

# **Science 21 Resource Package**

## **PHYSICS: Waves and Optics in Everyday Life**

### **Suggested Lessons and Activities**

## Course Outline

The course will consist of three units selected from the following four units of study:

1. Biology (Human Body Systems)
2. Chemistry (Our Liquid World – A Focus on Water)
3. Physics (Waves and Optics in Everyday Life)
4. A unit of study determined by local interest and selected by the teacher and the student.

The teacher may use the three units selected from this course, or any two of these units as well as a locally determined unit of study. Each unit consists of a series of suggested lessons that are designed to meet the foundational objectives for the unit. Each lesson contains the learning objectives covered in the lesson, an overview of the lesson, a list of instructional documents that are included within the unit, and a list of supporting resources. The supporting resources may include reading materials to support the lesson or additional lesson ideas and activities that meet the objectives that are outlined for the lesson.

The units within this course outline are not intended as a complete Science 21 course. Teachers should integrate some of the suggested lessons within their own unit plans and modify the suggested lessons to meet the diverse needs of their students. Some of the objectives are addressed in more than one of the suggested lessons within a unit; therefore, not all of the suggested lessons need to be used. Teachers may request an electronic version of this course outline from their school division office so that they can modify the instructional documents to meet diverse needs.

## Introduction

This unit is designed to allow students to understand wave phenomenon by relating concepts to their everyday experiences. The demonstrations, animations and activities aim to provide students with a basic understanding of waves and optics without the mathematical component. Students learn the main categories of waves, the parts of a wave, basic wave behaviors, and wave interference. Students are introduced to the reflection and refraction of waves through activities and learn about lenses through a study of the optics of the eye. A hands-on approach to all of the topics is emphasized. A unit end project is provided as an alternative to a unit exam. Extensive teacher support material has been included to make this unit easier for the general science teacher without a physics background.

NAME \_\_\_\_\_  
DATE \_\_\_\_\_

④ BIGGER PICTURE  
SCIENCE 21

② LAST UNIT/Experience	① CURRENT UNIT WAVES and OPTICS in EVERYDAY LIFE	NEXT UNIT/Experience
⑧ Student Activities or Assignments	⑤ UNIT MAP	
<p>1. <b>INTRODUCTION TO WAVE PHENOMENA</b> - vocab, notes &amp; Qs on waves - vocab &amp; slinky lab - vocab &amp; graphing wave interference</p> <p>2. <b>THE PINHOLE CAMERA</b> - vocab, lab &amp; Qs</p> <p>3. <b>REFLECTION &amp; PLANE MIRRORS</b> - vocab, lab &amp; Qs</p> <p>4. <b>INVESTIGATING REFRACTION</b> - vocab, activity &amp; Qs</p> <p>5. <b>THE OPTICS OF THE EYE</b> - vocab, dissection &amp; Qs</p> <p>6. <b>FINAL PROJECT</b></p>	<p><i>is about...</i></p> <p>how the study of WAVES can help us understand what we hear and see</p> <div style="display: flex; justify-content: space-around;"> <div style="text-align: center;"> <p><b>INTRODUCTION to WAVES</b></p> <ul style="list-style-type: none"> <li>1. Electromagnetic</li> <li>2. Mechanical                             <ul style="list-style-type: none"> <li>2a. Types                                     <ul style="list-style-type: none"> <li>-longitudinal</li> <li>-transverse</li> <li>-surface</li> </ul> </li> <li>2b. Interference                                     <ul style="list-style-type: none"> <li>-constructive</li> <li>-destructive</li> </ul> </li> </ul> </li> <li>3. Pinhole camera</li> </ul> </div> <div style="text-align: center;"> <p><b>REFLECTION &amp; REFRACTION</b></p> <ul style="list-style-type: none"> <li>1. Plane mirrors</li> <li>2. Refraction of light by different materials</li> </ul> </div> <div style="text-align: center;"> <p><b>OPTICS</b></p> <ul style="list-style-type: none"> <li>1. Anatomy of the Eye</li> </ul> <p>types of materials</p> <ul style="list-style-type: none"> <li>-translucent</li> <li>-opaque</li> <li>-transparent</li> </ul> </div> </div>	
⑨ UNIT SELF-TEST		
<p>1. What is a wave?</p> <p>2. a. What are the two types of waves? b. How are these two types of waves different?</p> <p>3. a. Describe the three types of mechanical waves. b. Provide examples for each type of mechanical wave.</p> <p>4. Describe the basic behaviors of waves.</p> <p>5. What is the Law of Reflection?</p> <p>6. What is the angle of reflection of a 40 degree incident ray?</p>	<p>7. What is the position, attitude, size and type of the image produced in a plane mirror?</p> <p>8. How do different materials affect how light refracts?</p> <p>9. a. Which way does a ray of light bend at the normal going from <i>air</i> to <i>water</i>? b. From <i>water</i> to <i>air</i>.</p> <p>10. How does a pinhole camera and the eye record an image?</p>	⑦

