

# MiSP Light and Sound Worksheet #2, L2

Name \_\_\_\_\_

Date \_\_\_\_\_

## SPEED OF LIGHT (AND OTHER ELECTROMAGNETIC ENERGY WAVES)\*

### Introduction:

The following facts are important to remember:

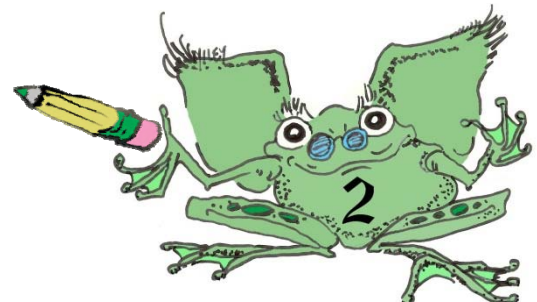
- Mechanical waves, such as sound waves, must transfer energy through a substance or medium.
- Electromagnetic waves—such as light waves, radio frequency waves, X-rays, and microwaves—can transfer energy in a vacuum, without a medium.
- Electromagnetic waves are created by electrically charged particles that move.
- All types of electromagnetic waves travel at the same speed.
- Both types of waves are initiated by something that vibrates.

Today you will calculate the speed of radio frequency waves, a type of electromagnetic wave. You will then compare this value to the value you calculated yesterday for the speed of sound.

### Speed of Radio Frequency Waves in Space:

The table below shows the distance of representative planets from Earth and the calculated time it would take for a radio frequency wave to travel from Earth to that planet.

Planet	Distance from Earth in km	Seconds needed for radio frequency wave to travel between planet and Earth
Mercury	92,000,000	306
Jupiter	629,000,000	2096
Saturn	1,277,000,000	4256
Uranus	2,721,000,000	9070



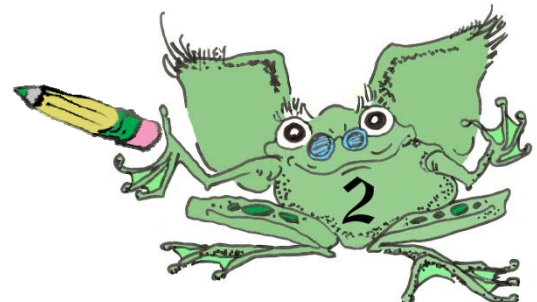
Graph the data. First convert the distance in km to a number that is easier to work with. Convert each distance into millions of km (distance in km given in table/1,000,000).

Convert the time in seconds to time in minutes:  $\text{time (minutes)} = \text{time (seconds)} \div 60$ .

Planet	Distance from Earth in km	Distance from Earth in 1,000,000 km	Seconds needed for radio frequency waves to travel between planet and Earth	Minutes needed for radio frequency waves to travel between planet and Earth
Mercury	92,000,000		306	
Jupiter	629,000,000		2096	
Saturn	1,277,000,000		4256	
Uranus	2,721,000,000		9070	

**Graph the data: (on the next page)**

- Label the  $x$ -axis “time in minutes” and the  $y$ -axis ”distance in millions of km.” Which is the
  - Manipulated/independent variable: \_\_\_\_\_
  - Responding/dependent variable: \_\_\_\_\_
- Decide on an appropriate interval for both the  $x$ - and  $y$ -axes.
- Plot the data.
- Draw a line connecting the points on your graph.

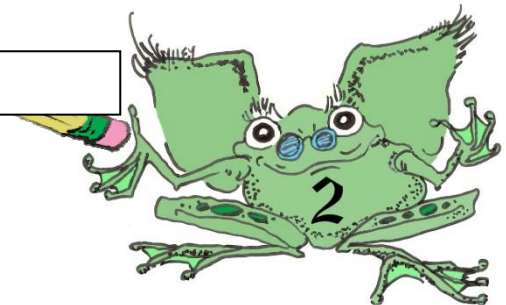


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**Analysis:**

1. On your graph, what two ordered pairs represent Mercury and Jupiter?

Mercury (\_\_\_\_ min, \_\_\_\_\_ millions of km)

Jupiter (\_\_\_\_ min, \_\_\_\_\_ millions of km)

2. On your graph, what two ordered pairs represent Saturn and Uranus?

Saturn (\_\_\_\_ min, \_\_\_\_\_ millions of km)

Uranus (\_\_\_\_ min, \_\_\_\_\_ millions of km)

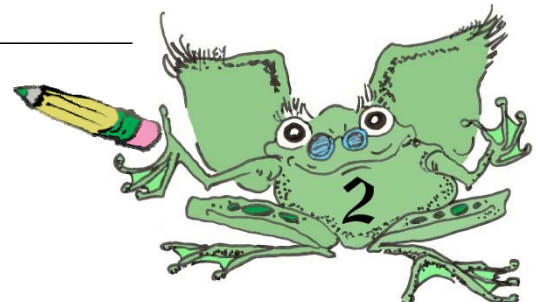
3. Determine the unit rate of change (slope) along the line on your graph.

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

Ordered Pair used for calculation ( $x_1, y_1$ ) ( $x_2, y_2$ )	$\Delta$ Distance (millions of km) $\Delta y$	$\Delta$ Time (min) $\Delta x$	Unit Rate of Change (slope) $\Delta y / \Delta x$
Mercury and Jupiter			
Saturn and Uranus			

4. Is change in distance divided by the change in time different for the two sets of points?  
\_\_\_\_\_

5. What does the unit rate of change represent? \_\_\_\_\_



6. Convert your calculated value to a value in km/second.

$$\frac{\text{_____ millions of km}}{\text{_____ minutes}} \times \frac{1 \text{ minute}}{60 \text{ seconds}} \times \frac{1,000,000 \text{ km}}{1 \text{ million of km}} =$$

\_\_\_\_\_ km/second

7. The speed of light is about 300,000 km/second. How does your value for the speed of radio frequency waves compare with this?

\_\_\_\_\_

8. Calculate the percent error.

$$\frac{(300,000 \text{ km/sec} - \text{your calculated value})}{300,000 \text{ km/second}} = \frac{\text{_____}}{300,000 \text{ km/second}} =$$

$$\text{_____} \times 100 = \text{_____} \%$$

9. Compare the speed of radio frequency (or light) waves to that of sound.

Speed of radio frequency waves and light waves: \_\_\_\_\_

Speed of sound (calculated yesterday): \_\_\_\_\_

Comparison: \_\_\_\_\_

\_\_\_\_\_

