TEACHER RESOURCE

SCIENCE CONTENT/ CURRICULUM LINK

DEEP SPACE: PHYSICAL WORLD – PHYSICAL ENQUIRY & PHYSICS CONCEPTS

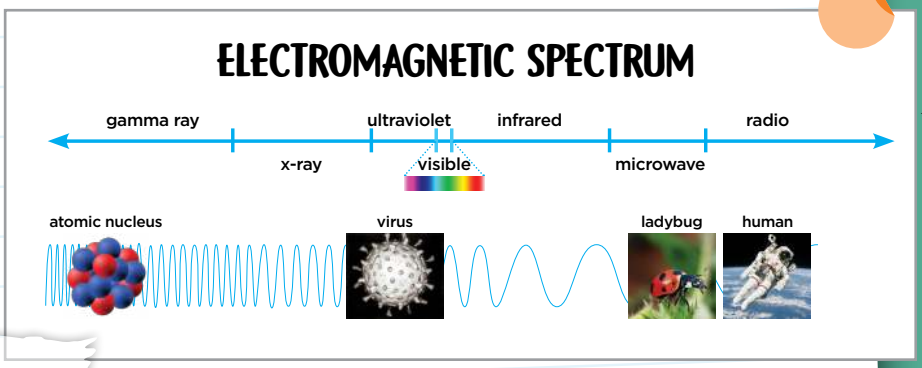
HISTORY OF ASTRONOMY: NATURE OF SCIENCE – UNDERSTANDING ABOUT/ INVESTIGATING IN

STARDOME OBSERVATORY & PLANETARIUM
FACTS, RESOURCES AND ACTIVITIES ON...

SPECTROSCOPY
A WINDOW TO THE UNIVERSE

Almost everything we know about the Universe came to us riding on beams of light. We once used only our eyes to study the Universe. Telescopes extended our horizons hugely then the unwrapping of **spectroscopy** opened an entirely NEW window to the Universe!

Spectroscopy is able to derive properties of stars and galaxies, the material around and between stars, and smaller objects like planets, comets, and asteroids, **without leaving home!** Properties such as their chemical composition, temperature, density, magnetic field, mass, distance, luminosity, and relative motion. It has provided evidence for our galaxy's central black hole, and for Dark Matter, and measured the expansion of the Universe.



Each element or compound has its own spectral 'fingerprint'.

Helium was discovered in the Sun before it was identified on Earth!

As the name suggests spectroscopy derives information from the **'spectra'** of the light from objects being studied. A rainbow is an example of a continuous spectrum – the Sun's light split up into its constituent colours. Isaac Newton understood this with his prism in 1666.

In the early 1800's Mr. Fraunhofer documented dark **lines** in the Sun's spectrum. Some 45 years later Kirchhoff and Bunsen noticed that Fraunhofer's dark 'absorption' lines corresponded with bright 'emission' lines which they had identified in the spectra of known elements heated over a burner.

Dark absorption lines result from an element absorbing wavelengths from light passing through it whereas bright emission lines are given off when an element is hot. These lines correspond to specific wavelengths. Each element creates its own set giving us its **'fingerprint'**.

Furthermore, an element's lines can appear displaced along the spectra – at different wavelengths than expected. This is the Doppler effect in action indicating motion relative to an observer. On the electromagnetic spectrum this is known as blue/ red shift. In the case of sound it is perceived as changes in pitch – e.g. a police siren approaching or receding. Magnetic fields can be measured by means of the Zeeman effect where the dark lines become split into multiple, closely spaced lines.

These few examples give an insight into the power of the science of spectroscopy. It's sophisticated, yet elegant, and especially powerful when employed alongside other methods. An amazing window to our Universe!

Check out these other resources...

- imagine.gsfc.nasa.gov/features/yba/M31_velocity/spectrum/spectra_info.html
- indiana.edu/~geol105/images/gaia_chapter_1/visible_light_spectral_emission_.htm
- rmg.co.uk/discover/explore/astronomical-spectroscopy
- en.wikipedia.org/wiki/Astronomical_spectroscopy

DISCUSSION POINTS

What is the electromagnetic spectrum and what is its extent?

Can spectra be studied in wavelengths other than visible light?

Are some wavelengths better for studying certain objects and if so why?

