Phenomenal experiences drive student inquiry.

Exploration begins with phenomena—showing students that physics is relevant to their lives. *Experience Physics®* uses phenomena to engage students in scientific inquiry through its organizational structure and real-world storylines.

**Phenomena Organization**

- **ANCHORING PHENOMENON**
  - 5 Storylines - Organized around Anchoring Phenomena
- **INVESTIGATIVE PHENOMENON**
  - 2-4 Investigations per Storyline - Organized around Investigative Phenomena
- **EVERYDAY PHENOMENON**
  - 3-4 Experiences per Investigation - Experience Everyday Phenomena
- **STORYLINE**

Experiences and Investigations build understanding of Anchoring Phenomenon

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**Investigation 11**

*Waves*

<table>
<thead>
<tr>
<th>Distance (m)</th>
<th>Depth (m)</th>
<th>Speed (m/s)</th>
<th>Wavelength (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>1.4</td>
<td>20</td>
<td>2.8</td>
</tr>
<tr>
<td>20</td>
<td>2.8</td>
<td>30</td>
<td>4.2</td>
</tr>
<tr>
<td>30</td>
<td>4.2</td>
<td>40</td>
<td>5.6</td>
</tr>
</tbody>
</table>

These questions will help you apply what you learned in this experience to the Investigative Phenomenon.

1. Revisit the Investigative Phenomenon. Construct both a distance and time graph of the ocean wave. Assume a wave comes towards the shore.
2. What is the wavelength of the wave? Construct a graph of the wave speed as a function of the depth.
3. After determining the frequency, you then use a handheld sonar system to determine the ocean depth at 10 m from the shore and determine there is 20 seconds between crests. Determine the frequency of the wave. Would you expect this frequency to change if you made your measurement further out from the shore?
4. Construct a graph of the wave speed as a function of the depth. What happened to the wave speed as you made your measurement further out from the shore?
5. At the beach, you time the wave crests hitting the shore and determine there is 20 seconds between crests. Determine the frequency of the wave. If applicable, state the principle that explains the phenomenon, state how that aligns with the definition and verifies the vocabulary you have learned in this course.

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**Claim-Evidence-Reasoning**

Use the Claim-Evidence-Reasoning format to broaden understanding as more student inquiry lab activities are completed. Students gather information and develop arguments over time.

- **CLAIM**
- **EVIDENCE**
- **REASONING**

Your claim should be a response to the stated question. Place only what you learned about in the space provided. If appropriate, use relevant vocabulary you have learned in this course.

**Date**

**GO ONLINE** to revisit your Investigative Phenomenon CER to broaden understanding as more student inquiry lab activities are completed. Students gather information and develop arguments over time.
Phenomena Launch
Exploration begins with a phenomenon video or class demonstration that introduces and unifies the physics concepts.

Student Sensemaking
Students gather information, develop arguments over time, and document their understanding using a Claim-Evidence-Reasoning model.

Everyday Phenomena
Engage students in a personal and relatable way. From Flinn Scientific inquiry labs to virtual simulations, students are motivated to figure out why and how a phenomenon happens.

How do waves change the coastline?

INVESTIGATIVE PHENOMENON
These questions will help you apply what you learned in this experience to the Investigative Phenomenon.

10 SEP Use Mathematics
At the beach, you time the wave crests hitting the shore and determine there is 20 seconds between crests. Determine the frequency of the wave. Would you expect this frequency to change if you made your measurement further out from the shore?

19 SEP Analyze and Interpret Data
After determining the frequency, use a handheld sonar system to determine the ocean depth at 10 m increments from the shore. The data is shown in the table. Complete the table and construct a graph of the wave speed as a function of the depth.

INVESTIGATIVE PHENOMENON DEMONSTRATION
Use a ripple tank or shallow baking pan to demonstrate the interaction between water waves and land. Put sand (or soil) at one end of the tank or pan, sloping down to the center of the pan. Fill the tank or pan with water. Then have a volunteer send waves from one end of the tank to the side that contains the sand. Have students observe how the waves interact with the sand.

Ask: “How would increasing the size of the waves affect how the water interacts with the sand?” (Increasing the size of the waves would cause the water to carry away more of the sand.)
How much energy is released when an object burns? One way to determine the amount of energy released when an object burns is to measure the heat flow from it to its surroundings will increase. This activity will introduce the concept of calorimetry and investigate the caloric content of organic fuels.

Focus on Science Practices

SEP 4

SEP 5

Wear safety goggles when performing this or any lab that uses chemicals, heat or glassware. Allow charcoal sample to cool before touching or discarding it. Use a glass stirring rod to stir the liquid; never stir with a thermometer. This lab should be performed in a well-ventilated room. Wash hands thoroughly with soap and water before leaving the laboratory.

Planning and Carrying Out Investigations

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Using Mathematics and Computational Thinking

INTRODUCTION TO ENERGY INQUIRY LABS – ADVANCED

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worksheet link TK

Measuring the Energy

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Differentiate instruction with

Explore concepts with an inquiry lab in every learning

and demonstrations and Performance Tasks directly

embeds

exclusive partnership with

Experience Physics

Our partner in Inquiry

to meet your diverse classroom needs.

- experience.

- from Flinn Scientific. Foster greater

connect physics concepts to real-world issues.

