NAVAL HISTORY STEM-H LESSON PLAN

LESSON PLAN: Ship, Submarine, and Sea Creature Sounds in the Sea

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ACTIVITY TWO: Calculate Logarithmic Equations Used in Passive Sonar Analysis

OBJECTIVE: Student will calculate logarithmic equations, used in Passive Sonar applications.

NOTE: In the back of most high school math texts there are logarithm tables. Scientific graphing calculators have a logarithm key. Before high technology, people had to use the logarithm tables found in the math text's index pages.

Demonstrate how to use the log tables and demonstrate how to use the scientific graphing calculators. Ask students which strategy they prefer. Relate to the students that the oceans and seas contain a large volume. When one is dealing with large numbers or a wide range of distance in the ocean, you can see more data on a smaller scale (sonar receiving equipment). A sonar technician on a submarine has to be able to analyze where the noise is coming from, what type of noise it is, and estimate the distance between the noise and submarine. All are important when working on a submerged submarine.

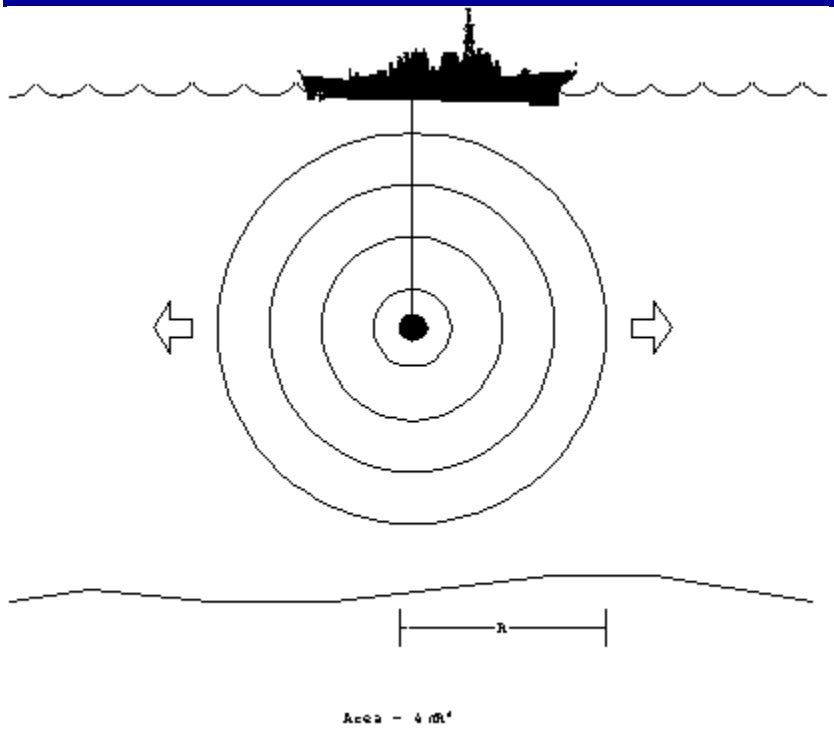
MATERIALS: Math textbook, math work sheet on logs, scientific graphing calculator, pencils, paper.

INSTRUCTIONS： Sonar, Sound Navigation and Ranging, is a very helpful tool for exploring and mapping the ocean. In the water, or ocean, sound waves travel faster and farther than in air. Sonar is like the volume control on a radio or cellphone. The radio can receive a signal from a tower and the volume control can be increased or decreased. We can control the volume output on a listening device. The sonar receives a signal from a transducer and the sensitivity control can be increased or decreased by a level that we can see on the sonar display monitor.

Submarine sonar technicians use passive sonar equations in aiding in the navigation of the ship and analyzing sounds in the ocean. Various data like noise intensity, signal level, and noise level are needed to get an accurate reading to help navigate the area surrounding the vessel as well as detect where other vessels are located.

Logarithms are one of the more important functions of mathematics, physics and engineering. Logarithms are used in dealing with radioactive decay, bacterial growth, population growth, continuous interest. They deal with exponential functions. If $y = a^x$, which is equivalent to log a (y) = x, logs are important.

In the deep ocean, a sound spreads out spherically in all directions as shown below, as range (R) increases:



The equation for the decrease in signal energy of the sound as it spreads out to range R, the Transmission Loss (TL), is:

$TL_{spherical} = 20 \log(R)$

Demonstrate to students how to solve logarithmic equations. Review the Order of Algebraic Rules, and Logarithmic Rules.

Calculating logarithm equation is a useful exercise when navigating a submarine, or translating wave motions.

Evaluate Logarithmic Expressions

Example 1:	Example 2:
$\log 3^x = \log 8$, solve for x.	$\log 5^x = \log 9$, solve for x
$x * \log 3 = \log 8$	$x*\log 5 = \log 9$
$x = \log 8/\log 3$	$x = \log 9/\log 5$
$x = 0.9030/0.4771$	$x = 0.9542/0.6989$
$x = 1.8927$	$x = 1.3653$

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Directions: Solve for x, using the rules of logarithm.

1. $\log 2^x = \log 10$
   x = 3.32

2. $\log 6^x = \log 4$
   x = .774

3. $\log 5^x = \log 8$
   x = 1.29

4. $\log 3^x = \log 9$
   x = 2

5. $\log 9^x = \log 2$
   x = .316

6. $\log 10^x = \log 5$
   x = .699

7. $\log 2^x = \log 4$
   x = 2

8. $\log 6^x = \log 7$
   x = 1.09

9. $\log 4^x = \log 8$
   x = 1.5

10. $\log 7^x = \log 3$
    x = .564