Light and Sound

TEACHER EDITION

Student Accessibility
In addition to the student accessibility standards inherent in the way we develop PLTW courses, PLTW supports purposeful student accessibility in the following ways:

Courses supports standard accessibility practices and techniques including the use of video captions, alternative text descriptions, and compatibility with screen readers. (Note: Features may vary based on course development date.) Some of our newer PLTW course developments feature a Student Accommodation section to help support you in adjusting course activities, projects, or problems to be accessible for your students. A non-digital, PDF version of the student course curriculum is available for use in the following classroom situations:

Technology issues.
Students who require a text or print version.
Another circumstance in which student access to digital course curriculum is not feasible or possible.

These course versions are intended to be used only to support student accessibility when access to digital content through Courses is not possible.

Important: Due to its non-digital nature, the PDF version of course curriculum will not feature digital interactivity and tools, embedded media, or any updates made available via Courses during the school year.

Learning Plan *(stage 3)*

Activities (A), Projects (P), and Problems (B)	Knowledge and Skills
Activity 1: Introduction to Communicating with Light and Sound • In this activity students learn about the design process and are introduced to the design problem they will face at the conclusion of the module.	K1, K2, K3, K4
Activity 2: Sound • In this activity students learn how sound travels over distances and is heard by humans. Students also discover the relationship between sound and vibration by exploring a variety of ways to generate sound.	K5, S10
Activity 3: Light • In this activity students learn how light travels over distances and how objects are seen by humans. Students also investigate how objects can be seen only if they reflect available light or if they give off their own light.	K6
Project: Light Investigation • This project is an inquiry experience. The teacher will guide the students to an understanding of the effect that different materials have on a beam of light, including reflection, refraction, the creation of shadows, and color.	K7, S11
Problem: Communicating with Light and Sound Design Problem • In this design problem, students will create a device to communicate over a distance using light or sound with available materials.	K1, K2, K3, S1, S2, S3, S4, S5, S6, S7, S8, S9
Light and Sound Check for Understanding	K5, K6, K7, S10, S11

PLTW LAUNCH

Introduction to the Module

Light and Sound

Teacher Resources

PREFACE

All products created by designers and engineers were created to meet a human need or want. One of the most basic of human needs is to communicate over a distance. In this module, students will investigate light and sound, including vibration from sound waves and the effect of different materials on the path of a beam of light. The students will use a design process to sketch, build, test, and reflect on a device that uses light or sound to communicate over a distance.

Students read about three fictional characters facing a similar design problem. Mylo, Suzie, and Angelina are lost and need to use only the materials in their backpacks to communicate using light or sound.

T

TRANSFER

Students will be able to independently use their learning to ...

1. Evaluate a problem in a novel situation.
2. Apply a step by step design process to solve a problem.
3. Communicate over a distance using light or sound.

U

UNDERSTANDINGS

Students will understand that ...

1. The design process is a step by step method used to guide people in developing solutions to problems.
2. Engineers and designers create new products or improve existing products and technology to meet human needs and wants.
3. Engineers ask questions, make observations, and gather information about a situation people want to change.
4. The shape of an object can help it perform as needed to solve a given problem.
5. Products may be analyzed by comparing objects designed to solve the same problem.
6. Engineers keep and organize all of their work in an engineering notebook.
7. Engineers share their work and get feedback from others during the design process.
8. Light and sound travel over distances.
9. Vibrating materials can make sound, and sound can make materials vibrate.
10. Objects can be seen only if they reflect available light or if they give off their own light.

11. Placing different materials in the path of a beam of light may cause the light to spread out, separate into colors, bounce back, or magnify.
12. Light and sound can be used to communicate over distances.

K

KNOWLEDGE

It is expected that students will ...

- List products created by engineers and designers that meet a human need or want.
- State questions that engineers may ask when gathering information about a situation people want to change.
- Identify the differences between a new object and an improved object.
- Recognize that light and sound travel over distances.
- Describe how we hear sound.
- Describe how we see objects.
- Describe what can happen when different materials are placed in the path of a beam of light.

S

SKILLS

It is expected that students will ...

- Follow a step by step method to solve a problem.
- Examine how other people have tried to solve a design problem.
- Gather information about a situation that people want to change.
- Describe how the shape of a structure helps it function as needed to meet a human need or want.
- Brainstorm possible solutions and select one solution to develop, taking into account strengths and weaknesses of each design.
- Build and test a physical model of an improved object or tool designed to meet a human need or want.
- Collect and analyze data from two models and compare the strengths and weaknesses of how each performed.
- Organize and maintain an engineering notebook to document work.
- Share findings and conclusions with others.
- Discover the relationship between sound and vibration.
- Experiment and document results of placing a variety of objects in the path of a beam of light.

EQ

ESSENTIAL QUESTIONS

1. What are unique properties of light?
2. What are unique properties of sound?
3. How can people communicate over a distance?

Resources

Curriculum Framework

Standards

First Grade Curriculum Revisions

Preparation

Time: 10 instructional hours FOR PLTW ENTIRE COURSE

Note: In preparation for teaching this module, it is strongly recommended that the teacher read the Light and Sound Teacher Resources, including the Understandings, Knowledge, and Skills addressed in the module. The day-by-day plans call for students to access the curriculum using the curriculum course on a tablet.

You may review the **Light and Sound Frameworks** for a three-stage guide to curriculum planning, assessment, and instruction. Each stage is described below:

- **Stage 1: Desired Results**

  The desired results stage identifies what students should know and should be able to do in the course.

