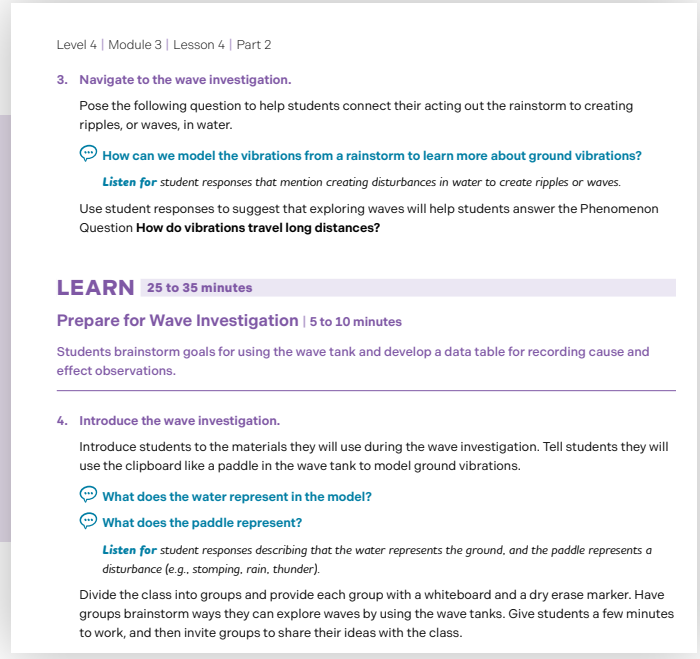
PhD SCIENCE®
Hands-On Investigations

Students learn to think and act like real scientists

Created by our team of teacher—writers and experts, *PhD Science*® inspires students to wonder about the world and empowers them to understand it. Students conduct investigations and collect and analyze data, just like real scientists. Each module includes **hands-on investigations** and a **Science or Engineering Challenge**, allowing students to practice problem solving, collaborate, and build content knowledge.

Activity Before Concept > Concept Before Terminology Approach

The ABC > CBT approach ensures students engage in **hands-on activities** to develop a deep understanding of scientific concepts before learning terminology. This method helps students create evidence-based explanations and retain their knowledge longer.



Level 4 | Module 3 | Lesson 4 | Part 2

3. **Navigate to the wave investigation.**

Pose the following question to help students connect their acting out the rainstorm to creating ripples, or waves, in water.

How can we model the vibrations from a rainstorm to learn more about ground vibrations?

Listen for *student responses that mention creating disturbances in water to create ripples or waves.*

Use student responses to suggest that exploring waves will help students answer the Phenomenon Question **How do vibrations travel long distances?**

LEARN **25 to 35 minutes**

Prepare for Wave Investigation | **5 to 10 minutes**

Students brainstorm goals for using the wave tank and develop a data table for recording cause and effect observations.

4. **Introduce the wave investigation.**

Introduce students to the materials they will use during the wave investigation. Tell students they will use the clipboard like a paddle in the wave tank to model ground vibrations.

What does the water represent in the model?

What does the paddle represent?

Listen for *student responses describing that the water represents the ground, and the paddle represents a disturbance (e.g., stomping, rain, thunder).*

Divide the class into groups and provide each group with a whiteboard and a dry erase marker. Have groups brainstorm ways they can explore waves by using the wave tanks. Give students a few minutes to work, and then invite groups to share their ideas with the class.

Level 4 Module 3

Engaging in the Science and Engineering Practices

Activities in lessons may range from drawing a model to planning and carrying out an investigation.

Application of Concepts

Each module includes a **Science or Engineering Challenge**, where students apply concepts to solve real-world problems. Rather than memorizing terms or watching videos, students actively use their knowledge in performance-based tasks, collaborating with peers and presenting findings. **Performance Checkpoints** provide an opportunity for teachers to assess student performance using the three dimensions.

Level 4 Module 3

Application of Concepts

LESSON 8 SCIENCE CHALLENGE

Task | Science Challenge

Phenomenon Question | Can elephants understand information from the vibrations they feel?

