This course supports the assessments for Physics: Waves and Optics. The course covers 6 competencies and represents 3 competency units.

Introduction

Overview

Physics: Waves and Optics addresses foundational topics in the physics of waves and optics as well as thermal physics and the laws of thermodynamics. Students will study basic wave motion and then apply that knowledge to the study of sound and light with even further applications to optical instruments. They will also learn about the law of thermodynamics and theories governing the kinetic theory of gases.

Getting Started

Welcome to Physics: Waves and Optics! In this course you will continue your study of physics from the point where the previous physics course (Physics: Mechanics) ended. Many of the topics within this course are directly related to the topics you learned previously. For example, the study of waves flows naturally from your previous study of oscillations.

Look around you. Do you see the application of waves and optics? If not, you soon will. As you read this, you are viewing electromagnetic waves through the optical lenses within your eyes. Can you hear anything? Those noises are also waves—sound waves. If you are wearing a watch, there is a small quartz crystal on your wrist that is vibrating 32,768 times per second in order to keep accurate time.

Throughout this course, you will learn about foundational topics in the physics of waves and optics as well as thermal physics and the laws of thermodynamics. You will study basic wave motion and then apply that knowledge to the study of sound and light with even further applications to optical instruments. You will also learn about the law of thermodynamics and theories governing the kinetic theory physics of gases. Like many areas of physics, the ideas and concepts learned in this subdomain will come up again and again in other topics, so learn this material thoroughly.

Competencies

This course provides guidance to help you demonstrate the following 6 competencies:

- **Competency 207.2.1: Mechanical Waves**
  The graduate applies models of wave motion to solve mechanical wave problems, including sound waves.
- **Competency 207.2.3: Thermal Properties**
  The graduate applies concepts of temperature and heat to analyze microscopic and macroscopic properties of matter.
- **Competency 207.2.5: Thermodynamics**
  The graduate applies the concepts of thermodynamics to solve problems.
- **Competency 207.2.6: Nature of Light**
  The graduate applies models of light to solve problems and describe the behavior of light.
- **Competency 207.2.7: Geometric Optics**
  The graduate applies the ray model of light to demonstrate how mirrors and lenses are used in optical instruments.
- **Competency 207.2.8: Physical Optics**
  The graduate applies the wave model of light to demonstrate interference, diffraction, and applications of physical optics.

Teaching Dispositions Statement

Please review the WGU Statement of Teaching Dispositions

Course Instructor Assistance

While you prepare to demonstrate competency in this subject, remember that course instructors are ready to help you reach your educational goals. As subject matter experts, instructors enjoy and take pride in helping students become reflective learners, problem solvers, and critical thinkers. Course instructors are excited to hear from you and eager to work with you.

Successful students report that working with a course instructor is the key to their success. Course instructors are able to share tips on approaches, tools, and skills that can help you apply the content you are studying. They also provide guidance in assessment preparation strategies, troubleshoot areas of deficiency, and guide you through the revision process if necessary. You should expect to work with course instructors for the duration of your coursework, so you are welcome to contact them as soon as you begin. Course instructors are fully committed to your success!

Preparing for Success

The information in this section is provided to detail the resources available for you to use as you complete this course.

Learning Resources

The learning resources listed in this section are required to complete the activities in this course.

How to Access and Order Your Resources

For many resources, WGU provides access through links in your courses. However, you may need to enroll manually or acquire other resources independently. Read the full instructions provided to ensure that you have access to all of your resources in a timely manner.

You will need to order your LabPaq. Please follow the instructions below carefully.

VitalSource E-Texts

The following textbook is available to you as e-text within this course. You will be directly linked to the specific readings required within the activities that follow.

• Hewitt, P.G. (2015). *Conceptual physics* (12th ed.). New York, NY: Pearson. ISBN-13: 978-0-321-90979-4.

• Young, H.D., & Freedman, R. A. (2016). Sears and Zemansky's university physics with modern physics (14th ed.). New York: NY: Pearson. ISBN-13: 978-0-321-97361-0

Note: These e-texts are available to you as part of your program tuition and fees, but you may purchase a hard copy at your own expense through VitalSource or a retailer of your choice. If you choose to do so, please use the ISBN listed to ensure that you receive the correct edition. The following sites provide instruction on how to create a VitalSource account, use features such as downloading your e-texts for offline use, and purchase a print-on-demand option, if available.

VitalSource Navigational Video
Print-On-Demand Option

Physics LabPaq

The cost of the lab kit (LabPaq) is covered by your program lab fee and is used across three courses within your physics program: Mechanics, Waves and Optics, and Electricity and Magnetism. If you have not done so already, you will need to order your Physics LabPaq from Hands-On Labs. If you have previously ordered this kit for another course, there is no need to order another. This kit contains the science equipment and supplies you will need to complete experiments at home and will be shipped to you.