Students develop

Data Set Activities

Engineering Workbench

Students design, test, and evaluate solutions that mimic the real-world activities of engineers. Activities are connected to related careers on the Using Physics Today Hook & Inspire site.

Lab Kits

Simplify set-up with time-saving kits from Flinn Scientific. Foster greater inquiry learning by having readily accessible lab materials.
As light travels from one medium into another, refraction often occurs. Refraction is the bending of a wave that occurs when it enters a new substance as shown in Figure 1. This bending occurs because the speed of light changes when it passes from one substance to another, due to a difference in the densities of the two substances. In 1621, Dutch astronomer and mathematician Willebrord Snellius (1580–1626) came up with a quantitative law of refraction, which is known today as Snell’s law. In this activity you will analyze data on the transmission of light from air into water to derive Snell’s law.

Data Set Activities
Students develop mathematical fluency using data sets that connect physics concepts to real-world issues.

Performance Tasks
Students demonstrate standards mastery by applying their understanding to a new situation in a Performance-Based Assessment at the end of every Investigation.
Virtual Explorations support the understanding of phenomena.

Savvas Realize™ is an award-winning platform that has transformed learning into an active and engaging experience for millions of students. Realize is a Thin Common Cartridge (TCC) certified provider, so content runs on all compliant LMS platforms. Access all your digital content, virtual labs, simulations, assessments, and student data in ONE location.

**PhET™ Simulations** engage students in an intuitive, game-like environment. Accompanying worksheets connect the simulations to the content.

**Virtual Labs** give all students access to compelling phenomena and advanced scientific equipment.

**Boclips® Videos** present physics concepts in an easy-to-understand way.

**Digital Interactivities** simulate real-world problem-solving to increase student interest.

Look for faster integration and enhanced data-fidelity through **LTI-Advantage (LTI-A)**.
The best way to learn science is to do science. That’s why this modern program puts the focus on your classroom experience.

- Organizes learning around phenomena for an authentic, 
- Includes a variety of hands-on and digital activities designed to give you many different ways to learn about physics, 
- Engineering workbench activities, and performance assessments.

Take a look at the cover image. What do you think is happening here? How often do you think about the behavior of fluids? Probably water flowing out of a faucet to the flow of air over a moving vehicle.

Flinn Scientific, the leading supplier of lab equipment, chemicals, and safety solutions, partners with Experience Physics
design challenges, performance-based assessments, videos, and lab kits.

The Student Experience Handbook is during the Explain section. Only after students have interacted with phenomena they complete the readings and math practice in the Student Experience Handbook. This way the content is relevant to students, while providing necessary information for them to continue with the more in-depth Elaborate activities and Evaluations.

Virtual Explorations
A mechanical wave is an oscillation of matter that is either up-and-down (transverse) or back-and-forth (longitudinal). Math Practice
Physics and Math Skills Workbook
Review and practice problems for every learning experience. Use Models
In the art above and the P wave on the second and third diagrams.

Investigation 11
Wave Properties
is wave speed, \( f \) is frequency, and \( \lambda \) is wavelength. Differentiate your lessons with four versions...

Mathematical Practices:
Model with Mathematics
Mathematical equations can be used to model phenomena that occur in nature. For example, scientists and engineers use equations to model seismic waves, ocean waves, and sound waves.

A sine equation can be used to show the displacement, \( y \), of a particle due to a passing wave with amplitude \( A \) and frequency \( f \):

\[
y(t) = A \sin(2\pi ft)
\]

You can change the parameters \( A \) and \( f \) in the equation to model any observed data in a time graph.

Mathematical Support
- Physics and Math Skills Workbook includes four pages of review and practice problems for every learning experience.
- Stepped-Out Examples break down sample problems for clarity and process guidance.
- Problem Banks provide students with additional problems to build mathematical fluency.
- Analyzing Data activities include opportunities for students to apply mathematical concepts in real-world contexts.
- Math Readiness Test allows instructors to gauge student understanding before taking the course.

3D Assessment
- Performance Based-Assessments measure students’ mastery of the science and engineering practices.
- Problem-Based Learning projects require students to obtain and evaluate information about a related phenomenon and communicate their findings in a written report.
- Revisit the Phenomenon multiple times to help students make sense of the topic.
- Online Quizzes that are customizable and interactive conclude every Experience.
- Assess-on-the-Spot ideas in the Teacher Guide provide quick formative assessments.
- For a summative assessment of the Investigation, assign customizable 3-Dimensional Assessments in Realize.
- End-of-Year Tests work well for a summative final exam.

Desmos™ Graphing Calculator on the Savvas Realize™ digital platform supports students in problem solving and mathematics.

Math Tutorial Videos reinforce mathematical processes making them ideal for remediation.

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A phenomenal and flexible teaching experience

The Experience Physics Teacher Guide isn’t a traditional teacher edition. We put the focus on teacher resources, with teacher background, learning objectives, lab and activity modifications, point-of-use formative assessments, professional learning, and more.

The flexible structure makes it easy to adapt your physics program for any classroom situation, no matter the level of your students or the location of your classroom.

• “Got More Time?” activities make it easy to enhance your instruction.
• Related Phenomena give you options when you want to make a substitution.
• Detailed Planners use the 5E model for an inquiry-based approach.
• Activities includes a wide variety of hands-on labs and virtual simulations.

Experience It for Yourself
Request samples and online demos at Savvas.com/ExperiencePhysics