Virtual Laboratory

Topic 11 – Electromagnetism and Light

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Name	Section #	Date	Topic #

REFRACTION

Purpose: To investigate the behaviors and characteristics of light when it bends due to refraction. These properties and characteristics will be true for all other EM (electromagnetic) waves - and sound as well.

Questions:

1. What happens to the speed of light as it goes from air to water?

_____

2. What happens to the frequency of light as it goes from air to water?

_____

3. What happens to the wavelength of light as it goes from air to water? Enter your hypothesis here.

_____

Procedure:

Go to the PhET website http://phet.colorado.edu/en/simulation/bending-light. or use the link provided in Canvass. Click on Run Now. Experiment with the controls and tools provided on the Intro tab. Perform the following tasks:

- Learn how to turn the beam on and off.
- Learn how to change the beam to a wave.
- Learn how to change the angle of the beam.
- Note that the symbol c = the speed of light on the light meter.

You will be systematically learning about changing angles in **refraction.**

4. Which beam is best suited for measuring angles. the ray or wave? _____

5. Which tool should you select for measuring angles. the protractor or intensity meter? _____

Using this setup and tool. you will investigate and discover: (Indicate towards or away from normal or no bending.)

6. How the **angle of refraction** compares to the **angle of incidence** measured from the **normal** when going from air to water.

_____

7. How increasing and decreasing the **index of refraction** of the bottom material changes the angle of refraction.

_____

8. What conditions produce no refraction? What conditions produce maximum refraction?

_____

Investigate the materials further set the *top* material to be water and the *bottom* one to be air. Systematically investigate and discover:

9. How does the angle of refraction compare to the angle of incidence measured from the normal when going from water to air?

_____

10. At what angle of incidence does something different happen that did not occur in the first investigations?

_____

11. Describe what happens to the refracted beam at this **critical angle**.

    _____

12. How does increasing or decreasing the index of refraction of the bottom material change the angle of refraction?

    _____

13. How does increasing or decreasing the index of refraction of the bottom material affect when the critical angle appears?

    _____

14. What conditions produce no refraction? What conditions produce maximum refraction?

    _____

You are now ready to investigate the beam itself. Click on the More Tools tab. and change your beam to a wave. **Note: The distance between dark bands. or the red bands. is the wavelength.**

15. Using the speed tool what is the connection between the **index of refraction** of the bottom material and the **speeds of the beams** in air and in the bottom material?

    _____

16. Using the time tool. what is the connection between the **index of refraction** of the bottom material and the **frequency of the beam** in that material compared to the beam in air? What is the **wavelength of the beam** in the material compared to its wavelength in air? (You can slow down or pause the simulation for this. The wavelength is the distance between the black bands.)

    _____

17. What is the effect **changing the color** (wavelength) of the beam on any of the refraction behaviors you already recorded?

    _____

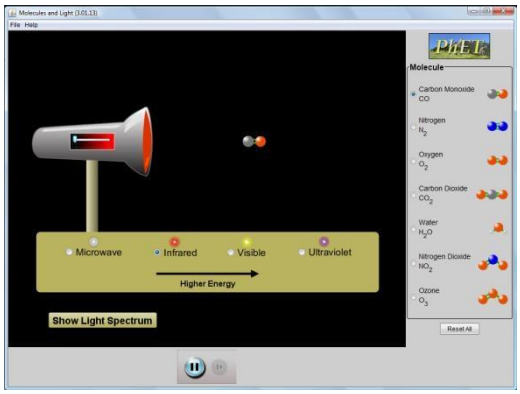
Conclusion:

18. What were your hypotheses. and were they validated by the results of your investigations? If not. what did you learn?

    _____

MOLECULES and LIGHT

Purpose: Explore how light interacts with molecules in our atmosphere.