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ACTIVITY

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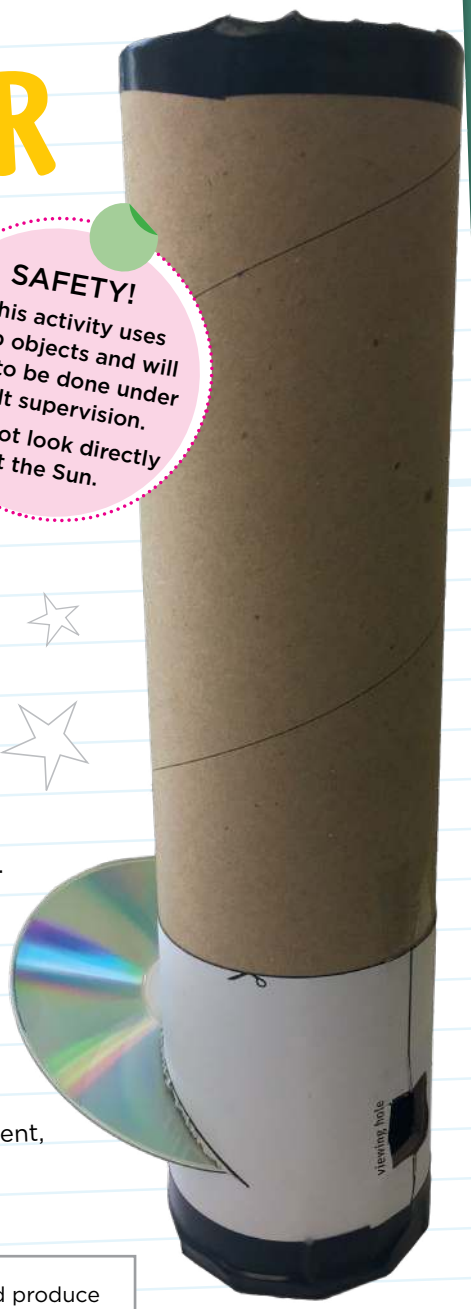
CONSTRUCT YOUR OWN CD SPECTROMETER

Split up light from various sources and observe and photograph your own spectra!



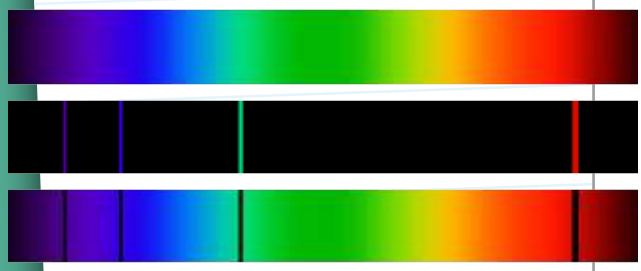
SAFETY!
- This activity uses sharp objects and will need to be done under adult supervision.
- Do not look directly at the Sun.

WHAT YOU'LL NEED:

- A recordable CD
- Cardboard tube at least 30cm long (if the tube comes with two plastic end covers, that's even better!)
- 2x black card
- Black tape
- Cutting guide (attached)
- Craft knife
- Saw

INSTRUCTIONS:

1) Wrap the cutting guide around the tube end, until the viewing holes meet. Our guide is scaled for an 80mm diameter tube, but you can scale yours up or down dependant on your tube size.
2) Saw the tube at an angle along the line on the cutting guide. The cut will make the CD tilt at a 30-degree angle.
3) Use a craft knife to cut out the rectangular viewing hole.
4) Tape black card securely to this end of the tube.
5) Cut a clean slit 1mm wide and 3-5cm long in the other piece of card. Tape to the opposite end of the tube (If your tube comes with a plastic cap, cut a slit in this also and keep it on underneath the black card – it will help keep the extraneous light out).
6) Use black tape to secure any leaks of extraneous light.
7) Insert the CD into the slot, so it reflects light coming through the top slit and into your eye.
8) Point your spectrometer at various light sources (daylight, fluorescent, incandescent or street lights, a bright t-shirt outdoors even!) and observe the different spectra.



Your spectrometer should produce images similar to these. In order, these are examples of continuous, emission, and absorption spectra. The emission lines are produced by a glowing hot gas. The absorption lines are caused by the same gas in a cold state soaking up light from a background source.

Need help?