  Stage 2: Evidence

  In the evidence stage, teachers can assess the transfer of knowledge in a number of ways. This stage further supports the concept of balanced assessment in the classroom by outlining assessment opportunities for both Assessment OF Learning and Assessment FOR Learning in a PLTW course.

  Stage 3: Planning

  The planning stage is where teachers create learning activities that prepare students to acquire the knowledge and skills outlined in the Stage 1 goals.

Curriculum Revisions

The Launch curriculum is continuously updated to provide content and instructional resources that are current and based on best practices. Significant revisions to the curriculum implemented since the prior release of Launch are documented in the **First Grade Curriculum Revisions**.

PLTW LAUNCH

Activity 1

Introduction to Light and Sound

Teacher Resources

View Student Edition

Equipment

The list below is based on 30 students. The equipment lists in the activities, project, and problem are for one student or student group. Please note that additional resources, such as documents and presentations, may need to be accessed from the curriculum course throughout the module.

APB	Not included in Equipment Kit
Activity 1	• Tablets • Light and Sound Launch Log (1 per student)

Resources

Launch Log Light and Sound

Introduction to Light and Sound

Learning Goals

By the end of this activity, students will be able to …

- List products created by engineers and designers that were created to meet a human need or want.
- State questions engineers may ask when gathering information about a situation people want to change.
- Identify the differences between a new object and an improved object.
- Recognize that light and sound travel over distances.

Preparation

- As part of the activity, the teacher reads the Light and Sound Introduction, which is a fictional story that introduces the problem. The Introduction may be accessed in the curriculum course or printed for students.
- The teacher distributes a Light and Sound Launch Log to each student. All written student work for the module will be completed in this log.

- In Activity 1: Introduction to Light and Sound, students learn about the design process and are introduced to the design problem they will face at the conclusion of the module.
- As part of this activity, the students view the design process video. Students fill in the steps of the design process in their Launch Logs during the presentation.

Activity 1: Introduction to Light and Sound

40 minutes

Introduction

Light and sound can be created naturally or using human-made products. Students will work through a short activity on the tablets to prompt their curiosity about sources of natural and human-made light and sound.

All products created by designers and engineers were created to meet a human need or want. One human need is to communicate over a distance. In this activity, students will be introduced to the design problem they will solve at the conclusion of the module.

Procedure

Fictional Story

1. Read aloud the Light and Sound Introduction. This is a fictional story that describes the problem three friends experience as they are lost and need to communicate with either light or sound.
2. Lead a class discussion about the problems faced by the students. The teacher guides students to identify the need to call for help or communicate with others as the main problem.
3. The students draw a picture of the problem on Page 1 of their Launch Logs.

Design Process

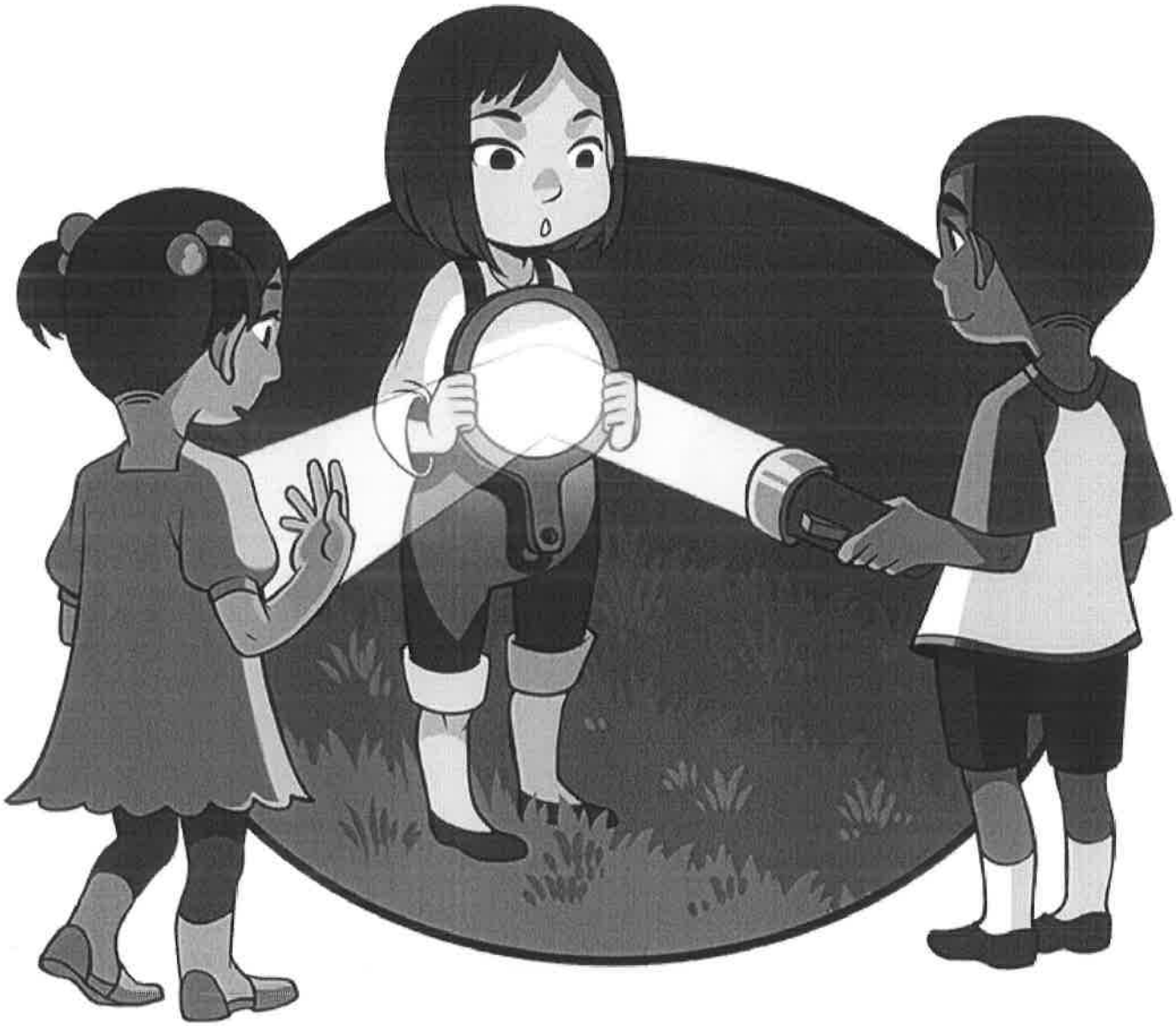
4. Present the design process video entitled *Design Process* located in the student edition of the course. Students fill in the steps of the design process in their Launch Logs during the presentation.

