

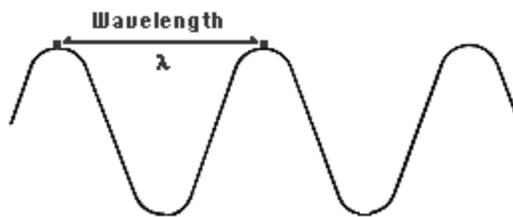
Name \_\_\_\_\_

## The Relationship Between Wavelength and Frequency in the Electromagnetic Spectrum

**Purpose:** To discover and verify the relationship between Wavelength and Frequency of the Electromagnetic Spectrum.

**Background Information:** Visible light is Electromagnetic radiation at wavelengths which the human eye can see. We perceive this radiation as colors ranging from red (longer wavelengths; ~ 700 nanometers) to violet (shorter wavelengths; ~400 nanometers.)

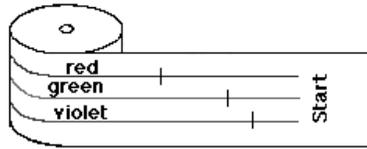
The visible light from the Sun is actually composed of the colors red, orange, yellow, green, blue, and violet, which can become distinguishable when sunlight passes through a prism. A good way to remember the order of the colors is to note that the first letters of the colors spell out the name ROY G. BV. We can think of light traveling in waves with properties of wavelength and frequency. Wavelength is the distance between identical locations on adjacent waves (see figure below).



Frequency is the number of complete waves, or wavelengths, that pass a given point each second. All light travels at the same speed, but each color has a different wavelength and frequency. It is their different wavelengths that cause the different colors of light to separate and become visible when passing through a prism.

Look at the illustration of the visible spectrum above. Can you guess which color has the longest wavelength? It's red! *The wavelengths of the other colors decrease in order, with violet light having the shortest.*



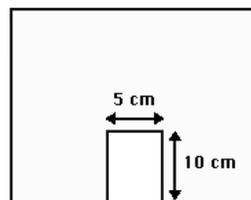


Note: This is how to get started, keep labeling the colors until you reach 100 cm.

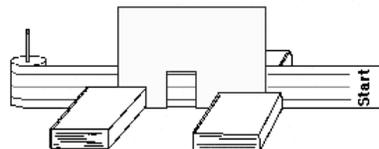
5. Use the colored pencils to draw three evenly spaced horizontal lines along the tape from Start to End.
6. Make the top line red, the middle line green and the bottom line violet to represent three different colors in the spectrum of light.
7. Divide the red line every 14 cm with dark marks in red pencil. The green line should be divided every 10 cm and the violet every 8 cm. The marks that you make on the three color lines will represent the different wavelengths of the different colors of light.

*(NOTE: The true wavelengths are actually measured in terms of angstroms. An angstrom is  $10^{-8}$  cm or 0.00000001 cm. Red has a wavelength of 7800-6220 angstroms, green has a wavelength of 5770-4920 angstroms and violet has a wavelength of 4550-3900 angstroms. However, in this lab, the simple relationship among the visible light waves will be what is important.)*

8. Use masking tape to fasten the marked adding machine tape to a pencil.
9. Cut a manila folder along its crease.
10. Then cut a rectangle out of the center of one of the long sides. This rectangle should be about 10 cm high and 5 cm wide as shown below.



11. Set the manila folder cut out on the table supporting it with the four books (see below).



12. Feed the end of the adding machine tape through the narrow space between the manila folder and the two back books until "Start" appears in the middle of the opening in the manila folder.

13. Sit in front of the tape and manila folder model.
14. Time Keeper should call "start" and begin timing as he or she slowly pulls the tape along. *Try to pull the tape at about the same speed for every trial!*
15. Tally in the appropriate box on the data table every time he or she sees a wavelength mark.
16. When "End" appears, tell the Time Keeper to stop timing.
17. Make a "trial run" and then repeat the procedure an additional 5 times.
18. On the data table, determine and record the average number of wavelengths observed for each color and the average time (in seconds) from start to finish.
19. Determine and record the frequency for each of your colored light waves.  
*Note: frequency is defined as the number of wavelengths passing a given point per second.*

