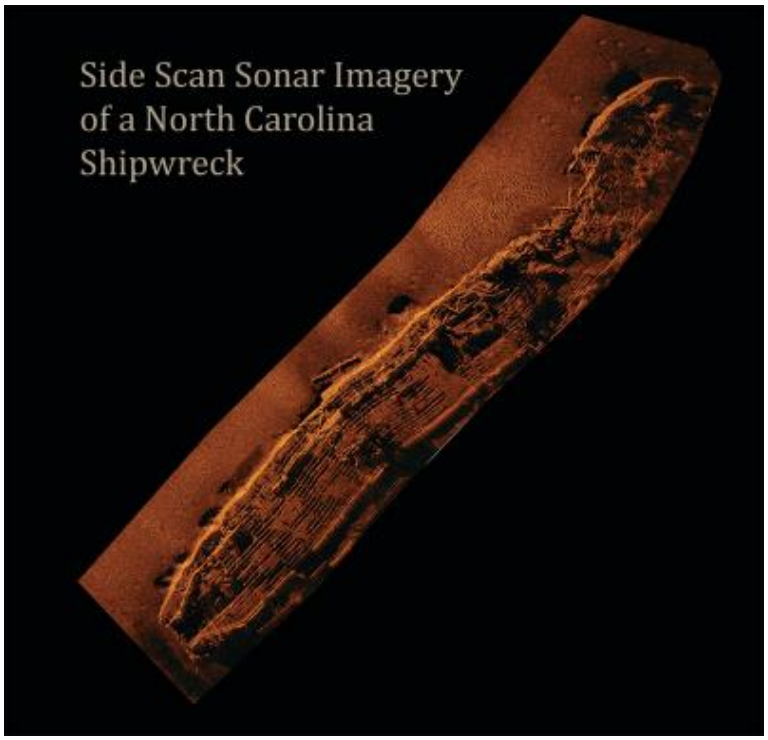
Coastal Studies Institute
East Carolina University Outer Banks Campus

Using Sound for Scientific Discovery



ABSTRACT

Ocean scientists like geologists and maritime archeologists use sound waves to detect underwater features using sonar. This program gives students an opportunity to gain a better understanding of sonar as one of the important tools marine scientists use to answer questions about our underwater world.

Grade Level: 6-12

Duration: 45 minutes

Standards: PS.6.3.1, PS.6.3.3, PS.6.3.4, HS.TT.1, PS.Phy.7.1, PS.Phy.7.3

Key Words: sonar, remote sensing

OBJECTIVE

Students determine the speed of sound through air using experimentation and data collection. This activity provides students with a better understanding of how sonar works.

MATERIALS

- Two metal objects (a small set of iron weightlifting weights works well)
- Tape measure
- Stopwatch
- Data sheet
- Pencil

BACKGROUND

Sound waves travel through various materials at different velocities. The composition of the material dictates the velocity of the sound wave. More dense materials transmit waves better than

less dense materials. Because of this, sound travels faster through the steel hull of a ship than it does through a column of water, and faster through water than air (more than 4 times faster).

By determining the speed of sound as it travels through a certain material, we are able to calculate distance. Sound Navigation Ranging, or SONAR, was invented in the 1920s with the purpose of measure distances in water. Animals, such as bats and dolphins, use the same principle to navigate.

Some researchers who work in marine environments depend on sound waves to provide them with visual representations of the ocean floor. Devices like depth sounders use sonar to measure the time it takes for a sound produced just below the surface of the water to echo from the bottom of the body of water, effectively creating an image of the sea floor. Sonar is advantageous to marine scientists because they can collect large amounts of data over vast survey areas in a shorter period of time. Because sound travels faster through water, sonar can take measurements of the sea floor at greater depths than light can penetrate. Sonar is also useful in shallow water where visibility may be low.

This experiment demonstrates how we can determine the speed of sound.

PROCEDURE

1. Identify a location in your school that will allow you to bounce waves off the wall to determine the speed of sound (school hallway without side corridors indoors, a gym wall outdoors).
2. Measure a distance of 100 meters away from the wall.
3. Clang the weights together to produce an echo. Silence is important, so loud ambient noises will make the experiment difficult to perform.
4. Having established an echo, clang the weights together at a steady rate until an echo is produced between taps. It will take time to find the rhythm.
5. Once the rhythm is established, count how many taps are made in 10 seconds. Don't count the echoes.
6. Have students duplicate the experiment twice more and record the results in the data sheet provided.

The speed of sound can be determined by using the equation: **D/T = V**

D is distance **T** is time **V** is velocity

For this experiment, the distance that the sound wave traveled was twice the distance from you to the wall (round trip). The time it took was one half the time between taps.

REFERENCE TABLE FOR VELOCITY OF SOUND THROUGH DIFFERENT MEDIUMS

Material (at 20°C)	**Speed of Sound (m/s)**
Air*	343
Helium	1005
Water	1440
Seawater**	1560
Hard Wood	4000 (approx.)
Steel	5000 (approx.)

*The speed of sound in air will increase approximately 0.6 m/s for each increase of 1°C
**The speed of sound in seawater depends on salinity, temperature, and pressure. An increase in depth of 1,000 m will increase the velocity by approximately 18 m/s. Every 1% increase in salinity increases velocity by 1.5 m/s. Each 1°C rise in temperature increases velocity by 4 m/s.

REFERENCES

This program is an adaptation of Activity 1 of Physics Part 2 in Science Experiments and Activities (SEA) Lab, Marine Science for High School Students in Chemistry, Biology and Physics, a publication through UNC Sea Grant College Program.

DATA SHEET: VELOCITY OF SOUND DETERMINED BY REFLECTION

TRIAL	TIME	# OF TAPS	TIME PER TAP	½ TIME PER TAP	DIST. (m)	VELOCITY
1	10					
2	10					
3	10					

AVG: _____

% ERROR = [(AVG. – REFERENCE) / REFERENCE] X 100]
% ERROR = _____

QUESTIONS:

A research vessel is towing a side scan sonar in search of ship wrecks. The research vessel is 100 meters above the see floor and the side scan sonar is located 20 meters above the sea floor.

1. How much time would elapse between a sonar's ping from the research vessel?

2. How much time would elapse between a side scan sonar's ping located above the sea floor at a distance of 20 meters?

3. 3. How much time would elapse between a side scan sonar's ping located above the sea floor at a distance of 30 meters if it encounters a shipwreck that rises off the sea floor a distance of 10 meters?

4. A scientist is on the deck of the research vessel when she sees a bolt of lighting strike land. The sound of thunder follows 8 seconds later. How far is the research vessel from land?

5. The project director is in the galley getting lunch when the crew accidently drops the sonar onto the deck of the steel hull. The galley is located 10 meters away from where the accident occurred. How much time does the crew have to come up with an excuse?