Conclusion Questions

1. What is the problem faced by Suzi, Mylo, and Angelina?

2. If you could give the characters any human-made product to use to get help, what would it be and why?

Introduction to
Light and Sound



PLTW | Launch

Part 1
Preparing for the Hike

Mylo, Suzi, and Angelina were enjoying the warm sunny afternoon while riding their bikes through the park with Angelina's mother. As they rode, the three friends were busy making plans for going on a hike on Saturday.

"I have been wearing my new sneakers to make sure they are comfortable," Suzi shared. "I really don't want to end up with blisters while we are hiking."

"That would not be fun," Angelina added. "I remember getting blisters when my family spent a day at an amusement park. It was painful."

"Have you guys started packing your backpack yet?" asked Mylo.

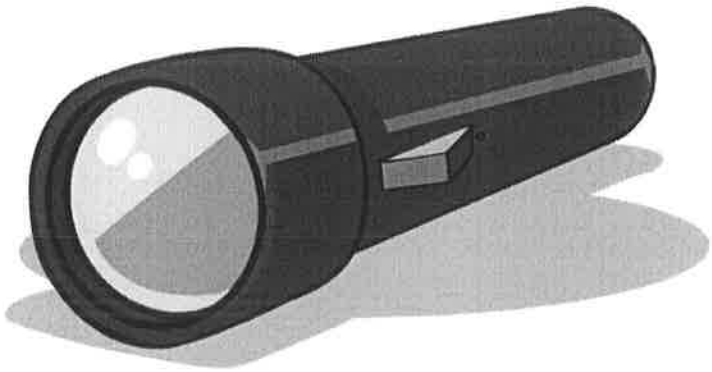
Mylo's parents had prepared a list of supplies to help everyone know what they would need to pack for their hike.

Hiking List:

- Backpack
- Comfortable Walking Shoes
- Water Bottle
- Bandana
- Rain Jacket
- Snack
- Flashlight

Suzi, Angelina, and Mylo talked about the items on the list and why they might need each one.

"I don't really understand why we need to bring a flashlight," Angelina stated. "We plan to be back before it gets dark."



"My dad says that you need to always be prepared in case something happens that you weren't expecting," Mylo responded.

Suzi's excitement about hiking showed as she told her friends about what she had packed for the hike.

"I agree with your dad, Mylo," Suzi said. "You never know what might happen when you are in the forest. I have all of the items on the list plus some other things I wanted to bring. I have a mirror, some tape, and a bunch of other

things I found in my bedroom."

Angelina said, "Suzi, your backpack is going to be heavy if you keep adding things. We'll know who to find if we need anything."

Mylo just laughed at the thought of Suzi carrying a heavy backpack up the trail. He wanted to be prepared for the hike, but he didn't want to have a heavy backpack to carry around all day.

Part 2
The Day of the Hike

On Saturday morning Suzi woke up very early. Today was finally the day of the hike. Suzi jumped out of bed, ran down the stairs, and started looking for her family. Everyone was still asleep. She decided to start getting dressed and make sure her backpack was ready to go.

At 8:00 Suzi's mom called everyone to help with breakfast and getting snacks ready for the hike. Mylo's parents had planned the trip for some of the families in their apartment building.

"Does everyone have their backpack ready?" Suzi asked as they sat down for breakfast.

"Suzi's backpack has been ready since Wednesday," her father announced.

"Mr. King said we need to be prepared," Suzi responded.

"I know, Suzi," Mr. Chin teased. "I can always count on you to make sure everything is ready to go."

Mrs. Chin added, "Suzi, your backpack seemed heavy when I sat it on the counter. What did you bring?"

"Well, I brought everything on the list and some other things from my bedroom," Suzi answered. "I wanted to make sure I had everything I might need."

As soon as the breakfast was over and the dishes had

been put away, Mr. Chin began to organize the rest of the family's backpacks for the hike. Since the group would eat lunch at the picnic area before the hike, Suzi and her mother packed the family's lunch. Suzi thought that 10:00 would never come.