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**Total Approximate Time For Unit:** 12 hours

### Foundational Objectives

- Observe, describe, and record the characteristic properties of waves.
- Transfer an understanding of properties of waves to practical examples and common experiences.
- Predict the behaviour of waves in analogous situations to those which are investigated experimentally.
- Extract meaning from models and multi-sensory media.
- Give some examples from common experiences which illustrate the behaviour of light.
- Perform activities to investigate the behaviour of light.
- Appreciate the importance of experimentation in science.
- Classify ideas and information.
- Recognize the importance of observation in science.

## Lesson 1 – An Introduction to Wave Phenomena

### Learning Objectives

- Define the following terms: wave, disturbance, medium, pulse, vibration, cycle, transverse vibration, longitudinal vibration, crest, trough, compression, rarefaction, frequency, amplitude, wavelength.
- Solve problems involving period, frequency, and wave motion.
- Define the following terms: interference, constructive interference, destructive interference.
- State the Principle of Superposition.
- Predict the resulting wave pattern when two waves traveling in opposite directions meet at a given point.
- Illustrate constructive and destructive interference using diagrams, models, or computers.
- Define the following terms: medium, amplitude, fixed-end reflection, free-end reflection.
- Explain that a change in medium or a change in the condition of a medium will usually result in a change in the speed of a wave passing through that medium.
- Explain that the frequency of a wave depends on the source which produced it.
- Demonstrate an understanding of wave transmission and reflection by relating these phenomena to practical and common experiences.

### Lesson Overview:

This lesson serves as a general introduction to waves. This includes types of waves, wave behavior, the anatomy of waves and wave interference. Students are introduced to these concepts through an exploration of real world examples of waves, animations and demonstrations. Properties of waves are further investigated through a Slinky© lab activity and the graphing of the interference of pulses.

Suggested Timeline: 4 hours

### Instructional Document(s):

- Activity #1 - Catching the Concept of Waves (Teacher Support Material)
- Activity #1 Review: Did You Catch the Concept of Waves (Teacher Support Material)
- Activity #1 - Catching the Concept of Waves (Student Handout - Individual)
- Activity #1 – Catching the Concept of Waves (Student Handout – Group)
- Activity #1 Review – Did You Catch the Concept of Waves (Student Handout)
- Activity #2 – Using a Slinky© to Investigate Waves (Teacher Support Material)
- Activity #2 – Using a Slinky© to Investigate Waves (Student Handout)
- Activity #3 – Getting Into Interference (Teacher Support Material)
- Activity #3 – Getting Into Interference (Student Handout - Individual)
- Activity #3 – Getting Into Interference (Student Handout – Group)

Unit: Physics A – Outline and Lesson Plans

Supporting Resources:

1. Wave Properties, pp.381-391 *Glencoe Science Physics: Principles and Problems*
2. Refraction, pp.449-452 *Hands-On Physics Activities with Real Life Applications*
3. Waves and Energy Transfer, pp.287-305 *Merrill Physics: Principles and Problems*

## Lesson 2 – The Pinhole Camera

### Learning Objectives:

- Define the following terms: luminous, nonluminous, beam, incandescence, ray, transparent, translucent, orientation.
- Give examples of some common luminous and nonluminous objects.
- Explain that light usually travels in straight lines.
- Give some examples which illustrate the rectilinear propagation of light.

### Lesson Overview:

In this lab, students will investigate pinhole optics to learn how light travels in straight lines to form an image.

