EXPLORE
MOBILE LAB POWERED BY DUKE ENERGY

Looking at the Stars

Summary

Students create and decorate their own spectrographs using simple materials and holographic diffraction gratings. A holographic diffraction grating acts like a prism, showing the visual components of light. After building the spectrographs, students observe the spectra of different light sources, while discussing the properties and behavior of waves.

Spectrographs are used both in ground-based telescopes and in space to help astronomers answer questions about what makes up atmospheres of planets and stars. Mechanical and electrical engineers design spectrographs to advance our knowledge of astronomy.

After completing this activity, students should be able to:

- Explain that light seen through a diffraction grating shows all the colors of that light.
- Explain the different parts of waves and how they interact to form visible light.
- Use a spectrograph to gather data about different light sources.
- Describe how engineers may redesign a spectrograph based on what the spectrograph is being used to examine.

Setting the Stage

Before the students start working, initiate an introduction/discussion about the topic using some of the following open-ended questions.

1. What light sources exist that you see in your everyday life? Sources of light (6:02)
2. What are the colors of the rainbow? Science of rainbows (5:36)

Materials

Each group needs:

- 7-inch (18-cm) high oatmeal container
- 3 x 5 index card
- 1 holographic diffraction grating (500 lines/mm or 12,700 grooves/in)
- 1 ruler
- colored pencils to draw the spectra
- copies of instructions, questions and homework pages (see Engr. Notebook pages)

To share with the entire class:

- black spray paint (optional, but desirable)
- masking tape
- 1 incandescent light bulb
- thick black markers
- markers, aluminum foil, glue and other materials to decorate the outside of container
- prism (optional for Introduction/ Motivation section)

Test Procedure

1. Tell students that their job as engineers today is to design and build a prototype spectrograph for studying a variety of light sources.
2. Hand out student instructions that include directions and diagrams for building a spectrograph.
3. Teachers, using a knife, cut a small rectangular hole, off-center in the lid of the oatmeal container, approximately 2.5 cm wide by 3.5 cm high. Do this for each group before passing out the containers.

4. Cut a hole the same size roughly opposite the hole in the lid on the opposite side of the container.
5. Be careful not to cover any portion of the hole with tape. Gently tape the diffraction grating to the inside of the lid.
6. Cut 2.5 cm off each short end of the index cards. Keep the two pieces you cut.
7. Trim 1.5 cm off the length of the index card pieces.
8. Color the index card pieces black using black marker.

Half way done!

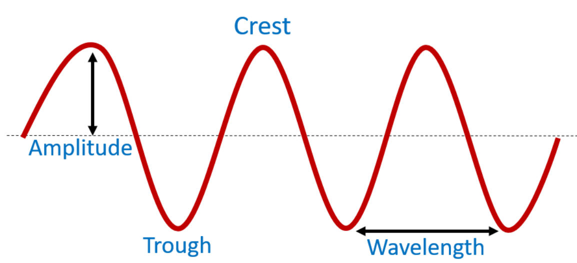
9. Tape the index cards to the bottom of the container with a small gap between them.

10. Using the straightest edge of the index card pieces, tape over the hole in the bottom of the container so that they are almost touching, but not quite. Make a gap of about 1mm.

11. Put the lid back on, look through the lid, and point your spectrograph at the light source. You should see a continuous spectrum (a rainbow) very clearly. If you do not see a continuous spectrum clearly, rotate just the lid until you do.
12. Once your spectrograph is finished, decorate the outside of your container.

Vocabulary

- **diffraction:** When light bends, as through a prism or diffraction grating
- **diffraction grating:** Usually a piece of film designed to act like a prism
- **spectrograph:** (also spectroscope) a tool that allows the components of light to be seen easily with the eye
- **spectrum:** (plural: spectra) The pattern light produces as can be seen through a spectrograph
- **visible light:** electromagnetic radiation at wavelengths which the human eye can see
- **wavelength:** the distance between identical locations on adjacent waves
- **speed:** how fast a wave is traveling
- **amplitude:** the height of the wave from equilibrium
- **frequency:** the number of complete waves, or wavelengths, that pass a given point each second
- **refraction:** the bending of waves when they travel through different material
- **reflection**: when a wave bounces off a surface
- **transmission:** when a wave passes through a given point or medium
- **absorption:** when a wave transfers its energy to the material it penetrates



References

Teach Engineering

https://www.teachengineering.org/activities/view/cub_spect_activity4

https://www.teachengineering.org/activities/view/cub_spect_activity5