SPECTROSCOPE

ACTIVITY INSTRUCTIONS

http://www.ncsciencefestival.org/starparty

OBJECTIVE

Use a spectroscope to examine different kinds of light sources and how light comes in many wavelengths.

SUGGESTED AGE RANGE

Ages 4 and up

ACTIVITY DURATION

10 minutes for spectroscope use;
5 minutes for diffraction glasses use; 25 minutes for spectroscope construction

SETTING

Indoors or outdoors – inside is preferable for young participants to avoid possibility of looking directly at the Sun.

MATERIALS

- Pre-made spectroscopes
- Diffraction glasses
- Tape or glue

If constructing new spectroscopes with participants (these supplies not included in the 2020 Statewide Star Party kit):

- Spectroscope templates (http://physicsbusking.ie/make-your-own-spectroscope/)
- Black cardstock
- Tape or glue
- CD broken into quarters with edges taped

PREPARATION

Check spectroscopes to ensure functionality and use tape or glue to fix any cracks that could let in light. Practice orienting the spectroscopes toward the light source. Identify a few different kinds of light sources in your area to allow participants to compare the spectra.

If you will be making spectroscopes with your participants, consider pre-cutting the CDs and wrapping the edges in tape. Prepare the templates by gluing the spectroscopes to a piece of black cardstock before cutting. Consider precutting the templates for efficiency.

SAFETY NOTICE

Do not allow participants to look directly at the Sun using their spectroscopes, as this could cause permanent eye damage. Advise participants to watch for sharp edges on the pieces of CDs.

PROCEDURE

1. Invite participants to the table by asking “Have you ever seen a rainbow?” Ask them to describe their experiences with rainbows. Do they see them every day, or only on special days? What are those days like?
2. Ask participants if they know how rainbows work. Where do all the colors come from? Explain that the colors come from sunlight shining through the water vapor left in the air after rainfall. Sunlight usually looks just like white light, but white light is made of all the colors we can see. Rain droplets scatter and separate this light so that we can see all of the colors in a rainbow. Participants might have also seen this effect with something called a prism.
3. Explain that you have a device that helps make different kinds of rainbows inside, even if it hasn’t rained! Show the participants the spectroscope and show them where light will come through to hit the CD piece and scatter into the component parts of the light source. Spectroscopes can be used to find different kinds of rainbows from different light sources—each kind of light source has a slightly different spectrum or kind of rainbow that it presents.
4. Advise participants that they can take turns exploring light sources to see different spectra, but that they should not use the spectroscopes to look directly at the Sun. They should look at the sunlight shining through a window onto a white wall, floor, or piece of paper instead.
5. Have participants take turns looking through the eyehole and pointing the slit in the direction of a light source until they find the correct angle and see bands of different colored light reflected from the CD. This might take a few tries, so be encouraging! Advise that the light must go down through the slit, then bounce up to the eye. Arrows on the sides of the spectroscope will show the angle to peer into the spectroscope, and the angle to point it at the source. If participants hold their forefinger along the arrow labeled “to light,” they can simply point at the light source and look down into the eyehole. Note that they will not look directly at the light source, but at a reflection off the CD wedge.

6. Encourage them to explore different light sources. For example, check out the differences between the Sun, incandescent light bulbs, fluorescent light bulbs, white LED light bulbs, and various colored LED light bulbs. Do they see any differences between the light sources?
7. Explain that the CD in our spectroscope is acting as a diffraction grating as the tiny lines on the CD spread out the light based on wavelength. Each kind of light has its own distinct wavelength, and the diffraction grating separates these kinds of light. The shorter the wavelength, the more it is spread out by the grating, so we get a rainbow of colors from short wavelengths to longer wavelengths. We see short wavelengths as blues and purples, long wavelengths as reds and oranges, with yellow and green fitting in between.
8. Explain further that different light sources will show different kinds of rainbows through the spectroscope. Some of them may show fewer colors or may just show strong spectral lines against a

PROCEDURE (CONTINUED)

darker background rather than full rainbows transitioning smoothly between all the colors. See below for some things to look for from different kinds of light sources, white light and otherwise:

- Incandescent bulbs and sunlight produce light that spreads into a continuous spectrum where one color bleeds into the next with no gaps between them.
- Fluorescent lights do not present continuous spectra. Their spectra contain bright lines of specific colors, with dark gaps in between. Fluorescent bulbs produce light only in these precise colors and no others.
- Explore other light sources, such as computer screens, LEDs, or candles.

9. Ask participants why they think scientists might use tools like spectroscopes to study space. What information could light give us about objects like planets, stars, and nebulae? Tell participants that different chemicals—such as oxygen, helium, and nitrogen—all have different spectral line patterns, almost like a fingerprint. Studying the spectra from different light sources in space can help astronomers figure out information such as the age of a star or the composition of a distant planetary atmosphere. Light gives us so much information about our universe.

Using the diffraction glasses (modification for participants who are very young or in a hurry):

Ask participants about rainbows and explain how white light is made up of all the different colors of light. Explain how scientists can split light into these parts to learn more about distant objects in space. Allow participants to try on the glasses to see the effect for themselves. Older participants may be interested in knowing more about this effect, in which case refer to the explanation provided for the spectroscope. The diffraction glasses will not show resolved spectra or spectral lines in the same way as the spectroscope, but participants should still be cautioned to not look at the Sun.

If you would like participants to make their own spectroscopes:

1. Give each person a prepared spectroscope template with a black backing.
2. Show your group how to fold the spectroscope. The printed side should be out. Fold along the dotted lines to construct the spectroscope. Then tape (or glue) the edges together.
3. Using tape, attach a CD wedge to the inside of the spectroscope (where the hole is in the template, near the eye slit). Make sure the reflective data side of the CD faces up. Cover the edges of the CD wedge with tape. This small wedge of CD is the spectroscope's diffraction grating.
4. When folding and taping, try to avoid making cracks where light might leak in. If such cracks occur, advise participants to cover the cracks with tape or scrap pieces of paper. Avoid covering the slits when making the spectroscope.

ADDITIONAL NOTES

This activity may complement the other activities about the electromagnetic spectrum that are included in the 2020 Statewide Star Party kit. If you desire, integrate this activity with Filtered Light and Representational Color, starting with an explanation of the electromagnetic spectrum to explore different aspects of this concept at the same time.

CREDIT

Adapted from the Inter-University Center for Astronomy and Astrophysics Muktangan Science Exploratorium

NORTH CAROLINA SPACE GRANT

The Statewide Star Party is made possible by the generous grant support of the North Carolina Space Grant.