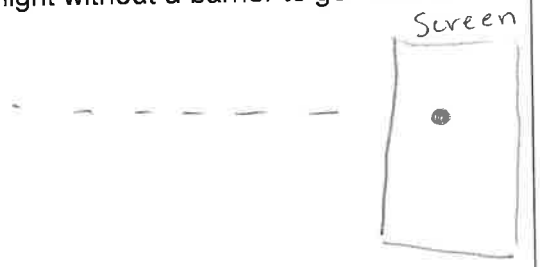
Name KEY Period _____

Splitting Hairs

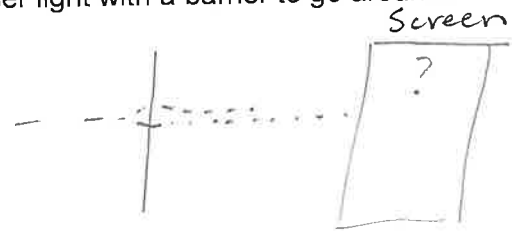
Guiding Question: Why does the pattern of light get dimmer as it moves away from the center?

1. Hypothesis: Draw the pattern that you expect to see.

Laser light without a barrier to go around:



Laser light with a barrier to go around:



$$d = \frac{\lambda L}{\Delta y}$$

d = width of the object λ = wavelength of light L = distance between the object and the screen

Δy = Distance from center of one dark band to the center of the next dark band

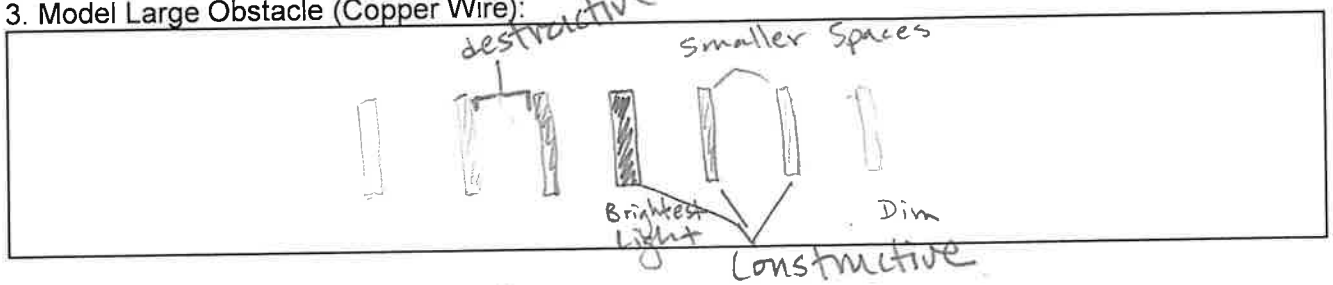
2. Data Table: Measure and record the distance between the dark spaces. Complete calculations when directed by the teacher.

Object Copper Wire	Wavelength of laser light λ (mm)	Distance from Object to Screen L (mm)	Distance between dark spaces Δy (mm)	**Calculate** Object width (mm)
Red Laser	0.00065	2000	5	0.26
Green Laser	0.000532	2000	4	0.27
Blue Laser	0.000405	2000	2	0.405
Object Human Hair	Wavelength of laser light λ (mm)	Distance from Object to Screen L (mm)	Distance between dark spaces Δy (mm)	**Calculate** Object width (mm)
Red Laser	0.00065	2000	20	0.065
Green Laser	0.000532	2000	15	0.071
Blue Laser	0.000405	2000	10	0.081

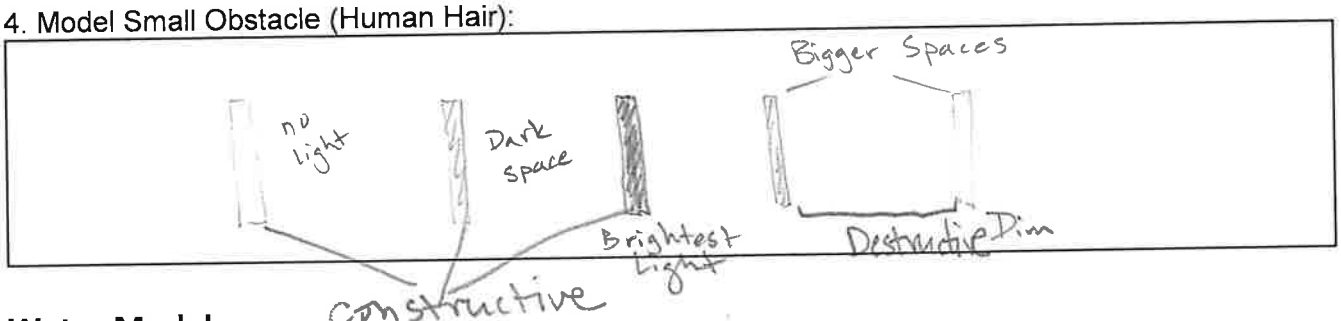
3D-RST is supported by the NSF under grant number #DRL-2101383

