



Echolocation and SONAR: Speed of Sound¹

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Students explore the speed of sound by experiencing the delay for sound to reach them when they know a noise has been made. They will explore what it feels like to identify objects from a distance.

Science Topics	Process Skills	Grade Level
Echoes	Observing	1-12
Echolocation	Predicting	
Speed of sound	Scientific Inquiry	
	Comparing	
	Classifying	
	Communicating	

Time Required			
Preparation	Set-Up	Activity	Clean-Up
See advanced preparation	15 minutes	45 minutes*	10 minutes

*345 minutes leave enough time to get to and from the field and do the activities. If you're escorting younger children, the activity may take up to 50 minutes.

Learning Goals

Students will be able to...

- Describe that there is a delay between when they see a sound happen and when they hear it
- Name several animals that use echolocation and SONAR to find food or objects
- Describe the limits of the size and distance that dolphins and bats can echolocate

Materials	
In the Kit	Not in the kit
Worksheet (page 5) for each student	Additional Supervision*
	A very large field, 200 yards or bigger (twice a football field)
	A rock and a metal post
	7 different objects
	6 landscaping flags (or other markers)

*Since students will be outside and spread out, you might want to have extra supervision.

Advanced Preparations

Gather materials (see list above).

Set-Up

Label the 7 different objects with numbers 1-7. Set up the field with landscaping flags (or other eco-friendly markers) every twenty large paces (or every 20 meters) from the metal pole

¹ This activity can stand-alone or be done in correlation with the Echolocation Indoors activity.

until you reach 100 meters, then place the last marker at the 200-meter mark. Leave that rock, and 7 objects next to the metal post.

Introduce the Activity

Students will answer question 1 in their packets to get them thinking about the speed of sound. Explain that the class will be going outside for the remainder of the activity. You should also identify any safety concerns that may exist.

Doing the Activity

Speed of Sound

1. The class will travel to the field set up with the markers. Have the students stay 200 feet away from the metal post.
 - a. Ask the class why you think you can see fireworks before you can hear the boom.
2. The assistant should walk to the metal post that's 200 meters away from the rest of the class (the length of two football fields). It's very important to be this far away to show the delay of sound.

NOTE: We tried 100 meters and the delay wasn't large enough.

3. With a large, visible arm motion, the assistant will strike the metal post with a rock. The assistant should do this at least 10 times. It's helpful to prearrange a signal for the assistant to know when to stop hitting the post.
4. Discuss the following questions with the class:
 - a. Do you hear the sound at the same time that you see the rock hit the post?
 - b. Why do you think this is?
 - c. How can you tell how far away lightning is?
5. Briefly demonstrate the calculation for the speed of sound. The speed of sound in air in Colorado is about 750 miles per hour. Calculate how many seconds it takes sound to travel 1 mile (time = distance/speed).

speed (v) equals distance over time. $v = \frac{x}{t}$

$$\text{so } t = \frac{x}{v} = \frac{1 \text{ mile}}{750 \text{ miles per hour}} = 0.00133 \text{ hours}$$

$$0.00133 \text{ hour} \frac{3600 \text{ seconds}}{1 \text{ hour}} = 4.8 \text{ seconds} \sim 5 \text{ seconds}$$

Sound take about 5 seconds to travel 1 mile in air

This is where the rule of thumb comes from that says for every five "one-thousands" that you count, the lightning is a mile away from you.

Identification from a Distance

1. Students should go to a point that is 100 meters away from the metal post, halfway across the field. They should each have the Identification from a Distance chart (page 5) and a writing utensil.
2. Explain that at this distance – using echolocation – a dolphin can identify small fish just 6 inches in length and some bats can identify a certain type of moth with a 1.25-inch wingspan!
3. While the students are still 100 meters away, the assistant will hold of the 7 objects one at a time, in order. Students will look at each object and try to discern what each one is and write down their best guess on the chart, even if it’s just the color. After they have done this for all 7 objects from 100 meters away, students will up to the 80-meter mark and repeat the process. Then the same for 60 meters, 40 meters and 20 meters. The assistant should hold up the 7 objects in the same order each time.
4. As soon as the students think they know for sure what the objects are, they will circle the word in their chart under that distance.

For example, they figure out object 1 is a fish at 40 meters, circle the word “fish” in the 40- meter column.