Part 3
The Hike

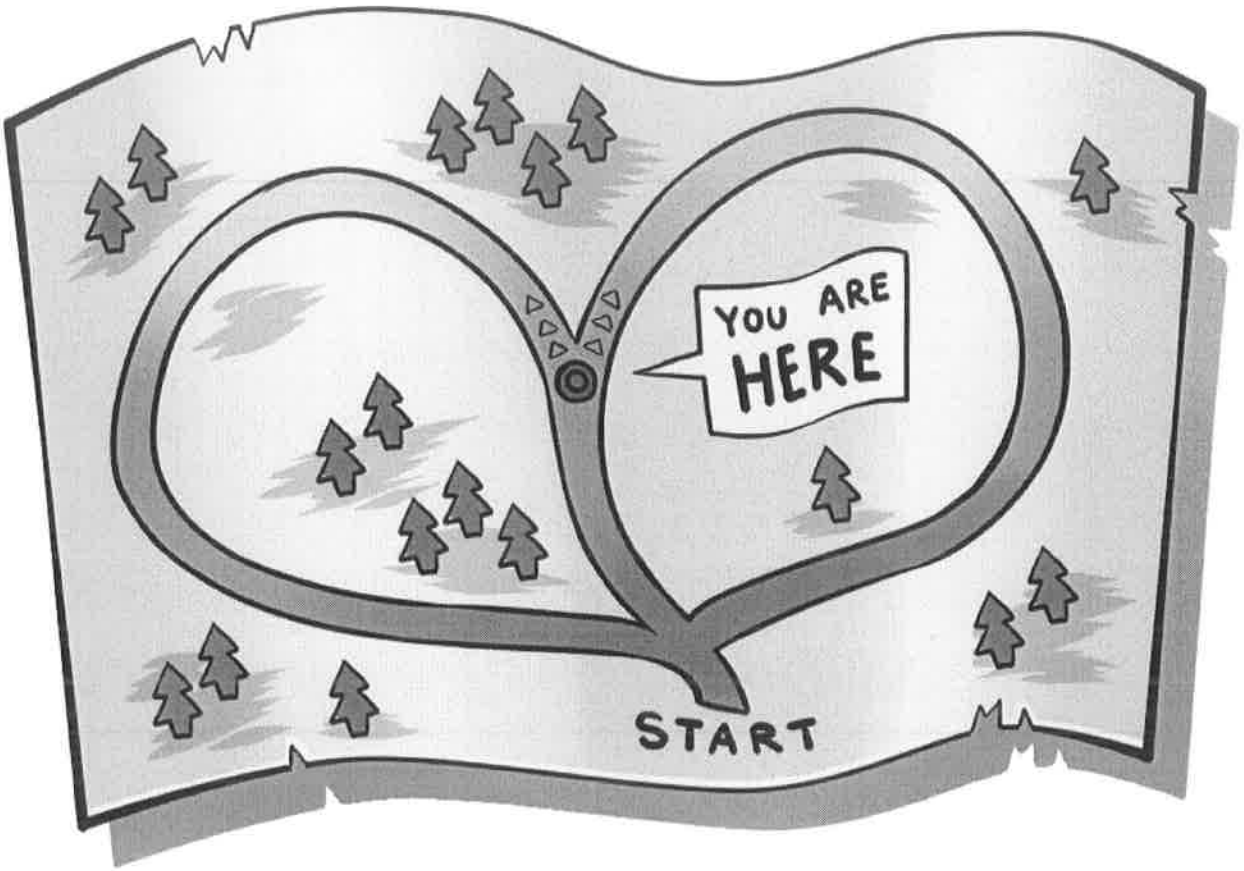
When the families finally made it to the National Park, it was time for lunch. Suzi, Mylo, and Angelina sat together and talked about all of the things they hoped to see on the trail. Soon Mr. King was calling the group together to give instructions for the hike.

"This is a beautiful trail with lots of wildflowers and trees. We may even see a bit of wildlife along the way," Mr. King began.

Soon they were on their way. The three close friends stayed together near the front of the group with Mr. King. They didn't want to miss anything along the way.

After an hour the group stopped by a stream to have a snack and enjoy splashing in the cold mountain stream. Angelina, Suzi, and Mylo talked about the amazing things they had seen: three deer, a rabbit, beautiful flowers, and trees that seemed to reach the sky. The day seemed just perfect.

Later in the afternoon, the group came to a place where the trail split into two trails. From the map it looked as if the trails would both lead back to the starting point. Mr. Chin and another one of the dads decided that they would take a small group on a different path and see who made it back first.



Angelina, Mylo, and Suzi were excited about their adventure. After walking for about 45 minutes, Mr. Chin noticed that the trail was starting to climb the mountain rather than traveling down the mountain. They found a trail that was leading down and decided to take it. Very soon Mr. Chin realized the path was coming to an end.

The adults decided that the best strategy would be

to stay put rather than continue in the wrong direction. They knew they were close to where they needed to be, but they didn't know how to get there. Mr. Chin knew that when they did not return to the starting point, Mr. King would soon realize there was a problem.

At first the children enjoyed trying to find interesting things around them, but they soon grew tired of just sitting.

"I am hungry," Angelina said. "Does anyone have another snack?"

Suzi opened her backpack and found two more granola bars.

"Of course! I knew you would have something in that heavy backpack," Angelina said.

As the men realized that sunset would be coming in a

a few hours, they started working on a plan.

Mr. Chin asked the group, "Let's see what we have that might be helpful if we need to try to make contact with the other group."

"We all have flashlights," Mylo answered. "The hard part will be getting the light to be seen from a distance because there are so many trees."

Angelina added, "Remember how we have been learning about how light and even sound can travel over distances? We need to find a way to get the light or maybe a sound to be heard by others."

"I know everyone thought it was funny that I had so

much in my backpack," Suzi began. "But I think there might be some useful things. I have a mirror, some masking tape, a tennis ball, and some string."

Suzi's dad said, "I don't think we can use all of that, but some of those extra items might be useful."

"Mirrors are a good way to reflect light," Mylo added.