OVERVIEW

Previously we explored how vibrations in the ground travel in ways similar to how water waves travel. We observed water waves to identify wave properties and applied our new understanding to compare how different sound waves in the air travel to elephants. We wondered how elephants receive and process information from ground vibrations and sound waves.

In this lesson we design and carry out an investigation to test whether we can use our sense of touch to tell the difference between two different vibration signals. We collect and analyze data for patterns and connect our findings to how elephants receive and process information. We wonder how elephants' sensory structures compare to ours.

Later we will learn that elephants have specialized touch sensory structures in their feet and trunk. We will explore how information travels to their brain and how they change their behavior in response to information from their environment.

Lesson Objective

Plan and conduct a fair test investigation (SEP.3) to determine how well **touch receptors sense (LSD.1) surface vibration signals (CC.1)**.

Performance Descriptors

Part 1: **Plan a fair test investigation (SEP.3)** to determine whether **touch receptors can sense and process (LS1.D) different patterns of information (CC.1)**.

Part 2: **Analyze data (SEP.4)** to **identify patterns in the data that can be used to explain (CC.1)** why **touch receptors are specialized for sensing vibrations (LS1.D)**.

Part 3: **Use evidence to support a claim (SEP.7)** about whether **animals can understand vibrations they sense with their touch receptors (LS1.D)**.

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Science Challenge

Students conduct real-world investigations to answer questions. For example, in Level 4 Module 3 students collect and analyze data for patterns in vibration signals and compare their findings to how elephants receive and process information.

Engineering Challenge

Students engage in the engineering design process while considering the criteria for success and the limitations imposed by constraints. All students have the opportunity to find creative solutions to a shared problem. For example, in Level K Module 1 students apply their knowledge of the warming effect of sunlight to solve the problem of how to help archaeologists feel cooler when they work.

Application of Concepts

LESSON 7 ENGINEERING CHALLENGE

Task | Engineering Challenge

Phenomenon Question | How can we help archaeologists feel cooler when they work?

OVERVIEW

Previously we developed an understanding of the warming effect of sunlight.

In this lesson we apply our knowledge of the warming effect of sunlight to solve a problem during an Engineering Challenge. We start by identifying a problem and wondering how we could help archaeologists feel cooler when they work. Using the engineering design process, we build a model of a shelter that would protect archaeologists working at a dig site from the warming effects of sunlight. We conclude that shelters are designed for many purposes, including protection from weather.

Later we analyze weather data to determine whether we notice patterns.

Lesson Objective

Define a problem (SEP.1) caused when **sunlight warms Earth's surface (PS3.B)**, and **record observations (SEP.4)** of a **solution (ETS1.A)** that includes a **shade structure that can block sunlight (CC.6)**.

Performance Descriptors

Part 1: **Define the problem of (SEP.1)** archaeologists feeling **too warm (CC.3)** in **the sunlight (PS3.B)**.

Part 2: **Record observations (SEP.4)** of a **roof structure that could function (CC.6)** to **provide shade (ETS1.A) when sunlight warms the Earth's surface too much (PS3.B)**.

Part 3: Describe how the **shape and stability of a structure (CC.6)** will help to **solve the problem (SEP.1)** of **sunlight warming a dig site (PS3.B)**.

Part 4: **Record observations (SEP.4)** to determine how well **the shape and stability of a structure function (CC.6)** to **block the sunlight (PS3.B)**.

Part 5: **Redefine the problem (SEP.1)**, and then **describe how the solution could help (ETS1.A)** an **archaeologist feel cooler (CC.3)** while **working outside in the sunlight (PS3.B)**.

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Level K Module 1

Materials Kits

Materials kits with consumable and non-consumable supplies are available by module or level and designed for 24–32 students. K–2 kits contain special Great Minds® tools, such as Knowledge Deck™ cards and posters (available in English and Spanish), combining carefully crafted text with engaging images. Students interact and collect knowledge cards during lessons as they learn about different phenomena.

To learn more, visit **greatminds.org/science/phdscience**