Light Waves

FRAMEWORK

I. Scientific and Engineering Practices
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II. Cross-Cutting Concepts
   - Scale, proportion and quantity (different colors as associated with different wavelengths)

III. Physical Sciences

SKILLS/OBJECTIVES

- To be able to describe light as a wave
- To relate colors

MATERIALS

- 4 clear glasses
- Oil
- Water
- 4 pencils
- 10 Diffraction gratings
- CD
- Cake pan
- Soap (or bubble solution)
- Water
- Bubble wands

NOTES

In the final activity, tell children NOT to look into sunlight with the defraction gradients.

BACKGROUND

- We have talked about different properties of waves and how waves can travel through matter. But there is still one type of wave we haven't talked about yet: light waves
- Light waves are super cool because they are different from sound and pressure waves. They do not need to travel through a medium. Light can still exist in a vacuum where there is no other matter; they are self-propelling.
- Light travels at the fastest speed of anything in the entire universe at $3x10^8$ m/s. That's 3 with 8 zeroes after it! Sound only travels at 340 m/s
- Light waves may not look like other kinds of waves, but we are going to demonstrate their wave-like properties.

Activity # 1	**Refraction Experiment 1**
Materials	o Kids and their bodies
Worksheet	N

- **Light can travel as a wave through space at a really really fast speed ($3x10^8$ meters/second). However, when light encounters other pieces of matter, like molecules in air or plastic or glass, the light bangs into these obstacles and has to slow down.**
- **Certain mediums make light slow to different speeds.**

- Have the kids line up in two lines facing each other. Make sure the kids in each line are shoulder-to-shoulder

- Have them stick out their arms in front of them. They are creating a passageway blocked by their arms.

- Designate one club member to "Light." Light is going to travel through this passageway which is dense with obstacles (the kids' arms).

- Now have the kids in each line spread out so their arms create a less dense space. Have light travel through passageway.

- **In which experiment did the light have an easier time traveling, with more hands in the way or fewer?**

- **What do you think happens when light encounters a lot of obstacles (pieces of matter) in its path?**

Activity # 2	**Refraction Experiment 2**
Materials	o 4 clear glasses o Oil o Water o 4 pencils
Worksheet	N

- **What do you think our eyes see when light slows down?**
- **Break the kids into smaller groups of 4-5**
  1. Place a pencil in a glass
  2. Have the kids examine the pencil. Does it look any different?
  3. Pour water into another glass
  4. place the pencil in the glass
  5. Have the kids examine the pencil. Does it look broken? How does it look from different angles?
  6. Pour the same amount of vegetable oil in another glass.
  6. Place another pencil in that glass.
  8. Have the kids examine the pencil. Does it look broken?
  9. Compare the two pencils? Do they look different? (Water has a lower index of refraction so the pencil in water may look less "bent" than the one in oil.)

Activity # 3	**Diffraction 2**
Materials	o Diffraction grating o CD
Worksheet	N

- White light or light from the sun is made up of many different colors of light which each have a different wavelength
- You've seen this when you look at a rainbow; white light is being split up into the colors that make it up because each color travels at a different speed. They are broken up when they travel through drops of water or prisms because they taken different amounts of time to travel through the medium and come out at different angles.
- Rainbows are tricky to produce, so we're going to use diffraction gradients instead

- These diffraction gradients are just like the activity we did before. They each have lots and lots of tiny slits; they have to be tiny because they have to be close to the size of the wavelengths of light
- Just like before the waves (this time light waves) are going to travel toward the slits, get squished through them, and spread out afterward
- This way, the colors are separated and visible!
- **Have each kid look at light through a diffraction gradient**
- **Hold a CD to show how it too is a diffraction gradient**
- **Do the colors always come out in the same order? They should! They are divided by wavelength, the rainbow-color order!**
- **Do you see any black lines? This is caused by interference, when waves bump into each other and result in net zero light. We talked about this last week when we saw this happen in water.**

Activity # 4	**Rainbows in soap bubbles!**
Materials	o Cake pan o Soap (or bubble solution) o Water o Bubble wands
Worksheet	Y

- Have you ever seen a rainbow in an oil puddle?
- This kind of light interaction uses both refraction and diffraction!
- Oil and water don't mix, so the oil sits in a thin layer on top of the water. Light travels through these substances at different speeds, so the light is bent like we saw with the pencil in oil and water.
- The light is reflects back to our eyes and different angles because of the different speeds. This separates the wavelengths of light.
- The various wavelengths of light can interfere, creating places where there is no color. This is easier to see in a puddle with motor oil.
- **Pour a thin layer of water in the pan.**
- **Pour in some soap and make some bubbles.**
- **Hold the bubbles on your hands and try to examine the rainbow. What order are the colors? What happens to the rainbow if you change angles?**
- **Use the bubble wand to create a flat surface and try again.**
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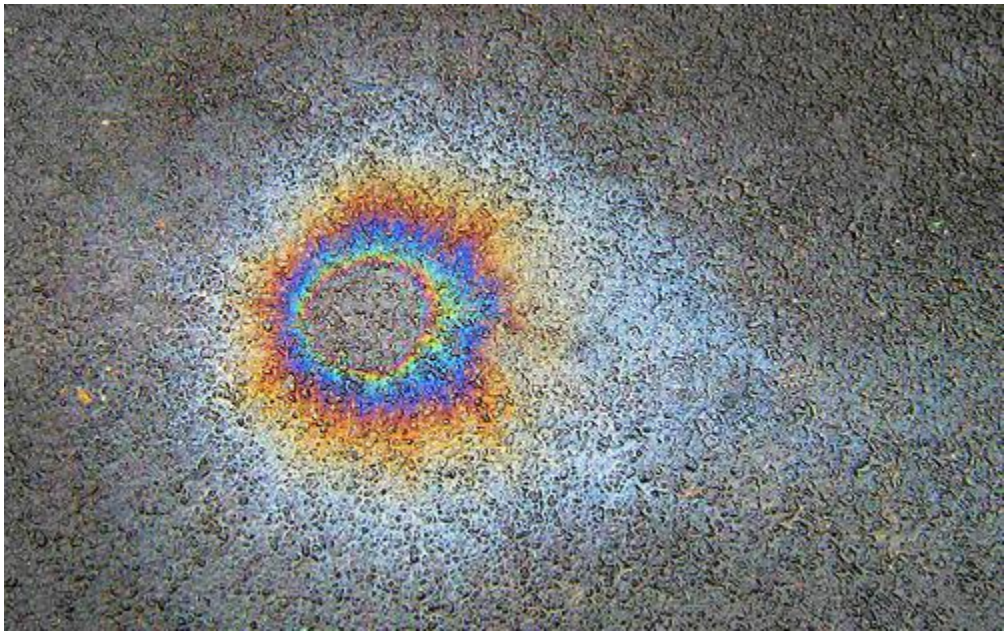

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