"Maybe we can put together a plan to use light to get the attention of another group on the trails," Mr. Chin responded.

"Our water bottles are metal. They could be used to create loud sounds," Angelina shared.

"Let's come up with a plan in case we are stuck here for a while," Mr. Chin told the group.

If you were with Angelina, Mylo, and Suzi, how would you help them communicate over a distance to get help?

PLTW LAUNCH

Activity 2

Sound

Teacher Resources

View Student Edition

Equipment

The list below is based on 30 students. The equipment lists in the activities, project, and problem are for one student or student group. Please note that additional resources, such as documents and presentations, may need to be accessed from the curriculum course throughout the module.

APB	Included in Equipment Kit	Not included in Equipment Kit
Activity 2	• Plastic cups (2 per group) • String (4 feet per group) • Paper clips (2 per group) • Plastic cups (2) • Square containers (2) • Rubber bands (2 sets of 3 different sizes) • Tape (optional) • Metal water bottles (3) • Stethoscopes (2) • Alcohol wipes • Aluminum tuning forks (2) • Plastic cups with water (2) • Metal Slinky® coil (1) • *The Energy We See: A Look at Light* by Jennifer Boothroyd	• Tablets • Light and Sound Launch Logs

Learning Goals

By the end of this activity, students will be able to ...

- Describe how we hear sound.
- Discover the relationship between sound and vibration.

Preparation

- The teacher introduces students to the curriculum course and assists students with the login process. For the remainder of the module, students will access Activity 2: Sound in the curriculum course and record their work in the Light and Sound Launch Log.
- In Activity 2: Sound, students learn how sound travels over distances and is heard by humans. Students also discover the relationship between sound and vibration by exploring a variety of ways to generate sound.

- In pairs or small groups, students access the Exploring Sound link on the Light and Sound Activity 2 page.

Activity 2: Sound

120 minutes

Introduction

In this activity students will learn how sound travels over distances and is heard by humans. Students will also explore the relationship between sound and vibration by analyzing a variety of ways to generate sound.

Procedure

Exploring Sound

1. In pairs or small groups, students access the **Exploring Sound** link on the Light and Sound Activity 2 page.
2. Students work through Exploring Sound and draw a picture demonstrating how we hear sounds in their Launch Logs.

Sound Stations

3. In pairs or small groups, the students visit three different stations and use the equipment to create sound at each station. Stations 1 and 2 can be set up twice to spread the students out around the room if desired. Alternately, the stations may be completed as whole class activities where the teacher demonstrates and students mimic. The above equipment list provides enough materials for two sets of stations 1 and 2 and one set for station 3.
4. Explain and demonstrate each of the stations to the class before the rotations begin. The students should have 10 – 15 minutes to explore each station and answer the related question in their Launch Logs. The teacher will guide students to either draw a picture to answer the question or write their response in their Launch Logs on pages 4 – 6.
    - Station 1
        - Equipment: 2 square containers, 6 rubber bands (2 sets of 3 different sizes)
        - Prepare one container with 3 different rubber bands wrapped around the container vertically so students can pluck the rubber bands at the top opening of the container.
        - Prepare one container with 3 different rubber bands wrapped around the container horizontally so when plucked the rubber band snaps against the side of the container.
        - Note: The rubber bands may be secured with tape if they slip off the container.
        - Related question: What did you do to get a sound from the rubber bands?
    - Station 2:
        - Equipment: 3 metal water bottles
        - Students can experiment with water bottles to determine how to make sound.

Students may attempt to tap the side of the bottles with their fingers, tap bottles on the table, or tap bottles against each other.
    - Related question: What did you do to get a sound from the metal water bottles?
- Station 3:
    - Equipment: Stethoscope and alcohol wipes
    - Students will take turns listening to their own hearts with the stethoscope. An adult will assist students with cleaning the ear pieces between each student use. If the students cannot hear their heartbeat, they may need to jog in place or complete another activity to raise their heart rate so it may be heard through the stethoscope.
    - Note: Depending on the classroom space the stethoscope station may need to be run in a quieter space or at a separate time from stations 1 and 2.
    - Related questions: What did you hear when you held the stethoscope to your chest? How did the sound travel to your ear?

5. Students record their responses in their Light and Sound Launch Logs.
6. If desired, the students can explore the stations and answer the questions in Part 2 as a class in their Launch Logs instead of responding during their exploration.

Sound and Vibration

7. Demonstrate sound and vibration with tuning forks by following the steps below:
    - Holding the tuning fork by the handle, strike the tines against a solid surface such as the palm of your hand.
        - This will cause the fork to begin vibrating and create sound.
        - Discuss with the students the timing of when they heard the sound. Could they hear the sound before the tuning fork began vibrating? Why not?
        - Demonstrate that sound is only created when the fork is vibrating after being struck.
    - Strike the tuning fork again and hold the tines on top of the water in the cup.
        - Students should observe the splashing and movement of the water as evidence that the tines are vibrating.
    - Strike the tuning fork again and hold it next to, but not touching, another tuning fork that is the same pitch. This fork will begin vibrating and generating sound.
        - Discuss this with the students. They should infer that the sound from the first tuning fork caused the second one to begin vibrating and creating sound.
    - (Optional) Allow the students to experiment with the tuning forks as they pass them around. They may hold the fork to their skin gently to feel the vibrations, hold the fork close to their ear, and try the water demonstration on their own. Remind students that to hear the sound from the tuning fork they will need to tap the fork, wait, and listen.
8. Demonstrate how sound travels using a metal Slinky coil.
    - Have a student volunteer hold one end of the coil and stretch across a table.
    - Quickly push the end of the Slinky coil while holding it to show the pulse moving from one end of the coil to the other.
    - Discuss with students how this is similar to or different from:

- The way the vibration traveled from the tuning fork to the students' ears.
- The way the vibration traveled from one tuning fork to the other.

