MiSP Light and Sound Worksheet #3, L3

Name _____ Date_____

COMPARING THE SPEED OF SOUND AND THE SPEED OF LIGHT IN AIR AND WATER

You have learned that there are a number of differences between electromagnetic waves (such as light waves and radio frequency waves) and sound waves. One of these differences involves the ability to travel in a vacuum.

1. Can light travel in a vacuum? _____ Explain why or why not.

_____

_____

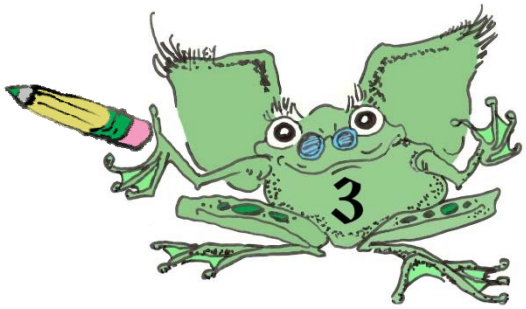
2. Can sound travel in a vacuum? _____ Explain why or why not.

_____

_____

There is also a difference in what happens to light and sound waves when they travel through different media. Complete the table below and then graph the data to see the difference.

Time traveled	**Distance (m) traveled**			
	Sound in air	**Sound in water**	**Light in air**	**Light in water**
0 seconds	0	0	0	0
1 second	343	1482	300,000,000	225,500,000
2 seconds				
3 seconds				

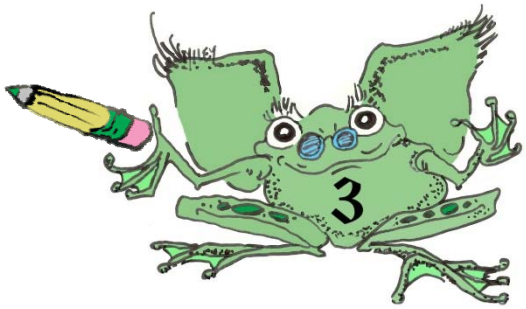


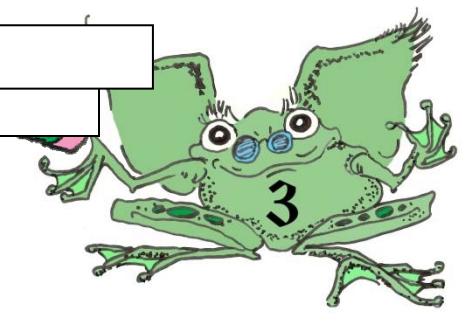
3. Convert the distance data for the distance traveled by light into millions of meters rather than meters. Place the new data in the table below.

Time traveled	**Distance (m) traveled**		**Distance (million m) traveled**	
	Sound in air	**Sound in water**	**Light in air**	**Light in water**
0 seconds	0	0	0	0
1 second	343	1482		
2 seconds				
3 seconds				

4. Graph the data. Make one graph for sound and one for light. Plot distance on the *y*-axis and time on the *x*-axis. You will have two lines on each graph. Use different symbols or colors to show the data points for distance traveled in air and the data points for distance traveled in water.

5. Draw separate lines connecting the data points for air and for water on both of your graphs. Make a legend for your graphs.

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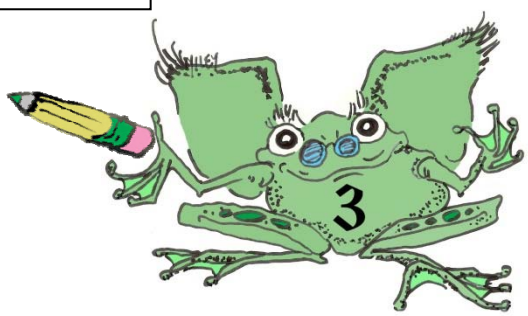
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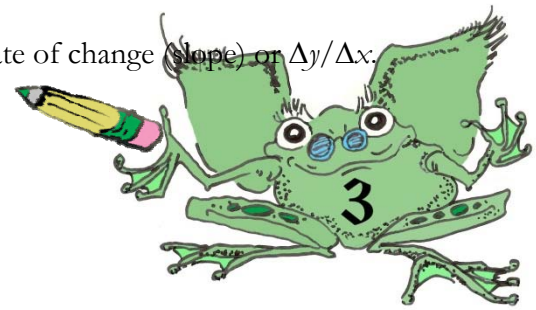
Analysis:

1. For each of the lines on your sound and light graphs, pick an ordered pair and calculate the unit rate of change.

   Unit rate of change = $\frac{\Delta y}{\Delta x} = \frac{(y_2 - y_1)}{(x_2 - x_1)} = \frac{\Delta \text{ distance}}{\Delta \text{ time}}$