19. What do the 4 types of radiation above have in common?

_____

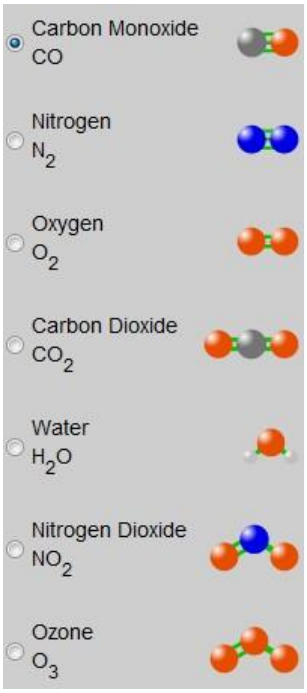
_____

20. How are the 4 types of radiation above different from each other?

_____

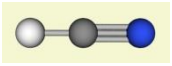
_____

Explore what happens for each molecule for each type of light.



21. Based on your observations. how would you predict HCN to interact with microwaves?

_____



22. Based on your observations. how would you predict HCN to interact with microwaves?

_____

_____

IV. Look closer at how Infrared light affects water in the sim or in the movie below.

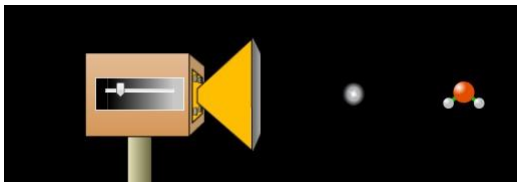
23. What do you think is happening?

_____

_____

24. Pick **<u>one</u>** of the topics below to study in more depth. *Run the simulation and then do some research.*

A. **Microwaves -** How do microwave ovens cook food?



_____

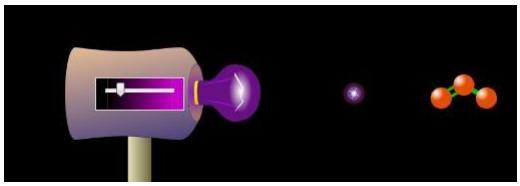
_____

B. **Greenhouse effect - What** is a greenhouse gas and why is it necessary on Earth?

_____

_____

C. **Ozone layer -** What does the Earth's ozone layer do?



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_____

ELECTROMAGNETISM and L I G H T

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Name Section # Kit # Topic #

PRE-LAB Prep: Develop your hypothesis. Plot the graph using 3 colored pencils and answer all questions 1- 16.

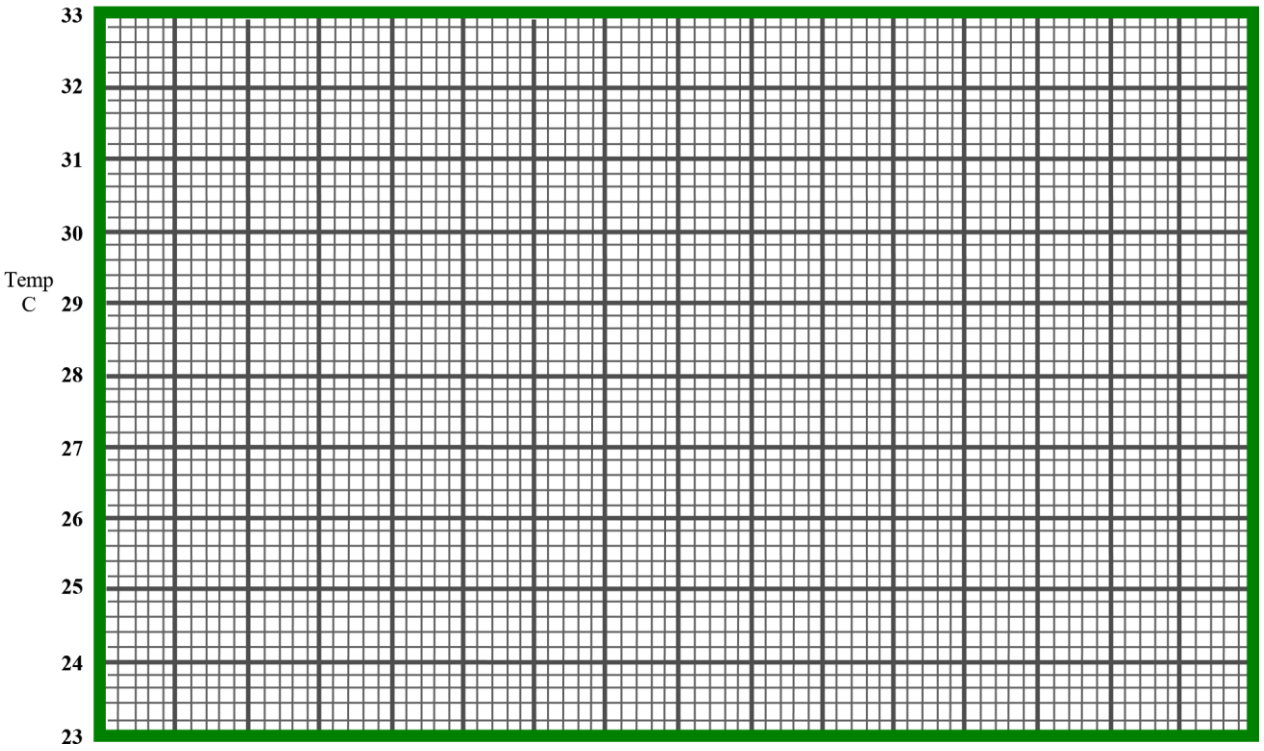
Part A – Research Question: How does surface color affect absorption of radiation (light energy) and emission of energy? Your Hypothesis (include prediction): _____

