

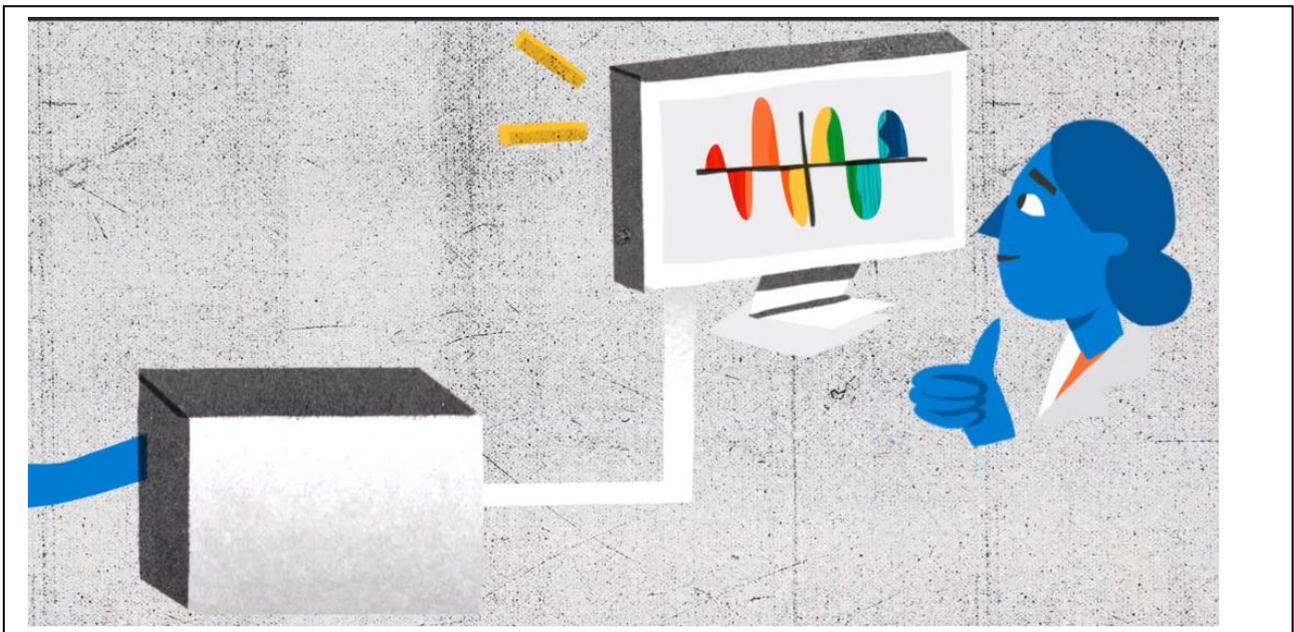


Key Stage 3 – How to read a rainbow

Notes for teachers

At a glance

We send a huge amount of information down fibre optic cables in the form of pulses of light. Currently these light pulses are either 'on' or 'off'. European scientists, lead by the University of Oxford, are looking at ways to send photons imprinted with entire spectra which would allow them to send more information at a time. In order to 'read' the imprinted photons they need to use spectroscopy. In this session, students will create their own spectroscope to look at natural and artificial light sources and find out about some of the other uses of spectroscopy.



Learning Outcomes

- 'White' light is a mixture of different colours that can be split using prisms and diffraction gratings
- Sunlight appears as a continuous spectrum whereas artificial light often has bright lines of individual colours
- Scientists use spectroscopy as a tool for their experiments

Each student will need

- Spectroscope template, scissors, glue, craft knife & cutting mat
- Spectroscope instructions (could be on screen – see link at end)
- Student sheet



Possible Lesson Activities

NB Before the lesson, it is strongly recommended that you make and use the spectroscope yourself. Not only will it provide you with an example of what the finished product will look like, it will alert you to the various steps required to complete the task.

1. Starter activity

- Demonstrate that you can split white light into different colours using a prism (this may be revision).
- Ask students to discuss in pairs where they have noticed this in real life – collect some examples - these will probably include various sections of glass and rainbows.
- If not cited as an example then ask them if they have ever noticed the rainbows/spectra created by CDs, DVDs.
- Pass round some old CDs/DVDs for them to have a look at – if they tilt them they should be able to see spectra on them.
- Tell students that as well as using a prism to split light you can also use something called a ‘diffraction grating’ which has lots of narrowly spaced lines next to each other. If they look carefully at the CD they should be able to see lots of fine lines next to each other (actually a continuous spiral).
- OPTIONAL – A variety of party/clubbing glasses use diffraction gratings and can be bought cheaply (the patterns produced depend on how the lines are ruled). These can be purchased and the students can look at the different patterns formed as well as examining them with a hand lens or similar.



2. Main activity: Make a spectroscope

- Making a spectroscope. There are several online resources for making a cardboard spectroscope using a CD. These instructions are based on using the one found at Arvind Gupta’s excellent Toys from Trash website (see links at the end).
- Tips for making the spectroscopes:
 - If your school has access to a laser cutter it might be possible to cut out the template on that.
 - It is difficult, but not impossible, to cut out the slits well with scissors and far easier to do this with a craft knife. You may wish to consider cutting the slits out in advance.
 - Students often fold the model the wrong way when making the spectroscope. In particular they tend to fold the bottom flaps in rather than out. Get them to check the pictures in the instructions often. Encourage them to look at your example if they get stuck.
 - CDs seem to work better than DVDs for this. They can be cut in advance into wedge.



shapes with sharp scissors/an old fashioned lever guillotine blade - although this will probably dull the blades.

- Make sure students are looking through the right slit when they use it.
- There's a bit of trial and error involved with finding the right angle to view spectra clearly. Encourage them to keep trying.
- You may wish to have some spare models or even diffraction gratings/commercial spectrosopes available for the next part of the session for students who haven't managed to get their spectroscope to work.

3. Main activity: Use the Spectroscope

- Hand out the student sheets (these will take them through the stages below).
- Get students to use their spectroscopes to look at sunlight and one or more sources of artificial light (remind them not to look directly at the sun, though).
- OPTIONAL If you have some emission tubes these are also good to look at – particularly ones with strong lines like sodium.
- Ask them to sketch/describe what they see when looking at the two different types of light.
- They should see a continuous spectrum for sunlight and most artificial light will produce distinctive individual lines (often strong red, green and blue lines).

4. Plenary

- Explain that scientists use spectroscopy for a variety of research; one type of research is to look at the light from stars and other objects in space (e.g., gas clouds/nebulae). By examining the light from these objects, we can, for instance, work out what stars are made of.
- Spectroscopy is also used currently for cutting edge science.
- Show Oxford Sparks animation 'What are quantum rainbows?' (see weblinks section).
- Here they are imprinting pulses of light with an entire rainbow and in order to read it again, they need to use spectroscopy.

Weblinks

- Spectroscope template and instructions:
<http://www.arvindguptatoys.com/toys/CDspectroscope0.html>
- Oxford Sparks 'What are quantum rainbows?' animation
<https://www.oxfordsparks.ox.ac.uk/content/what-are-quantum-rainbows>