Suggested Timeline: 1.5 hours

### Instructional Document(s):

- The Pinhole Camera (Teacher Support Material)
- The Pinhole Camera (Student Handout – Individual)
- The Pinhole Camera (Student Handout – Group)

### Supporting Resources:

1. Physics Lab – Pinhole Camera, p. 334 *Merrill Physics Principles and Problems*
2. Light Optics DVD, *Bill Nye the Science Guy* (available at [http://dep.disney.go.com/educational/store/detail?product\\_id=77A09PK00](http://dep.disney.go.com/educational/store/detail?product_id=77A09PK00))

### **Lesson 3 – Reflection and Plane Mirrors**

#### Learning Objectives:

- Define the following terms: ray, incident ray, point of incidence, normal, reflected ray, angle of incidence, angle of reflection.
- State the laws of reflection.
- Apply the laws of reflection in problem solving.
- Define the following terms: real image, virtual image, plane mirror.
- Identify the characteristics of an image formed by a plane mirror.
- Distinguish between a real and a virtual image.
- Label ray diagrams correctly, using conventional symbols.

#### Lesson Overview:

In this lesson, students will discover the law of reflection through a consideration of their everyday experiences. Through scientific inquiry, they will then use this knowledge to understand how light waves reflect in plane mirrors.

Suggested Timeline: 1 hour

#### Instructional Document(s):

- Reflection and Plane Mirrors (Teacher Support Material)
- Reflection and Plane Mirrors (Student Handout – Individual and Group)

#### Supporting Resources:

1. Reflection, pp. 347-350 *Merrill Physics Principles and Problems*
2. Light and Reflection, pp. 519-529 *Holt Physics*



## Lesson 4 – Investigating Refraction

### Learning Objectives:

- Define the following terms: refraction, boundary, point of incidence, refracted ray, angle of refraction.
- Explain why refraction occurs.
- Draw and label a diagram which illustrates the way in which light behaves when it undergoes refraction.
- Solve problems relating to the refraction of light.
- Define the following terms: speed, index of refraction.
- Explain that the speed of light is fastest in a vacuum and slower in other materials.
- Explain that light travels slightly slower in air than in a vacuum, but in many situations this difference is negligible.
- Recognize that the higher the value of the index of refraction for a particular medium the slower light will travel through that medium.

### Lesson Overview:

In this lesson, students will be introduced to refraction through a series of demonstrations. By observing how different materials affect the position of an object, the concept of the refraction of light waves will be further investigated.

### Suggested Timeline: 1 hour

### Instructional Document(s):

- Investigating Refraction (Teacher Support Material)
- Investigating Refraction (Student Handout)
- Bending Light – A Lab Investigation of Refraction (Student Handout)

### Supporting Resources:

1. Refraction, pp. 350-365 *Merrill Physics Principles and Problems*
2. Refraction, pp.561-567 *Holt Physics*
3. Refraction, pp. 449-452 *Hands On Physics Activities With Real-Life Applications*

## Lesson 5 – The Optics of the Eye

### Learning Objectives:

- Describe the function of the following parts of the human eye: cornea, lens, ciliary muscles, suspensory ligaments, iris, aqueous humour, vitreous humour, sclerotic, retina, rods, cones, optic nerve.
- Describe how the rods and cones on the retina respond to light differently.

### Lesson Overview:

In this lesson, students will learn about the mechanism of vision through a dissection of a mammalian eye.

Suggested Timeline: 1.5 hours

### Instructional Document(s):

- The Optics of the Eye – Discovery Through Dissection (Teacher Support Material)
- The Optics of the Eye – Discovery Through Dissection (Student Handout)
- The Optics of the Eye – Discovery Through Virtual Dissection (Student Handout)

### Supporting Resources:

1. <http://www.ebioinfogen.com/virtual.htm> - online virtual dissection and lab resources
2. The Eye, pp. 236-237 *Biology Coloring Workbook*
3. Lenses in Eyes, pp. 500-501 *Glencoe Science Physics Principles and Problems*

## **Lesson 6 – Waves and Optics Final Project**

### Learning Objectives:

- Integrate their knowledge of waves and optics.
- Communicate their knowledge in an effective manner.
- Explore common items that operate on the basis of important principles in physics.
- Give some examples from common experiences which illustrate the behaviour of light.
- Use a wide range of possibilities for developing knowledge of the major concepts within physics.
- Meet their own learning needs.

### Lesson Overview

In this lesson, students will learn how to integrate their knowledge of waves and optics into a final unit project. This will consist of either a presentation or a display on a piece of technology or an observed phenomenon that involves waves and/or optics. Students will realize how much of the information that they learned in the unit can be used to understand how everyday things work.

Suggested Timeline: 3 hours research + presentation time (if this option is chosen)

### Instructional Document(s):

- Physics Show and Tell (Student Handout)
- Physics Showcase Display Project (Student Handout)