Activity F

Rainbows

Introduction

This lesson develops pupils' understanding of how evidence relates to ideas and theories about the formation of rainbows. The lesson starts by asking pupils to provide and discuss their own ideas about rainbows. In the main activity they consider evidence from a series of practical demonstrations and use this to modify or confirm these ideas. The plenary provides an opportunity for pupils to consider evidence about the formation of rainbows and to decide how explanations and theories from the history of science can be matched to the evidence they have seen in the lesson.

Objectives

Pupils will learn:

- that white light can be dispersed to give a range of different colours;
- that their ideas can be modified by thinking about evidence from a number of examples;
- that there have been several competing theories to explain how rainbows form.

Outcomes

By the end of the lesson, pupils will be able to:

- describe how light is dispersed to form a rainbow;
- explain how evidence can be used to back up a theory (e.g. using *Theordoric's* theory);
- match evidence to theories and explanations.

Notes for Teachers

The starter activity could include a slide or large photograph of a rainbow. Pupils should save ideas, recorded on their whiteboards, for later in the lesson. Tell them that this is so that they can change their ideas about rainbows if they need to. The teacher should collect pupils' ideas record them on a board or flip chart.

Demonstrations:
Bubbles and compact discs can be shown to or distributed amongst the class.

Spectra (rainbows) produced by prisms can be demonstrated and later (if desired) pupils can see if they can produce one for themselves using the same apparatus.
The round-based flask is used to show that light shining through a sphere (of water) can produce a 'rainbow' (spectrum). These flasks often exist in the chemistry department but a gold fish bowl can also be used. Small flasks tend to work better.

Answers to questions
Answers to questions on the pupils' sheet will vary depending on what pupils have seen in the experiments and have gained from these experiences. Good answers will draw on the demonstrations they have seen, e.g. for the concept 'White light is split up to form all the different colours', pupils might suggest that evidence for this comes mainly from the experiment using a prism.

Theodoric
Theodoric (1250-1310) was a German monk who looked at what happened to sunlight when it passed through a glass sphere filled with water. He used his observations to work out how rainbows were formed. He hypothesised that light was being refracted and reflected within the raindrop (to form the first rainbow) and then reflected again to form the secondary rainbow.

Theodoric worked out that each raindrop created it's own rainbow whereas Aristotle had previously hypothesised that a cloud was needed to create a rainbow. Theodoric's work remained unknown for 300 years until *Descartes* rediscovered this refraction and reflection in a raindrop in the 17th Century.

Teaching Sequence

- Show pupils a slide or picture of a rainbow and asked them to write on a white board how they think it is formed. Use their explanations as the basis of class discussion.

- Demonstrate different ways of making a rainbow (spectrum)
    - CD (dispersion across the surface)
    - Spectrum produced by a ray box and prism
    - Soap bubbles (interference patters in the surface film)
    - Round flask on an OHP
    - Slide or photograph of a rainbow (thought experiment)

- Ask pupils to set up a prism and light box to see if they can produce a 'rainbow' (spectrum).

- Then ask pupils to return to their original ideas written on whiteboards and make any necessary changes.

- As a plenary, introduce pupils (verbally or using slides) to the theories of *Aristole* and *Theodoric* (see teachers' notes). Issue pupils with a sheet (pupil sheet 1) summarising these theories and two other statements about rainbows. Ask pupils to select evidence from what they have seen in the lesson against these, asking them why they have picked this as evidence. Class discussion on what evidence *Theodoric* might have drawn on to develop his theory and what experiments he might have done.

How are rainbows formed?

What evidence can you provide for following ideas?

White light is split up to form all the different colours of a rainbow.	The different colours in light are brought together to form a rainbow.
According to Aristotle, rainbows are caused by light being refracted by whole clouds.	According to Theodoric, rainbows are caused by light being refracted by single water droplets.