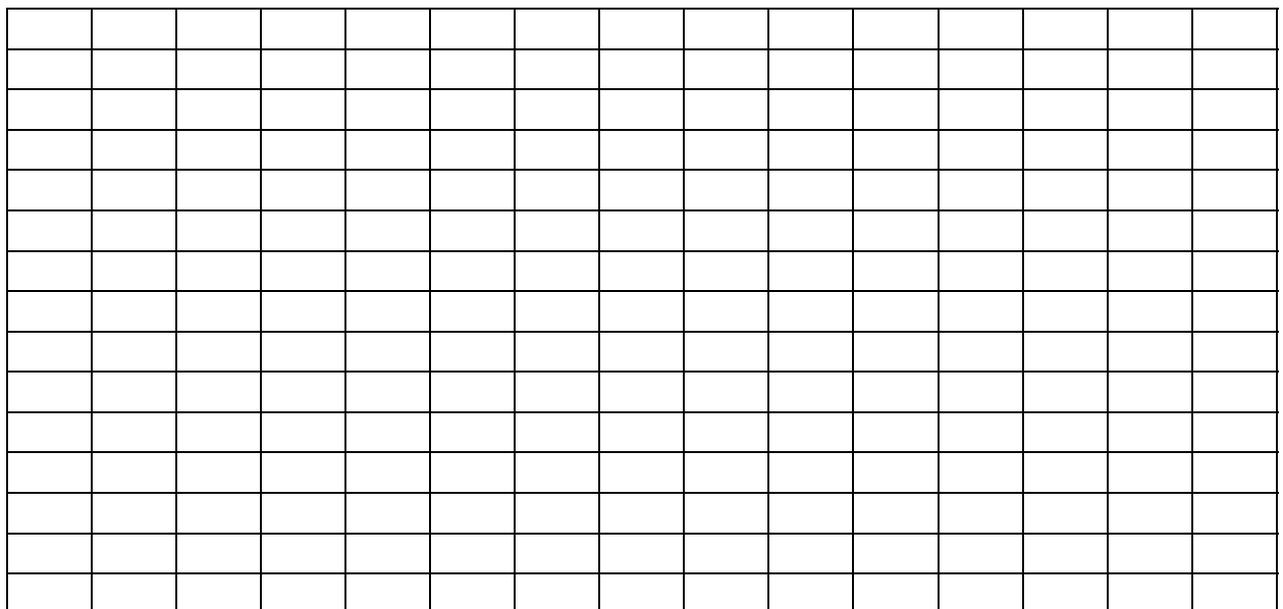
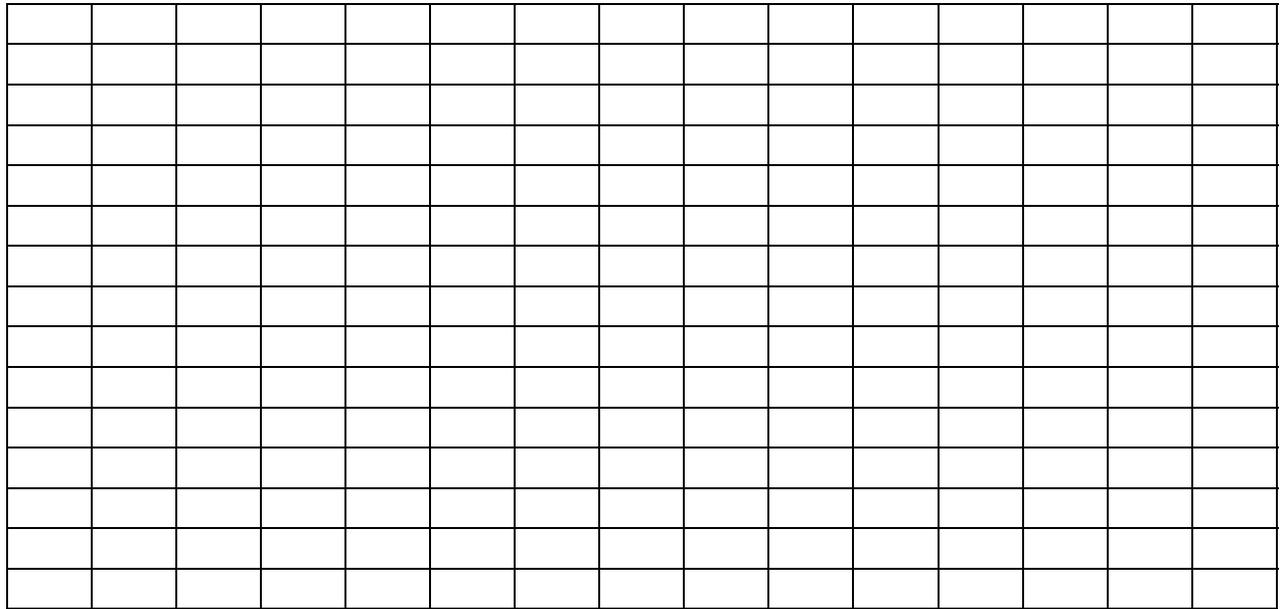
**Data:**

Trial	Red		Green		Violet	
	# Wavelengths	Time (sec)	# Wavelengths	Time (sec)	# Wavelengths	Time (sec)
1						
2						
3						
4						
5						
<b>Average</b>						

**Data Analysis:** Make a graph to compare light color number of wavelengths.

Make a second graph to compare light color and time.

Remember TAILS and DRY MIX.



**Conclusions:**

1. Compare the wavelengths and frequencies of the three waves. Write about any patterns you notice in their relationship.

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2. Which color has the shortest wavelength? \_\_\_\_\_  
Which color has the longest wavelength? \_\_\_\_\_

3. Which color has the highest frequency? \_\_\_\_\_  
Which color has the lowest frequency? \_\_\_\_\_

4. What is the relationship of the red **wavelength** to the green?

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Red to the violet? \_\_\_\_\_

5. What is the relationship of the red **frequency** to the green?

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Red to the violet? \_\_\_\_\_

6. From your answers to the questions above, name the relationship between **wavelength** and **frequency** in waves that travel at the same speed like the waves measured in this lab.

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7. Remember that speed = distance / time. What was the speed of the waves in this lab? \_\_\_\_\_

*\*NOTE: the actual velocity of light  $c = 2.99 \times 10^8$  meters per second, but for our purposes in this lab, it will appear only as fast as the Time Keeper is pulling the adding machine tape.*

8. Multiply the wavelength of the red wave by its frequency. Do this for the blue and green waves also and write the answers below.

red \_\_\_\_\_

green \_\_\_\_\_

violet \_\_\_\_\_

9. What do you notice about the results?

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