Item	100 meters	80 meters	60 meters	40 meters	20 meters
1	blue	blue stick	blue toy	blue fish	

Fish Finding Game

1. Groups of 8-10 students will work together for this activity. One student will be a dolphin, 3 will be fish, and the rest will be objects
 - The dolphin **must** keep their eyes closed the whole time.
 - Objects are to lay, sit or stand in one place.
 - Fish move around **slowly**, winding in and out of objects.
2. The dolphin tries to locate fish while avoiding objects
 - The dolphin makes a sound, “beep,” and any object or fish in front of the dolphin is required to respond.
Objects will say, “object”
Fish will say, “fish”
 - When a Fish is tagged, that fish becomes a dolphin, and the dolphin becomes a fish.

NOTE: If the dolphin is having trouble locating fish, or if the fish are misbehaving, have the fish move one step per beep or have them stand still.

3. After playing the game, students should answer questions 7 and 8.

Explanation

In-depth background information for teachers and interested students.

Key Lesson Terminology

- Echoes – reflections or repetitions of sound waves. Echoes can be produced and heard by clapping hands or shouting in a large empty room with hard walls or in a cave for example.
- Echolocation – a method used to detect objects by producing a specific sound and listening for its echo.
- Speed of Sound – the speed at which sound travels. This is very important for scientists who study sound. In air, sound travels 343 meters in 1 second (747 miles per hour), but in water, sound travels 1500 meters in 1 second (3350 miles per hour). compare these speeds to cars traveling on the highway at 65 miles per hour.
- SONAR – Sound Navigation And Ranging, is the process of listening to specific sounds to determine where objects are located.

Optional Extensions

- If there is extra time, students can switch roles in the Fish finding game and play from a new perspective
- Complete the Sound Not Sight activity
- Complete Echolocation Part 2

Modifications

Hard of hearing students will not be able to tell the difference between when they see the rock hit and when the sound reaches the class, so other students could raise hands when they hear the sound. This way the student can still tell that there is a difference between when a sound is created and when it reaches a specific location.

Younger students will not fill out the worksheets as they complete the activity.

Supplemental Materials

Worksheet below.

Echolocation and SONAR

Speed of Sound

Name: _____

Echoes

Quick fact: *Dolphins can make out an echo only 3 meters or 15 feet from an object. The speed of sound in water is 4.5 times faster so the echo is 4.5 times sooner!!*

Speed of Sound

1. Why do you think you can see fireworks before you hear the boom?

Stand the farthest point from your instructor and listen while your instructor hits a metal post with a rock. We will be set up 200 meters (approximately 200 yards) apart – that's two football fields.

2. Do you hear the sound at the same time that you see the rock hit the post?

3. Why do you think this is?

4. How can you tell how far away lightning is?

5. The speed of sound in air is about 340 meters per second or 750 miles per hour. Calculate how many seconds it takes sound to travel 1 mile (time = distance / speed).

Identification from a distance

Move halfway towards your instructor (100 meters away). *At this distance – using echolocation - a dolphin can identify small fish (6 inches in length) and some bats can identify a certain type of moth (1.25-inch wingspan).*

6. Identify the objects being hold up and fill in your best guess, even if it’s just the color. Circle the object when you “know” you have it figured out. For example, at 40 meters if you figured out that one object is a fish. In the 40-meter column circle the word fish.

Once you’ve seen all 7 objects, move up to the next marker which will be 80 meters. Identify the 7 objects again. Etc...

Item	100 meters	80 meters	60 meters	40 meters	20 meters
1					
2					
3					
4					
5					
6					
7					

Quick Facts: *A bat can identify a mosquito within 3 meters (15 feet)!*

Fish finding

One person is the dolphin, the rest are objects or fish

- The dolphin **must** keep their eyes closed (no cheating!!).
- Objects are to lay, sit or stand in one place.
- Fish move around *slowly* winding in and out of objects.

The dolphin tries to locate a fish.

- The dolphin makes a sound, “beep” and any object or fish in front of the dolphin is required to respond.
- objects will say, “object”, and
- Fish will say, “fish”.

Once the dolphin touches a fish, that fish becomes the dolphin.

7. What can the dolphin do to make their job of fish finding easier?
8. Does it help if they beep more often?