The experiments you will complete in each course support and reinforce the science content and also teach laboratory techniques.

Follow these instructions to order your Physics LabPaq.

Lab manuals and specific instructions for completion of each relevant lab are linked within the course.

Additional Preparations

Graphing Calculator

Acquire a graphing calculator and familiarize yourself with how to use it. Refer to the "WGU Calculator and Scratch Paper Guidelines" document for calculators permitted on WGU exams. If you are in a secondary mathematics program, refer to the "WGU Calculator Recommendations for Secondary Math and Science Programs" document for calculator suggestions for your degree program.

If you are not in a secondary mathematics program, contact your instructor to discuss calculators appropriate to your degree program.

Equation Sheet and Import Contributions Table

During your study of Physics: Mechanics, you created a table of individuals and their contributions to physics, a table of physics applications, and an equation sheet. You will continue to add to the tables and your equation sheet during your studies of Physics: Waves and Optics.

Pacing Guide

The pacing guide suggests a weekly structure to pace your completion of learning activities. It is provided as a suggestion and does not represent a mandatory schedule. Follow the pacing guide carefully to complete the course in the suggested time frame.

Week 1: Wave Motion and Sound Waves

- Waves and Wave Motion
- Sound Waves and Music
- Physics Lab: “Determining the Speed of Sound”

Week 2: Thermal Properties

- Thermal Properties of Matter Motion
- Physics Labs:
    - “Specific Heat Capacity of Metals”
    - “Caloric Content of Food”

Week 3: Kinetic Theory of Gases and the Thermal Properties Performance Task

- Kinetic Theory of Gases
- Online lab: “Pressure and Volume of a Gas”
- Task 1: Physics: Waves and Optics

Week 4: Laws of Thermodynamics and the Laws of Thermodynamics Performance Task

- Laws of Thermodynamics
- Task 2: Physics: Waves and Optics

Week 5: The Nature and Properties of Light

- Properties of Light
- Nature of Light

- Online labs:
- “Light Investigation Part I”
- “Light Investigation Part II”

Week 6: Reflection and Refraction and the Waves and Optics Performance Task

- Reflection and Refraction
- Physics Lab: “Reflection and Refraction”
- Task 3: Physics: Waves and Optics

Physics: Waves and Optics

Before you begin, be sure you have access to, and have enrolled in, all necessary learning resources as listed in the Learning Resources section. As you are completing the readings, make sure you take notes on any important ideas, concepts, and equations.

Week 1: Wave Motion and Sound Waves

In this topic, you will study wave motion. You will understand what identifies wave motion and behavior, and you will understand natural examples of wave motion.

Waves and Wave Motion

Read:

- Chapter 19: "Vibrations and Waves" from *Conceptual Physics*
- Chapter 15: "Mechanical Waves" from *University Physics with Modern Physics*
  - 15.1 (“Types of Mechanical Waves”)
  - 15.2 (“Periodic Waves”)
  - 15.3 (“Mathematical Description of a Wave”)
  - 15.4 (“Speed of a Transverse Wave”)
  - 15.5 (“Energy in Wave Motion”)
  - 15.6 (“Wave Interference, Boundary Conditions, and Superposition”)
  - 15.7 (“Standing Waves on a String”)
  - 15.8 ("Normal Modes of a String”)

Sound Waves and Music

Read:

- Chapter 20: "Sound" from *Conceptual Physics*
- Chapter 21: "Musical Sounds" from *Conceptual Physics*
- Chapter 16: "Sound and Hearing" from *University Physics with Modern Physics*
    - 16.1 ("Sound Waves")
    - 16.2 ("Speed of Sound Waves")
    - 16.3 ("Sound Intensity")
    - 16.4 ("Standing Sound Waves and Normal Modes")
    - 16.5 ("Resonance and Sound")
    - 16.6 ("Interference of Waves")
    - 16.7 ("Beats")
    - 16.8 ("The Doppler Effect")

Complete:

- Physics Lab: "Determining the Speed of Sound"

After completing the lab, you are welcome to submit your work to receive feedback from your course instructor.

Week 2: Thermal Properties

Temperature is an internal property of matter while heat is a relative measurement of the surrounding medium's energy. You will learn about how temperature is measured, in several different scales; and about thermal expansion, the effect that happens to a body when its internal temperature is increased.

Thermal Properties of Matter Motion

Read:

- Chapter 15: "Temperature, Heat, and Expansion" from *Conceptual Physics*
- Chapter 16: "Heat Transfer" from *Conceptual Physics*
- Chapter 17: "Change of Phase" from *Conceptual Physics*
- Chapter 17: "Temperature and Heat" from *University Physics with Modern Physics*

Complete:

- Physics Lab: "Specific Heat Capacity of Metals"
- Physics Lab: "Caloric Content of Food"

After completing each lab, you are welcome to submit your work to receive feedback from your course instructor.