9. Lead the students through the following steps to build and test a cup phone with a partner.
10. Build:
    - Equipment per pair: 2 plastic cups, 4 feet of string, 2 paper clips
    - The teacher may wish to punch a hole in the bottom of each cup with a paper clip or pen. The hole should be just large enough for the string to fit through.
    - Students tie a knot at the end of the string. Students may wish to tie the string to a paper clip to adequately hold the knot.
    - Thread the string through the hole in the bottom of one of the cups so the knot is on the inside of the cup.
    - Thread the end of the string through the bottom of the second cup and tie another knot inside the second cup.
11. Test:
    - To test phones, one student will speak into one cup while their partner holds the other cup to his or her ear.
    - Students will test their phone by pulling the string tight and speaking. Next students will allow the string to hang loose while they speak. Guide them through the remaining questions in their Launch Logs:
        - Does your phone work better when the string is pulled tight or when it hangs loose?

Teacher Only

The phone will work better when the string is pulled tight because it is easier for the string to vibrate and carry sound when pulled tight.

        - Hold the string when you talk. Is it easier or more difficult to hear? Why?

Teacher Only

It is more difficult to hear. In fact, sound may not be heard at all because holding the string causes the vibration to stop and sound cannot travel. This is similar to the tuning fork demonstration: when the tines were touched, the sound stopped.

Conclusion Question

1. What other objects make sound similar to plucking the rubber bands?

Teacher Only

Some possible answers include a guitar or violin.

2. What other objects make sound similar to plucking the rubber bands?

Teacher Only

Some possible answers include water or air.

3. How is sound used to communicate over distances?

Teacher Only

Some possible answers include sirens on emergency vehicles, phones, intercoms, etc.

PLTW LAUNCH

Activity 3

Light

Teacher Resources

View Student Edition

Equipment

The list below is based on 30 students. The equipment lists in the activities, project, and problem are for one student or student group. Please note that additional resources, such as documents and presentations, may need to be accessed from the curriculum course throughout the module.

APB	Included in Equipment Kit	Not included in Equipment Kit	Tablet Applications

Activity 3	• Flashlights (1 per group)
	• Colored lens sets (1 per group)
	• Handheld safety mirrors (2 per group)
		• Tablets
		• Light and Sound Launch Logs
		• Paper and tape or small reward stickers (optional)
			• Teacher tablet with Bobo Explores Light app (optional, iPad only)
			• One of the following:
			  ◦ Popplet Lite
			  ◦ Mindomo
			  ◦ Lensoo Create

Learning Goals

By the end of this activity, students will be able to …

- Describe how we see objects.

Preparation

- In Activity 3: Light, students learn how light travels over distances and how objects are seen by humans. Students also investigate how objects can be seen only if they reflect available light or if they give off their own light.
- As part of the activity, the students view a presentation entitled Exploring Light. This presentation may be viewed as a large group, in small groups, or as individuals as the teacher determines.
- Additional information on light is provided in the book by Jennifer Boothroyd entitled *The Energy We See: A Look at Light.*
- (Optional. App available for iPad only.) The teacher may wish to lead students through the iPad app entitled Bobo Explores Light to reinforce key concepts related to light.
- At the conclusion of the activity, students create a presentation using an app such as Popplet

Lite, Mindomo, or Lensoo Create to explain how we see objects.

Activity 3: Light

120 minutes

Introduction

In this activity, you will lead the students through an introduction to light as they view a presentation. Students will then explore the differences between light and dark.

Procedure

Exploring Light

1. Present the presentation entitled Exploring Light found in the curriculum course in Activity 3: Light. Alternately, students may access this presentation in pairs or small groups.
2. As you work your way through the presentation, students will take notes and draw sketches in their Light and Sound Launch Logs.
3. Follow the steps below with your students as you work through these sections found within the presentation:
    - The Sun
        - Read the introduction and discuss with your students. They will count and record the number of lights they see in the classroom.
    - Lightning
        - Read the introduction and discuss with your students. Ask them if they have seen lighting and what it looks and sounds like.
        - Click on the continue button to learn more. Students answer the following questions either individually or as a class:
            - How far away did lightning strike if you hear thunder 5 seconds after you see the spark?

> **Teacher Only**
>
> 1 mile

            - How long would it take to hear thunder from a lightning strike 2 miles away?

> **Teacher Only**

10 seconds

- Shadows
  - Read the introduction and discuss with your students.
  - Guide the students to draw a picture of the sun, themselves, and the shadow their body creates. You may also have them add other sources of light such as fire or lightning.
- Reflection
  - Briefly discuss how mirrors work, and then have the students answer the question in their Launch Log under the Reflection section.
    What would make the best mirror: ice, sand, or a leaf? Why? (Ice, because it has the smoothest surface for light to bounce off of.)
- Color
  - Read the introduction to the students and lead a demonstration with the flashlight and the red, green, and blue colored lenses. Ask students to identify what colors they see as the lights are mixed together.
  - Students answer the following question in their Launch Log:
    What color do you see when the colors red, blue, and green are mixed together? (White)
    Note: students will explore separating white light into the colors of visible light later in the module.
- The Human Eye
  - Read the introduction and discuss with your students.
  - Discuss with the students that it is the incoming light bouncing off of the object that enters the girl's eye and allows her to see the object.
  - Students complete the following statement in their Launch Logs: "We see an object when light bounces off of it and enters our eye(s)."