_____

	Light on (min.)							Light off (min.)					
	0	3	6	9	12	15	18	21	24	27	30	33	36
White °C	25.0	25.8	26.5	27.2	27.9	28.2	28.7	28.3	27.6	26.9	26.3	25.7	25.4
Gray °C	25.0	25.9	27.1	28.1	29.0	29.8	30.2	29.3	28.5	27.5	26.9	26.2	25.2
Black °C	25.0	26.0	27.2	28.2	29.3	31.2	32.4	31.2	30.0	28.1	26.9	25.9	25.0

If using a graphing program. delete the following graph. and copy and paste the plot from the program into the space below.

Title: _____



1. Identify the dependent variable from the graph(s). _____
2. Identify the independent variable (s). _____
3. Identify the constant(s). _____
4. Are all three cans made of the same material? (circle or highlight one of the following) YES or NO. Does this make the type of material used in the experiment a constant? (circle or highlight one of the following) YES or NO
5. What is the benefit of plotting the data for all three cans on one graph? _____
6. What is the benefit of plotting the data for when the light is shining on the can on the same graph as the data for when the light is not shining on the can?
   _____

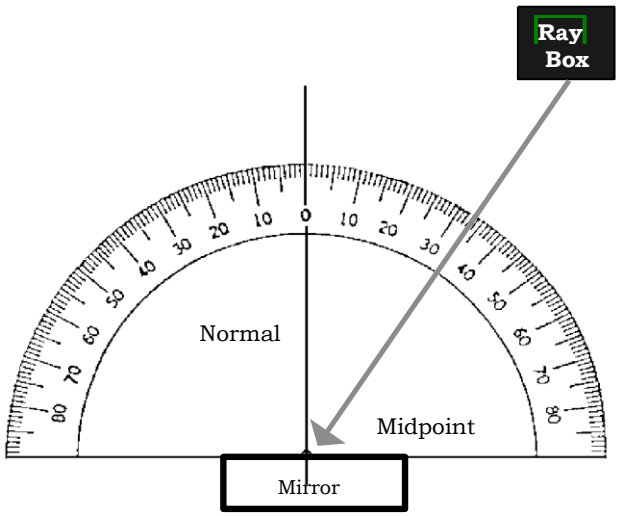
You may find the following helpful when answering the following questions to use terminology that is often used when analyzing a graph.

Directly Proportional relationship: Graph is a straight line that passes through the origin.
Linear relationship: Graph is a straight line that does not pass through the origin.
Non-linear relationship: The graph is not a straight line. but curves.
Increases. Decreases. gradual increase or decrease. drastic increase or decrease. remains constant. increases exponentially. Can you think of more?

