

SCIENCE AT HOME

CD SPECTROMETER

GRADE: 9

SNCID, SNCIP

SUBJECT: SCIENCE

STRAND: EARTH AND SPACE SCIENCE

TOPIC: INVESTIGATING STARS —
NATURE OF LIGHT AND CHEMISTRY

EXPECTATIONS: D2, D3, D3.2, D3.3, D3.4

VIDEO: youtu.be/gMNC0Jbq1cl

INTRODUCTION:

Have you ever looked up at the night sky and wondered what stars are made of? Or what light can reveal about the universe?

Astronomers can answer these questions, and decipher the composition of planets, comets, stars, galaxies and the universe at large, by using a technique called spectroscopy and an instrument called a spectrometer.

A spectrometer can identify the chemical composition of celestial objects by analyzing the light they emit or reflect. As it passes through the spectrometer, the light splits, separating into a range of spectral colours.

Each element in the periodic table, in its gas form, produces a specific series of bright, coloured lines. The lines for hydrogen don't look like the ones for nitrogen, and the ones for carbon don't look like those for oxygen. Using a spectrometer, astronomers can read the "emission lines" in light coming from celestial objects to figure out what those objects are made of.

You can do that too – with your own homemade spectrometer. Use it to investigate the emission spectra of light sources you can find inside and outside your home.

ACTIVITY: Build Your Own CD Spectrometer

Build a simple spectrometer using a CD and a cereal box, and use it to observe the patterns of light, or "spectra," of different light sources and measure their chemical composition.



TIME: 30 minutes

SAFETY: When using a utility knife, work on a stable surface, keep your body away from the cutting line and keep your eyes on what you're doing. Keep the blade retracted when you're not using the knife.

Never point the CD spectrometer directly at the Sun.

Never aim or shine a laser directly at anyone, including animals. The light energy from a laser aimed into the eye is dangerous.

WHAT YOU NEED:

- CD (compact disc)
- Thin cardboard box (for example, a cereal box)
- Pencil or marker
- Utility knife
- Protractor for measuring angles
- Aluminum foil (optional)



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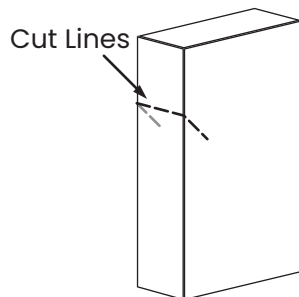
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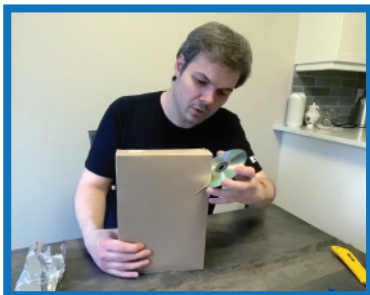
WHAT YOU DO:

Build

- On one of the tall, narrow sides of the box, measure one-quarter of the way down from the top, and draw a straight horizontal line from one edge to the other.
- Now draw two more straight lines, one on the front and one on the back of the box (the tall, wide sides) — 10cm long and at a 30 degree angle from the horizontal line.



- Use the utility knife to cut along all three lines and create a slit.
- Insert the CD into the slit, with the reflective "rainbow" side up.



- On the tall narrow side of the box directly opposite the CD, measure one-quarter of the way down from the top, and cut another small horizontal slit, about 1cm long. This is how light will enter your spectrometer.

- Now cut a hole on the very top of the box. This hole is a viewing window and needs to be big enough for you to look through, about 2cm by 1cm. When you look through the window, you should see the CD directly below.

INVESTIGATE:

Face the small slit towards the light source you want to examine. Your spectrometer will break the continuous visible spectrum of light into many colours. Observe and investigate the unique emission lines from some of the following:

- Incandescent, fluorescent or halogen bulbs
- Streetlights
- LED (like in a clock radio) or LED bulb
- Laser beams (Reminder: Never aim or shine a laser directly at anyone, including animals. The light energy from a laser aimed into the eye is dangerous.)
- Light from a cell phone
- Neon light
- Candlelight
- Computer screen
- Sunlight reflected off a white piece of paper
- Sunlit white clouds outdoors (Reminder: Never point the CD spectrometer directly at the Sun and never look directly at the Sun.)
- Moonlight



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INVESTIGATE (Continued):

Do you notice unique patterns of spectral lines appearing directly on your CD when you view the different light sources?

Think about how the patterns of colour are different for each light source.

Are all colours visible or only some?

Are there dark areas? If so, where are the dark areas positioned?

WHY THIS MATTERS:

Observing these spectral patterns gives astronomers valuable information about objects in the universe and their chemical composition. For instance, astronomers have been able to determine the chemical composition of the outer planets and of distant stars, and also that hydrogen gas is the most abundant element in the universe.