Week 3: Kinetic Theory of Gases and the Thermal Properties performance task

The kinetic theory of gases describes the collective behavior of gases that consist of many individual molecules. The theory explains the changes in the behavior of a gas in terms of its

disturbance on things (i.e., the gas pressure and temperature) and in terms of the collisions that happen between molecules. Certain assumptions are considered when studying the theory, and you will learn about what they are and why those assumptions are reasonable based on natural observation.

Kinetic Theory of Gases

Read:

- Chapter 14: "Gases" from *Conceptual Physics*
- Chapter 18: "Thermal Properties of Matter" from *University Physics with Modern Physics*
  - 18.1 (“Equations of State”)
  - 18.2 (Molecular Properties of Matter”)
  - 18.3 (“Kinetic-Molecular Model of an Ideal Gas")
  - 18.4 (“Heat Capacities”)
  - 18.5 (“Molecular Speeds”)
  - 18.6 (“Phases of Matter”)

Review:

- Theoretical Meteorology

Understand:

Theory and concept of how the ideal gas law and kinetic theory of gases relates to weather conditions within the Earth's atmosphere. Be sure to think about what factors impact weather systems, and answer the question: Is the Earth a closed or open system? In other words, is the atmosphere confined to a set volume? If not, what does that mean for the expected relationship between pressure and temperature?

Complete:

- Online Lab: "Pressure and Volume of a Gas"

Performance Task 1

Complete in Taskstream:

- Physics: Waves and Optics: Task 1

For details about this performance assessment, see the "Assessment" tab in this course.

Go to the following for an overview of this task and hints and tips.

Before submitting, check that you have covered all the requirements in the rubric. If you need help, contact the course instructor.

Week 4: Laws of Thermodynamics

Thermodynamics is the study of heat and its transformation to useable mechanical energy. Thermodynamics is the study of mechanical work in terms of a change in a medium's pressure, volume, and temperature. The foundation of thermodynamics is the conservation of energy and the natural observation that heat always flows from hot to cold.

Laws of Thermodynamics

Read:

- Chapter 18: "Thermodynamics" from *Conceptual Physics*
- Chapter 19: "The First Law of Thermodynamics" from *University Physics with Modern Physics*
- Chapter 20: "The Second Law of Thermodynamics" from *University Physics with Modern Physics*

Performance Task 2

Complete in Taskstream:

- Physics: Waves and Optics: Task 2

For details about this performance assessment, see the "Assessment" tab in this course.

Go to the follow for an overview of this task and hints and tips.

Before submitting, check that you have covered all the requirements in the rubric. If you need help, contact the course instructor.

Week 5: The Nature and Properties of Light

In this section you will learn about the properties of light and a few of the most important aspects of light propagation, including reflection and refraction.

Properties of Light

Read:

- Chapter 26 "Properties of Light" from *Conceptual Physics*

Nature of Light

Read:

- Chapter 33: “The Nature and Propagation of Light” from University Physics with Modern Physics
    - 33.1 ("The Nature of Light")

Complete:

- Online Labs:
    - "Light Investigation Part I"

- "Light Investigation Part II"

After completing the labs, you are welcome to submit your work to receive feedback from your course instructor.

Week 6: Reflection and Refraction

Most of the things around you do not actually emit their own light. So how do you see them? Instead of producing some internal light, all visible things reflect light around them. You say that light is reflected when it returns to the medium from which it came. On the contrary, light that is able to enter another medium (e.g., another gas, liquid, or transparent solid) is refracted, and its path is altered by some angle.

Reflection and Refraction of Light

Read:

- Chapter 27: "Color" from *Conceptual Physics*
- Chapter 28: "Reflection and Refraction" from *Conceptual Physics*
  - 28.1 (“Reflection”)
  - 28.2 (“Law of Reflection”)
  - 28.3 (“Refraction”)
  - 28.4 (“Cause of Refraction”)
  - 28.5 (“Dispersion and Rainbows”)
  - 28.6 (“Total Internal Reflection”)
- Chapter 33: "The Nature and Propagation of Light" from *University Physics with Modern Physics*
  - 33.2 (“Reflection and Refraction”)
  - 33.3 (“Total Internal Reflection”)
  - 33.4 (“Dispersion”)
  - 33.5 (“Polarization”)
  - 33.6 (“Scattering of Light”)

Complete:

- Physics Lab: "Reflection and Refraction"

After completing the lab, submit your work to receive feedback.

Performance Task 3

Complete in Taskstream:

- Physics: Waves and Optics: Task 3

For details about this performance assessment, see the "Assessment" tab in this course.

Go to the following for an overview of this task and hints and tips.

Before submitting, check that you have covered all the requirements in the rubric. If you need help, contact the course instructor.

Final Steps

Congratulations on completing the activities in this course! This course has prepared you to complete the assessment associated with this course. If you have not already been directed to complete it, schedule and complete the assessment now.