7. **White can**: How does the dependent variable change with respect to the independent variable while the light is shining on the can? _____
8. **White can**: How does the dependent variable change with respect to the independent variable when the light is <u>not</u> shining on the can? _____
9. **White can:** Compare and contrast the behavior of the dependent variable with respect to the independent variable when the light is shining on the can. and when it is not shining on the can.
   _____
10. **Gray can**: How does the dependent variable change with respect to the independent variable while the light is shining on the can? _____
11. **Gray can**: How does the dependent variable change with respect to the independent variable when the light is <u>not</u> shining on the can? _____
12. **Gray can:** Compare and contrast the behavior of the dependent variable with respect to the independent variable when the light is shining on the can. and when it is not shining on the can.
    _____
13. **Black can**: How does the dependent variable change with respect to the independent variable while the light is shining on the can? _____
14. **Black can**: How does the dependent variable change with respect to the independent variable when the light is <u>not</u> shining on the can? _____
15. **Black can:** Compare and contrast the behavior of the dependent variable with respect to the independent variable when the light is shining on the can. and when it is not shining on the can.
    _____
16. Does your data support your hypothesis? Explain your results.
    _____

Part B - Reflection of Light:

Reflection of A Light Ray	
Incoming Angle of Incidence	Outgoing Angle of Reflection
30	
50	
60	
70	
0	

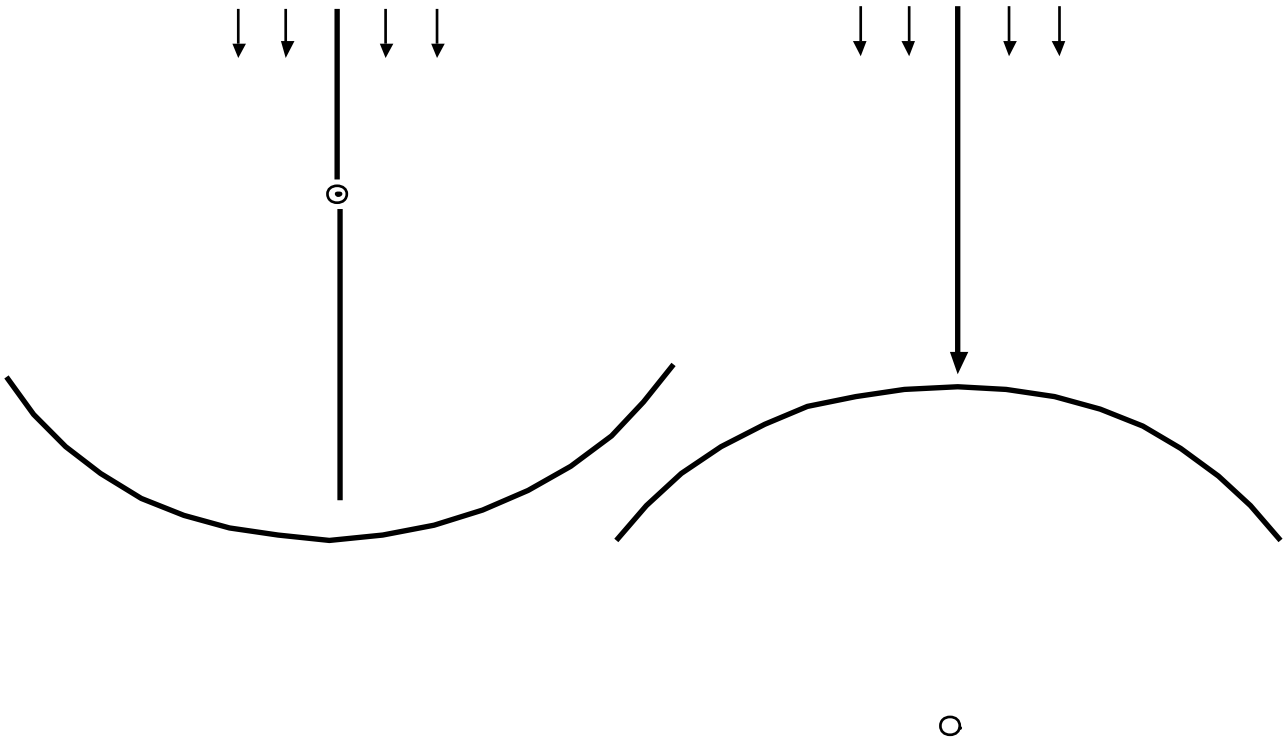


Section 1 - Plane surfaces:

Make a statement which summarizes your data and describes the Law of Reflection.

