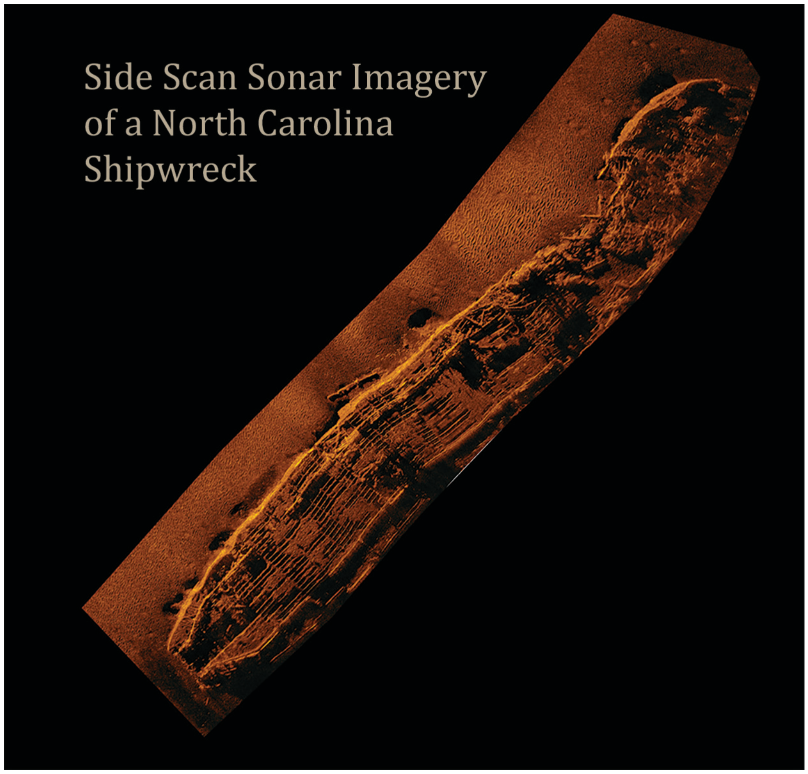
TITLE: Using Sound For Scientific Discovery



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

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

TIME: 45 mins. **GRADE LEVEL:** 6-12

STANDARDS: 6.P.1.3, 6.TT.1, 7.TT.1, 8TT.1, 8.E.1.2, HS.TT.1, Phy.2.2.1

SUPPLIES:

- Two metal objects (a small set of iron weightlifting weights work well)
- A tape measure
- A stop watch
- A data sheet
- A pencil

BACKGROUND:

Sound waves travel through various materials at different velocities. The composition of the material dictates the velocity of the wave. Denser materials transmit waves better than materials of a lower density. With this in mind, the speed of sound travels at a faster rate through the steel hull of ship than it does through a column of water, and the speed through water is greater than the speed through air.

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 by August Hayes and it is the system developed to calculate distances in water. Animals, such as bats and dolphins, use this same principal to navigate.

Some researchers who work in marine environments depend on sound waves to provide them with visual representations of the ocean floor. This is made possible through the use of sonar and computer technology. There are a number of advantages that sonar can offer these scientists. Using sonar, marine scientists can collect large amounts of data over vast survey areas in a more efficient time period. Sound waves travel remarkably better in water than in air (more than 4x faster) and sonar takes advantage of this trait by bouncing sound waves off the sea floor at greater depths than light can penetrate. Not only is it useful in deeper waters, but it also works just as well in shallow areas where visibility may be low.

The key to this principle is ascertaining the speed of sound waves. This experiment demonstrates how we can determine the velocity of sound.

PROCEDURES:

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 IN DIFFERENT MEDIAS

Material (@ 20°C)	Speed of Sound (m/s)
Air*	343

Helium	1005
Water	1440
Sea Water**	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 increase 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 TABLE: VELOCITY OF SOUND DETERMINED BY REFLECTION

TRIAL	TIME	# of Taps	Timer Per Tap	½ time per tap	Dist (m)	Velocity
1	10					
2	10					
2	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. 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?