



## Light's Fingerprints

Use a diffraction grating taped to a Pringles® can to observe that what we perceive as a single colour of light, is actually a combination of colours, called a spectrum.

When atoms are excited by electric current or heat, their outer electrons gain energy, move to higher levels and as they return to their ground states the atoms emit a unique pattern of light, known as a spectrum. Just as human fingerprints are unique to each individual so each spectrum can be associated with a specific element. We might call them the 'fingerprints' of light. And this is the exact method used by astronomers to decipher the chemical origin of the lights of the universe.

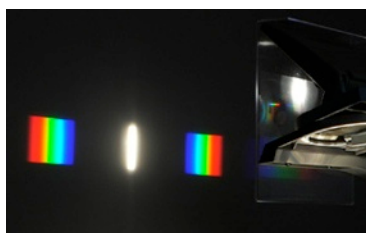
### What is a diffraction grating?

A diffraction grating is simply a light filter or screen made up of very narrow slits (500 slits/mm) – think of very, very small window blinds. When visible light of wavelength between 300 to 780 nm passes through these, the light is bent around the obstructions (1000 nm wide) and produces a specific light pattern known as a diffraction pattern. With ordinary blinds we do not get these patterns as the slit dimensions far exceed the wavelength of the light passing through.

Toy shop **X-ray glasses** use the narrow slits found in **duck feathers** to supposedly create an "X Ray" image of your fingers when held against a light source. This, by the way, makes a great classroom project: Simply cut a cardboard spectacle frame with two 5 mm holes in it and cover the holes with feathers.



Single-axis glasses



Produce a large spectrum from an OHP



Multi-axis glasses

Other popular (cheap) sources of diffraction gratings are rainbow glasses & peepholes. They have diffraction grating film as lenses that disperse light into its constituent colours. The [rainbow peepholes](#) have multi-axis lenses but note that the rainbow glasses come in two types: Single-axis and multi-axis. Most toy shops sell the cheaper [multi-axis type](#) that can be used for general observations. The [single axis glasses](#) are more handy in the physics classroom as you can use them to prepare a large spectrum on a white board from an OHP (overhead projector) or as a lens for our spectroscope. See Downloads on our website for more information on the OHP project.

### How to prepare a Pringles® Can Spectroscope

This is very simple.

1. Cut a small rectangular hole (2.5 x 2.5 cm) in the centre of a Pringles® plastic lid.
2. Cut a single-axis diffraction film from a rainbow glass or you can purchase these in sheets as [Diffraction Grating Film](#). Tape the film to the inside of the plastic lid to cover the rectangular hole.
3. At the opposite end of the can, score a 3 cm slit through the centre of the metal base, using a hobby knife and steel ruler. Take care with the knife!



4. Clean up the rough edges of the slit with sand paper. The slit width is the same as that of the knife blade.
5. Seeing a spectrum: Point the slit-end of the can to a light source and view through the diffraction grating lens. An ordinary incandescent lamp is a good starter.



First rotate the slit and then the plastic lid until the spectra shows up nicely. You should be able to see two sets of identical spectra that are well defined.

6. Try to view as many different light sources as possible. Look for specific colour bands and notice the spacing between the coloured lines:
  - Sunlight & an incandescent bulb will produce a wash of complete rainbow colours. These are known as **continuous spectra**. (These are produced by dense gas or hot solids). Warn students not to view sunlight directly. It may be of interest to mention that the sequence of the spectrum is reversed compared to that produced by a glass prism. Diffraction vs. refraction!
  - A fluorescent light should show a series of bright spectral lines against a dark background. These are called **emission spectra**. (They are produced by low pressure, transparent gases).
  - Out on the street at night sodium (yellow) and mercury (light blue) streetlights will show up different **line emission spectra** made up of bright lines of colour. Each line corresponds to a frequency that is produced by an electron in the mercury (or sodium) atom that changes its energy levels.
  - Turn off the lights, darken the room and view the spectra from [LED Microlights](#). Students should be able to tell which ones are 'pure' in colour.
  - View the different gas emissions that make up the colours of neon signs on shopping strips at night.
7. When viewing the **solar spectrum** and **high-pressure sodium lamps** you may recognise narrow black lines in the spectra. These are related to self-absorption of the light by cool atoms between the source and the viewer. In the sun's case the frequencies are absorbed by sodium, calcium and hydrogen in the sun's atmosphere. As well as oxygen molecules in the earth's atmosphere. The sun's black absorption lines are known as Fraunhofer lines. In general these spectra are known as **absorption line spectra**.