TAKING IT FURTHER:

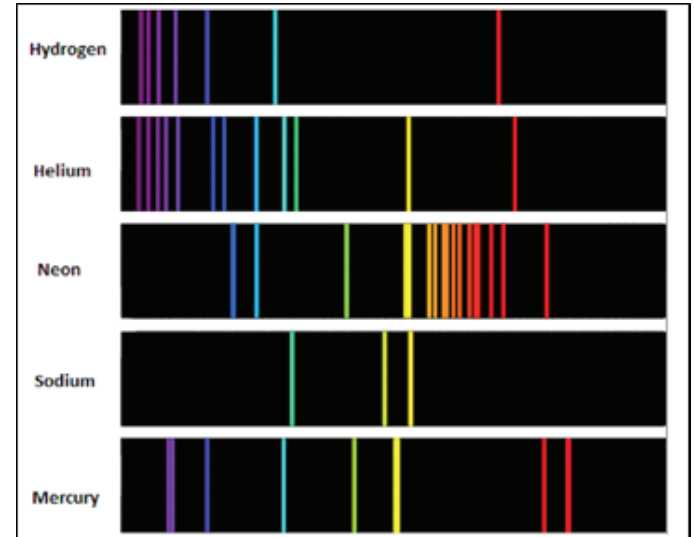
Place a red filter over the eyehole. (You can make your own red filter by colouring some clear plastic film with a marker.) Tape it in place. Can you predict what kind of spectrum you will see? Now try a blue or green filter. How does the filter change the visible spectrum?

Use your cell phone to take an image of spectra inside the spectrometer. Share your results with your classmates.

Match your emission spectra with the emission spectra of known elements. (See the HELP section below.) Your light source may also contain a mix of elements. Mixed light sources are called "compounds."

Create a colour chart of the emission spectrum for each of the light sources you observe.

HELP:



Emission Spectrum of Different Elements



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HELP (Continued):

Spectrum Demo: Continuum, Absorption and Emission Spectra

<http://astronomy.nmsu.edu/geas/lectures/lecture19/slide02.html>

Spectrum Demo: Continuous and Emission

<https://www.youtube.com/watch?v=oae5fa-f0S0>

Tour of the Electromagnetic Spectrum

https://science.nasa.gov/ems/01_intro

MORE ONLINE:

Spectra and What They Can Tell Us

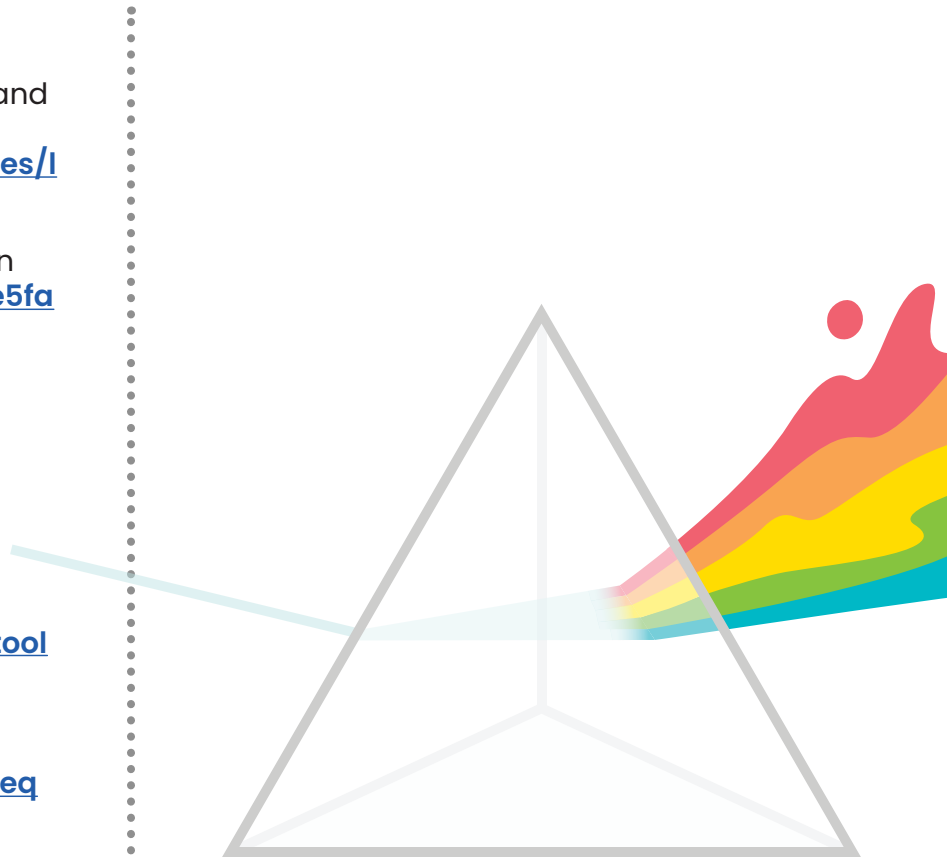
<https://imagine.gsfc.nasa.gov/science/toolbox/spectra1.html>

Crash Course Astronomy: Light

<https://www.youtube.com/watch?v=jjy-eqWM38g>

Emission Spectrum of Hydrogen

<https://www.khanacademy.org/science/physics/quantum-physics/atoms-and-electrons/v/emission-spectrum-of-hydrogen>



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