Light and Dark

1. Now that the students have been introduced to basic concepts of light, they will apply this knowledge to understanding why we cannot see an object in total darkness if that object does not produce its own light.
2. Tape a small piece of paper to each child's palm. Small stickers or pieces of sticky notes may also be used for this activity.
3. Have the students describe the paper in their hand.
4. Ask students to hold their hands together close to their eye so only a small amount of light is able to enter.
5. Have students close their hands tightly so no light enters their hands.
6. Lead a discussion on whether students could see the paper in total darkness. If students could

not see the paper, where did it go?

Conclusion Questions

1. Why can you not see objects in total darkness?

Teacher Only

Students should include an explanation of why we cannot see objects in total darkness and explain that light must bounce off an object into our eyes for us to see the object.

Guide students to create a digital presentation to explain how we see objects. Students can make a simple video response using the tablet's camera or they can prepare a digital presentation using Lensoo Create, Popplet Lite or Mindomo on their tablets.

PLTW LAUNCH

Project

Light Investigation

Teacher Resources

View Student Edition

Equipment

The list below is based on 30 students. The equipment lists in the activities, project, and problem are for one student or student group. Please note that additional resources, such as documents and presentations, may need to be accessed from the curriculum course throughout the module.

APB	Included in Equipment Kit	Not included in Equipment Kit
Project	• Flashlights (1 per group) • Colored lens sets (1 per group) • Handheld safety mirrors (2 per group) • Spectroscopes (2 per group)	• Tablets • Light and Sound Launch Logs • White paper as a backdrop or white blank wall (not a reflective surface such as a dry erase board) • Crayons or colored pencils (red, orange, yellow, green, blue, purple)

Learning Goals

By the end of this project, students will be able to …

- Describe what can happen when different materials are placed in the path of a beam of light.
- Experiment and document results of placing a variety of objects in the path of a beam of light.

Preparation

- Throughout the project, students describe the effect that different materials have on a beam of light and predict the effect of novel objects on a beam of light.
- The students access Project: Light Investigation assignment in the curriculum course and document their work as they follow the steps of the design process in their Light and Sound Launch Log.

Project: Light Investigation

120 minutes

Introduction

This project is an inquiry experience where students investigate and document the results of placing a variety of objects in the path of a beam of light. As a result of their investigation, students will be able to describe the effect that different materials have on a beam of light, including reflection, refraction, the creation of shadows, and color.

Procedure

1. Students will work in teams to complete this investigation. The materials listed above will equip 6 teams at one time.
2. Each team will need the following:
    - 1-3 Flashlights
    - 1 White paper to use as a backdrop
    - 2 Mirrors
    - 1 Set of 4 colored lenses (RGBY) or 1 set of 3 color filters (RGB)
    - 2 Spectroscopes or 1 diffraction grating per person
3. Students will place each object in the beam of light with a white paper behind the object and make observations. They will record their findings in the Light and Sound Launch Log.
4. Guiding questions, prompts, and expected results are listed below:
    - Mirror
        - The teams are supplied with two mirrors. Students should discover the basic understanding that light is reflected off of the mirror.
        - Students may also experiment with both mirrors and attempt to reflect the light from one mirror to the other.
        - The student's drawing should have light bouncing off of the mirror and not going through.
    - Hand
        - The student's hand will block light and therefore create a shadow.
        - The student's drawing should show light hitting the hand and possibly a shadow behind it.
    - Colored Lenses
        - The colored lenses are transparent and only allow a specific color through; therefore, the light that passes through is the color of the lens.
        - The student's drawing should show light going through the colored lens and the same color light coming out.
    - Spectroscope or Diffraction Grating
        - Students further explore refraction by viewing natural and man-made light through a spectroscope or diffraction grating.
        - Students look through the spectroscope or diffraction grating at classroom and natural light and view the rainbow of colors created by the diffraction gradient. Caution: Warn students not to look directly at the sun or any light source.

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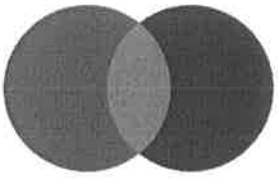
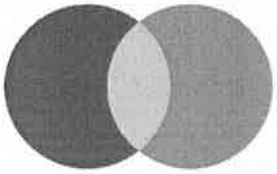
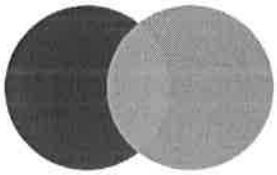
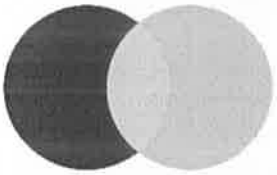
- Color Investigation
  - Students explore the color of light created as light passes through two or three colored lenses.
  - Students place a flashlight on top each colored lens (filter) holding it about six inches above a white sheet of paper and move the circles together so they overlap slightly. Students color the image they see in the circles next to the statements.

Red + Blue = Magenta	
Red + Green = Yellow	
Blue + Green = Cyan	
Blue + Yellow = White	

Conclusion Questions

1. What other objects reflect light like the mirror?

Teacher Only

Use this pattern to add teacher annotations to student content examples.

2. What else can you think of that splits light like the prism?

Teacher Only

Possible answers include water droplets in a rainbow or crystal glassware.

3. How is light used to communicate over distances?

Teacher Only

Possible answers include flashing lights on emergency vehicles, lighthouses for ships, and lights on an airport landing strip.