_____

Section 2- Curved surfaces: Does the law of reflection explain curved surfaces? Draw the ***incoming***. ***normal***. and ***reflected*** rays. using different colors for each type of ray. and compare the incoming and reflected angles.



Does the Law of Reflection apply to curved surfaces? Explain.

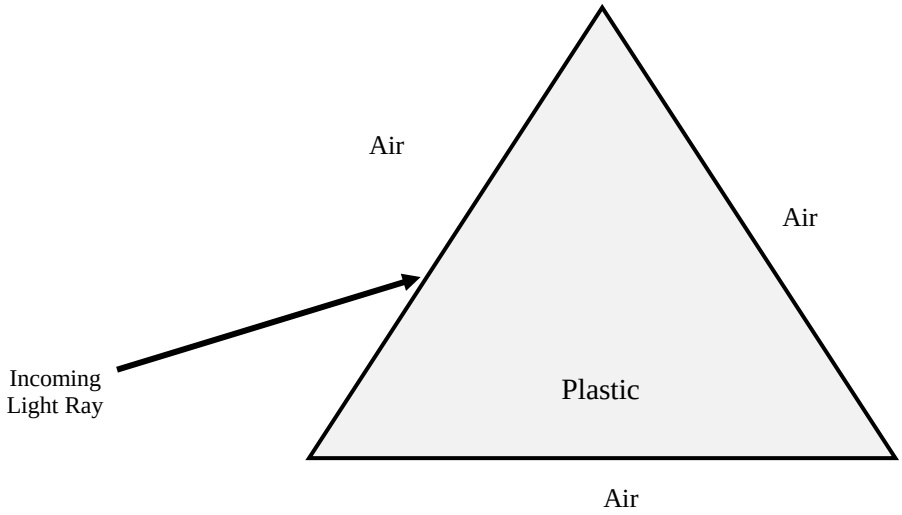
_____

Part C – Refraction

Section 1- How does light refract in a plastic triangle?

1. Place the plastic triangle as indicated on the drawing. And Draw the normal line at all points where the light ray enters or exits the triangle.
2. Draw a ray of light as it enters the plastic triangle. Make sure to include and label: a. the normal
   b. where the ray would have gone if it was not bent and
   c. where the light went due to refraction inside the triangle.

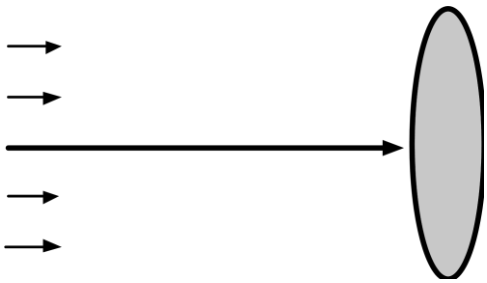
3. Repeat this process to describe the light *exiting* the plastic triangle.



1. How is the light bent (with respect to the normal) upon entering and exiting the block of plastic?

_____

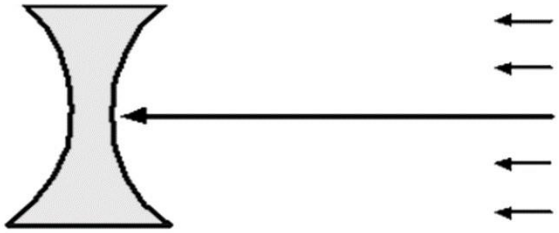
Section 2 - Convex Lenses (plastic):



Measure the focal length _____

Describe how the rays behave after passing through the lens. _____

Section 3 - Concave Lenses (plastic):



Measure the focal length _____

(2) Describe how the rays behave after passing through the lens. _____

Section 4 - Telescope: (record the distance between the glass lenses and the objective lens and the object)