Name_____ Period_____ Date_____

CONCEPTUAL PHYSICS	Activity

31.3 Diffraction and Interference: Interference

DIFFRACTION IN ACTION

Purpose

In this activity, you will observe the wave nature of light as it passes through a single, narrow slit. You will then observe the effect of light passing through many narrow slits.

Required Equipment and Supplies

point source of light (Mini Maglite™ or equivalent)
2 pencils (or equivalent)
diffraction grating
access to a compact fluorescent light (illuminated)

Discussion

We are accustomed to light traveling in straight-line paths. We don't expect light to bend around corners or to spread out after passing through small holes. Yet it is capable of doing both! In this activity, you will see the effect of light spreading out after passing through a narrow opening. And you will see that different colors spread out by different amounts.

Procedure

Step 1: Prepare the point source. For example, remove the lens housing from the body of the Mini Maglite by twisting it counter-clockwise until it comes off. When you are done, the point source (bulb) should be glowing brightly. You can use the lens housing as a stand for the Mini Maglite. See figure 1.

Question 1: When you look at the point source, you will see a "dandelion" of light around it. Where is the dandelion, actually? Is it really around the bulb of the point source, or is it in your eye? While observing the dandelion, rotate the flashlight then rotate your head. Where is the dandelion and how do you know?

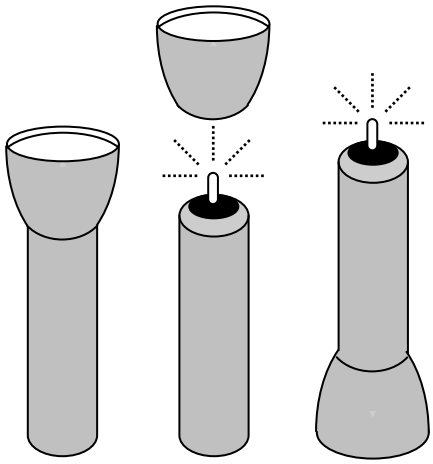

Figure 1

Step 2: Hold the two pencils so they are side-by-side and touching each other. Look through the tiny space between them toward the point source. Record your observations using words and pictures.

Step 3: Make the gap between the pencils smaller by squeezing the pencils against one another. How—if at all—does this change what you see? (Does the pattern get narrower, wider, or remain the same?)

The pattern you see is the result of light wave interference. Light passing through a narrow opening spreads out. As the light spreads out, an interference pattern results in the bright and dark bands or "fringes." This phenomenon is called **single-slit diffraction.**

Step 4: Set the single-slit materials aside and view the point source by looking through the diffraction grating (film slide). The diffraction grating has thousands of slits packed closely together. The phenomenon that results is called **multiple-slit diffraction.** Record your observations in words and pictures.

The point source emits light in all the colors of the spectrum. Viewed on its own, light from the bulb appears white. The colors of the point source light do not diffract equally. Some are diffracted less and remain closer to the point source when viewed through the grating. Some colors are diffracted more and appear farther from the point source.

Question 2: List the colors of the spectrum (blue, green, orange, red, violet, yellow), in order from least diffracted to most diffracted.

LEAST DIFFRACTED MOST DIFFRACTED

_____ _____ _____ _____ _____ _____

Step 5: Turn off the point source and set it aside. Turn on the compact fluorescent light and observe it through the diffraction grating. Record your observations in words and pictures.

Going Further

Obtain a white LED and observe its light through the diffraction grating. Is the light from the LED more like the light from the point source (flashlight) or the compact fluorescent light? Justify your answer.

Summing Up

1. Does the amount of diffraction increase or decrease as the wavelength of light increases? (Hint: among the colors in the spectrum, violet light has the shortest wavelength and red light has the longest wavelength.)

2. If you weren't sure whether a light source was incandescent (like the point source) or fluorescent, could you use a diffraction grating to help make the determination? Explain.

Diffraction in Action [Activity]

Light wave interference is simplest when it results from monochromatic light passing through a pair of thin slits. In this activity, students observe single-slit diffraction patterns, which are still the result of light wave interference. The bright areas of the fringe patterns still arise due to constructive interference and dark zones are still the result of destructive interference.

Answers to Procedure Questions

Question 1. The dandelion of light is in your eye. Rotating the point source has no effect on the dandelion, but rotating your head causes the dandelion to rotate the same way.
Step 2. A pattern of light and dark zones appears to the left and right of the point source.
Step 3. The pattern gets wider (more spread out) as the gap gets narrower.
Step 4. Bands of color appear to the left and right of the point source.
Question 2. From least diffracted to most diffracted: violet, blue, green, yellow, orange, red.
Step 5. Images of the CFL appear to the left and right of the actual CFL. The images are in different colors from one another.
Going Further. The LED light is like the CFL; it produces distinct dots of color instead of a continuous spectrum of colors.

Answers to Summing Up Questions

1. As the wavelength of light increases, the amount of diffraction it undergoes decreases. The longest wavelengths (red) diffract the most; the shortest wavelengths (violet) diffract the least.
2. A fluorescent light produces distinct bands of color; an incandescent light produces a smooth, continuous spectrum of colors.
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