PLTW LAUNCH

Problem

Communicating with Light and Sound

Teacher Resources

View Student Edition

Equipment

The list below is based on 30 students. The equipment lists in the activities, project, and problem are for one student or student group. Please note that additional resources, such as documents and presentations, may need to be accessed from the curriculum course throughout the module.

APB	Included in Equipment Kit	Not included in Equipment Kit	Tablet Applications

Problem	• Flashlights (1 per group)
	• Handheld safety mirrors (1 per group)
	• Metal water bottles (1 per group)
	• Bandanas (1 per group)
	• Plastic cups (2 per group)
		• Tablets
		• Light and Sound
		• Launch Logs
		• Masking tape
			• One of the following:
			  ◦ Popplet Lite
			  ◦ Mindomo
			  ◦ Lensoo Create

Learning Goals

By the end of this problem, students will be able to …

- List products created by engineers and designers that were created to meet a human need or want.
- State questions engineers may ask when gathering information about a situation people want to change.
- Identify the differences between a new object and an improved object.
- Follow a step by step method to solve a problem.
- Examine how other people have tried to solve a design problem.
- Gather information about a situation people want to change.
- Describe how the shape of a structure helps it function as needed to meet a human need or want.
- Brainstorm possible solutions and select one solution to develop, taking into account strengths and weaknesses of each design.
- Build and test a physical model of an improved object or tool designed to meet a human need or want.
- Collect and analyze data from two models and compare the strengths and weaknesses of how each performed.
- Organize and maintain an engineering notebook to document work.
- Share findings and conclusions with others.

Preparation

- In this design problem, students will create a device to communicate over a distance using light or sound with available materials.
- The students access the Problem: Communicating with Light and Sound assignment on the curriculum course and document their work as they follow the steps of the design process in their Light and Sound Launch Log.
- At the conclusion of the activity, students create a presentation using an app such as Popplet Lite, Mindomo, or Lensoo Create to explain how we see objects.
- Optional: Guide students to view the Design Process video before you begin working through the problem.

Problem: Communicating with Light and Sound

200 minutes

Introduction

In this design problem, students will create a device to communicate over a distance using light or sound with available materials. At the beginning of the module, students were introduced to the problem through fictional characters Angelina, Suzie, and Mylo. The three friends are on a hike with their classmates and become separated from the group. As evening falls, the students must communicate with the rest of the class using only available items. This includes a flashlight, mirror, water bottle, bandana, masking tape, and plastic cups.

Students will follow the design process and document each step in their Launch Log as they solve the design problem of communicating over a distance using light or sound.

Procedure

1. Remind students that their design problem is to work in a team to design, create, and evaluate a device to communicate across a distance using light or sound. To be successful, the students must be able to signal for help across a distance. The length may be determined by the teacher and may be across a classroom or a larger outdoor area.
2. The students document their work as they follow the steps of the design process in their Light and Sound Launch Logs.
3. **Ask**
    - Guide a discussion where students **Ask** questions to gather information that will help them define the problem.
    - Students may ask questions about available materials or why the students would want to communicate with the rest of the group.
    - Students write or draw the problem faced by the group of fictional characters under the **Ask** section of the engineering notebook.
4. **Explore**
    - Allow students to **Explore** ideas by talking in small groups about possible ideas for a communication device. Remind students that during this part of the process, no ideas are too silly.

- Using the Launch Log as a guide, have students sketch ideas for their communication device using pencils, crayons, or colored pencils.
- Allow students to examine the available materials that they can use to create their devices. Items may be displayed on a table for students to observe or held up in front of the group one at a time. The teacher may also wish to place a set of each of the items in a backpack or other bag for each team.
- Note: The list of items included in the fictional story include: a backpack, comfortable walking shoes, water bottle, bandana, rain jacket, snack, and a flashlight. The fictional characters chose to add items to their backpacks before they went on the hike including a mirror, tape, and plastic cups. The teacher may choose to allow students additional materials for the creation of their communication device or may limit students to communicating with either light or sound.

5. **Model**
   - Ask the students to circle their best design; this is the one that solves the problem of communicating over a distance using light or sound the best.
   - The teacher facilitates the creation of the communication devices.
   - Students document their models in their engineering notebooks by drawing the final version of the device under the heading **Model**.
   - The students will use the iPad® tablet to photograph the device.
6. **Evaluate**
   - Students test their communication devices to see if they can communicate over the distance set by the teacher. The students can also compare their device with another group and discuss how each group solved the problem.
   - Students record their findings in their engineering notebooks. Additionally, students explain one strength and one weakness of their model. If these terms are too advanced for the students, the teacher may ask them to write or draw one good thing about their design and one thing they would like to change about their design.
7. **Explain**
   - Students open an app such as Popplet Lite, Mindomo, or Lensoo Create to create a graphic explaining their device.
   - Students use the app to take a photo of their device in action and either write or draw over the top of the image to explain how the device works.
   - The students use this image and explanation to present their device to the class.
8. Lead a discussion on the features, strengths, and weaknesses of the different communication devices.

Conclusion Questions

Note: The Conclusion Questions may be for discussion only and documented as a class. Alternatively, the teacher may choose to record student responses with the video camera on the tablet.

1. Now that you have seen other communication devices and how other students used the materials, what would you do differently if you were allowed to start all over again?

2. What other materials do you think would work well to communicate over a distance using light or sound?

Check for Understanding

Teacher Resources

At the conclusion of the module, the students complete the Light and Sound Check for Understanding. Answers are provided in the Check for Understanding Key. Note that student work may vary.

Resources

Light and Sound Check for Understanding

Light and Sound Check for Understanding Answer Key