SOUND			
Ordered Pair (x_1, y_1) (x_2, y_2)	Change in distance (meters)	Change in time (sec)	$\frac{\text{Change in distance}}{\text{Change in time}}$
Sound in air			
Sound in water			
LIGHT			
Ordered Pair (x_1, y_1) (x_2, y_2)	Change in distance (millions of meters)	Change in time (sec)	$\frac{\text{Change in distance}}{\text{Change in time}}$
Light in air			
Light in water			

2. Speed = Δ distance ÷ Δ time. On your graph, this is the unit rate of change (slope) or $\Delta y/\Delta x$. What is the



a. Speed of sound in air: _____

b. Speed of sound in water: _____

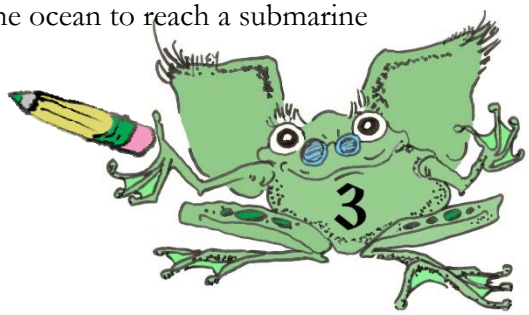
c. Speed of light in air:_____

d. Speed of light in water: _____

3. The equation for a line is ***y = mx + b***, where *m* is the unit rate of change (slope) and *b* is the *y*-intercept. Use the slope you just calculated and one ordered pair from each of your lines to find the *y*-intercept for each line. Then write the equation for each line.

Y–Intercept for Sound in Air	*Y*–Intercept for Sound in Water
m = Ordered pair (*x*, *y*) = (___ , ___) *y* = *mx* + *b* Solve for *b*: Equation for the line:	*m* = Ordered pair (*x*, *y*) = (___ , ___) *y* = *mx* + *b* Solve for *b*: Equation for the line:
Y–Intercept for Light in Air	*Y*–Intercept for Light in Water
m = Ordered pair (*x*, *y*) = (___ , ___) y = mx + b Solve for *b*: Equation for the line:	*m* = Ordered pair (*x*, y) = (___ , ___) *y* = *mx* + *b* Solve for *b*: Equation for the line:

4. How long would it take for sound produced at the surface of the ocean to reach a submarine one mile below the surface? (One mile = about 1610 m.)



Use your graph to estimate the time needed. _____

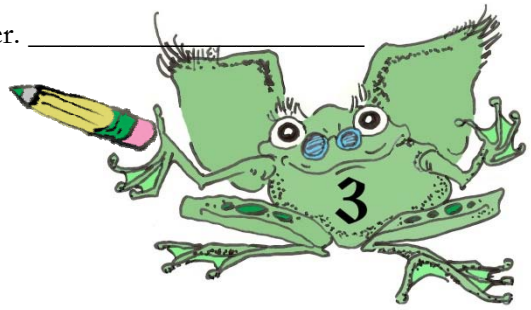
Calculate the time needed using your equation for sound in water. _____
Show your work.

5. How long would it take for the sound to travel a mile in the air?
   Use your graph to estimate the time needed. _____

   Calculate the time needed, using your equation for sound in air. _____
   Show your work.

6. How long would it take for a light signal to reach the submarine?
   Use your graph to estimate the time needed. _____

   Calculate the time needed, using your equation for light in water. _____
   Show your work.



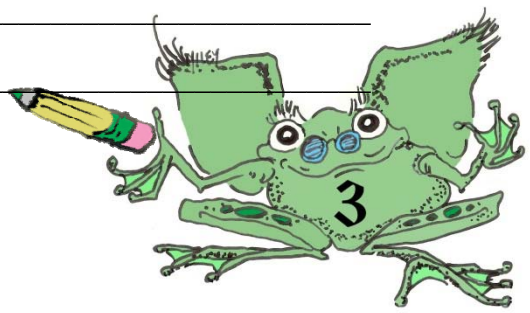
7. How long does it take for light to travel a mile in air?
   Use your graph to estimate the time needed. _____

   Calculate the time needed, using your equation for light in air. _____
   Show your work.

8. Using what you know about the differences between electromagnetic waves and mechanical waves, write a possible explanation for the difference between sound and light when they travel in air and water.

   _____

   _____



Extension:

Your calculation for the speed of sound in the ocean is undoubtedly inaccurate because the ocean is salt water, not pure water. On the basis of what you know about the density of salt water compared to pure water, would you predict that sound would travel faster or slower in salt water compared to pure water? Explain your answer.