, critical-thinking questions, and interpreting-graphics questions that assess their understanding of the section objectives. (GENERAL)
__ Study Guide, Wave Interactions, ANC Use this worksheet to review the main concepts presented in the section. (GENERAL)
__ Section Quiz, ANC Use this quiz to assess students' understanding of the section. (BASIC)

OTHER RESOURCE OPTIONS

__ Holt Online Learning Students can access interactive problem-solving help and active visual concept development with the Holt Physics Online Edition available at my.hrw.com.
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END OF CHAPTER REVIEW AND ASSESSMENT

PACING
Regular Schedule: with lab(s): N/A days without lab(s): 2 days
Block Schedule: with lab(s): N/A days without lab(s): 1 days

__ Chapter Highlights, p. 395, SE This page summarizes the vocabulary terms and key concepts of the chapter.

__ Chapter Review, pp. 396–398, SE Students review the chapter material with review questions, conceptual questions, practice problems, and a mixed review section.

__ Alternative Assessment, p. 399, SE These projects challenge students to apply and extend concepts that they have learned in the chapter. (ADVANCED)

__ Graphing Calculator Practice, p. 399, SE Students program their graphing calculators to predict the period of a clock pendulum with a known period if the pendulum were moved to various locations with different free-fall accelerations. (GENERAL)

__ Standardized Test Prep, pp. 400–401, SE This feature helps students sharpen their testtaking abilities while reviewing the chapter content. (GENERAL)

__ Appendix D: Equations, p. 859, SE This appendix summarizes the equations introduced in the chapter.

__ Appendix I: Additional Problems, pp. 888-889, SE This appendix provides additional mixed practice problems that cover the equations introduced in the chapter.

__ Study Guide, Mixed Review, ANC Students can use this worksheet to review the main concepts of the chapter in preparation for the chapter test. (GENERAL)

__ Holt PuzzlePro® Use this software to create crossword puzzles and word searches that make learning vocabulary fun.

__ Chapter Test A, ANC Assign this test for general-level chapter assessment. (GENERAL)

__ Chapter Test B, ANC Assign this test for advanced-level chapter assessment. (ADVANCED)

__ Test Generator Create a customized homework assignment, quiz, or test using the