Light Model

3. Model Large Obstacle (Copper Wire):

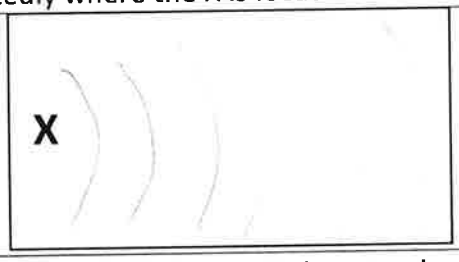


4. Model Small Obstacle (Human Hair):



Water Model

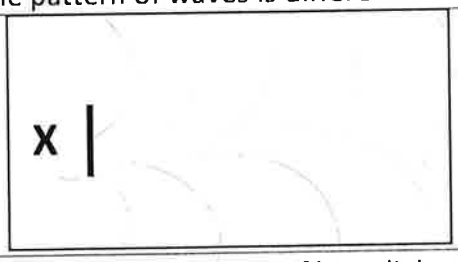
5. Carefully fill your plastic tub with one inch of water. Tap the water lightly with your fingertip repeatedly where the X is located in the diagram below. Draw and describe the pattern of waves.



Describe:

waves move out from source

6. Now, repeatedly tap again but stand a ruler up in front as a barrier as shown in the diagram. Observe how the pattern of waves is different from before. Draw and describe them.



Describe:

wave move out from each side & merge together

7. Think about the patterns of laser light that were observed while measuring the copper wire and hair and look at your water models from questions 5 and 6. Explain how the patterns of light are similar to the patterns observed in the water?

the water waves cancel each other out in some places

3D-RST is supported by the NSF under grant number #DRL-2101383

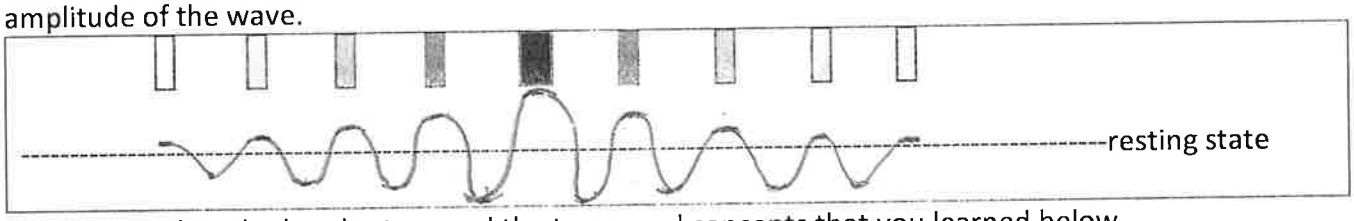
8. Simply shining a laser at the wall or creating one wave in the water did not cause a pattern of empty areas with no waves. Think about the anatomy of a wave. How could multiple waves possibly interact that might explain those patterns of empty areas?

waves of light can overlap & cancel each other out

9. Why are there multiple bright spots and dim spots when the laser is shone around the hair?

the waves blend together, sometimes neutralizing & sometimes staying.

10. Draw a wave pattern below the light patterns to match what we saw on the wall by changing the amplitude of the wave.



11. After reading the handout, record the terms and concepts that you learned below.

Diffraction - when light bends around a barrier

Interference - when waves interact w/ each other, changing

Constructive Interference
in sync
waves get bigger/add together

Destructive Interference
out of sync
waves cancel out

12. Go back to your light model and water model. Label the interference areas resulting in the wave pattern. Did you label? Yes No

13. The diffraction grating used at the beginning of class has 1000 microscopic lines per mm. Create an explanation for why we saw the pattern we did when the laser was shone through the diffraction grating.

the light moved around the barriers in the grating and overlapped. This caused interference & the dark spaces & bright spaces

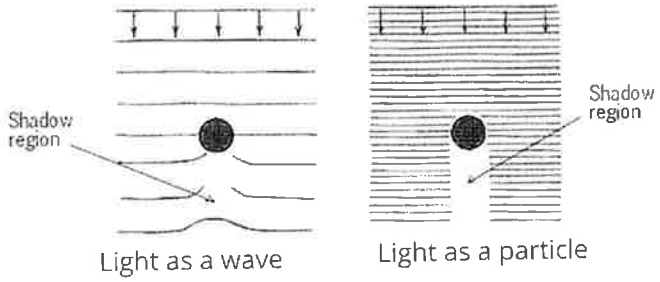
3D-RST is supported by the NSF under grant number #DRL-2101383

14. Light has properties of both waves and particles as shown in the picture below. Did the properties we observed today support the wave model or the particle model of light? Create an explanation based on the patterns observed in the activities to support your answer.

Circle one: Particle (Wave)

Explanation:

light can bend around barriers & create interference patterns



Light as a wave Light as a particle

3D-RST is supported by the NSF under grant number #DRL-2101383