Follow along with Exploratorium's video
https://www.exploratorium.edu/snacks/cd-spectroscope?media=6869

TAKE A PHOTO OF YOUR ACTIVITY AND SEND IT TO US. WE'D LOVE TO SEE IT! EDUCATION@STARDOME.ORG.NZ

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ACTIVITY

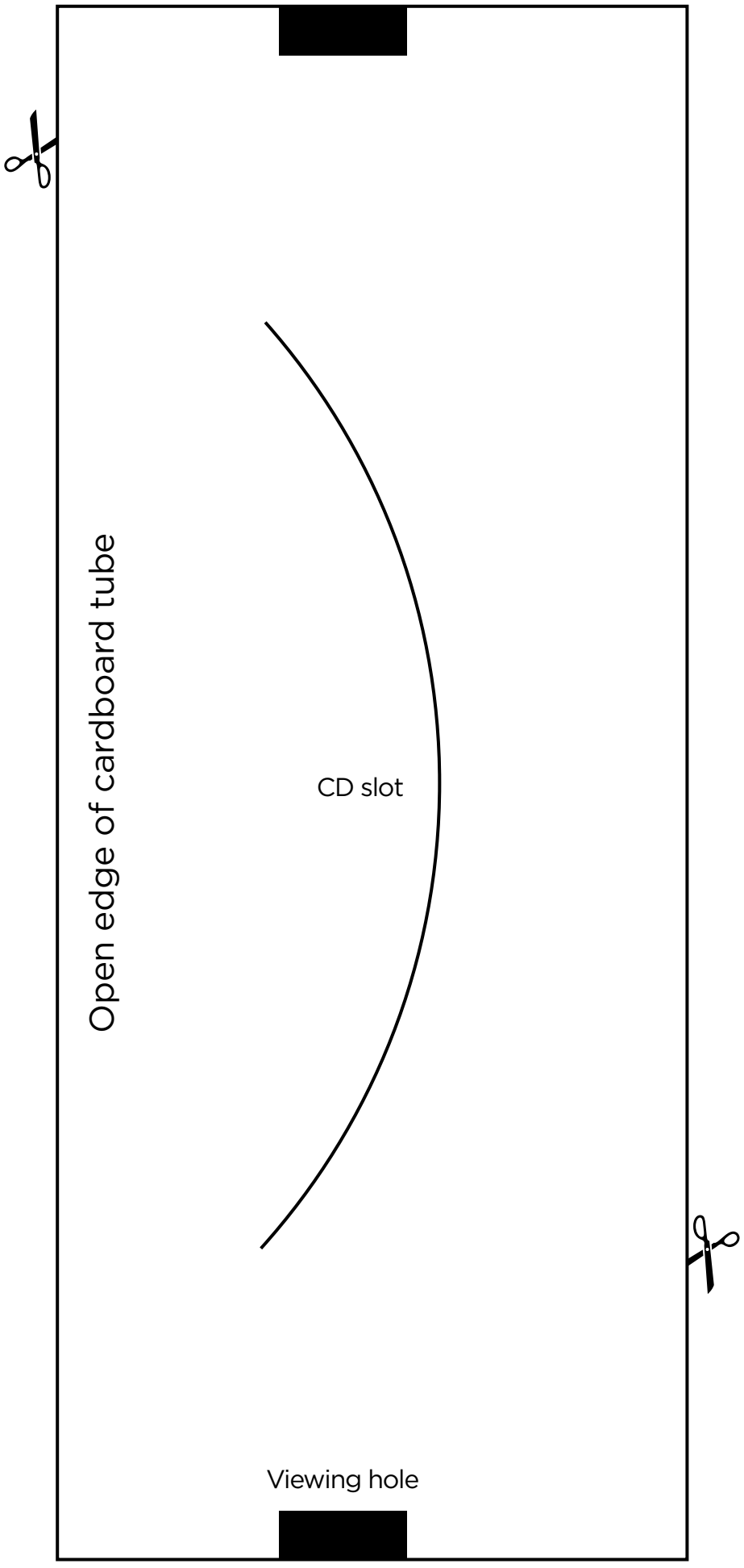
CD SPECTROMETER CUTTING GUIDE

This fits an 80mm diameter tube.

Reduce or enlarge when printing dependant on your tube size.

The edges of the viewing hole need to meet (not overlap) when wrapped around your tube.

Adapted from Exploratorium



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