Student Sheet

In this practical I will be:

- Carrying out an experiment and observing what happens when light passes through water droplets.
- Reporting my findings, using scientific evidence to explain my observations.
- Comparing my initial drawings and my results, and reflecting on how my understanding of rainbows has changed.

Introduction:

Whilst travelling north from Athens to Pella, in Macedonia, your route takes you by some awe inspiring sites- the Edessa waterfalls. When you stop to paint a picture of the waterfalls, you see light of various colours. Like all good ancient Greek science-artists, you decide to investigate further…

Equipment:

- Hose pipe connected to a water tap
- White paper, 1 piece
- Dark paper, 1 piece
- Crayons (various colours)
- Felt pens (various colours)
- Towels
- Clear glass bottle or beaker with water
- Good torch with a strong white beam of light

Method:

Your teacher might show you the following experiment but if you are supervised at home you could do it for yourself.

The ‘rainbow’ will be created with water coming out of a hose pipe. Working with another person one of you will spray the water while the other observes the water spray from a number of different angles.

On a sunny day early in the morning, when the sun is low on the horizon, use a garden hose with a fine spray nozzle on to spray a fine mist arc of water so the sun shines through it. One of you is to stand in different positions to look through the spray of water and see if you can see the ‘rainbow’.

Do not look directly at the sun. Change over so you can both make observations. Draw a picture of the rainbow you saw.

Questions:

1. In relation to the sun and the spray of water, where were you looking when you saw the best rainbow?
2. Compare your first drawings of rainbows to the final drawing of the rainbow. Did you get the right colours? If not, which colour(s) were different?
3. Did you get the order of the colours right? If not, which colours were out of order?
4. What was the order of colours in the rainbow you saw?
5. When you drew the rainbow using different types of pen and crayon did you get the same colours? If not, why do you think there were differences?
6. Which pens or crayons and which colour paper would you choose to draw a rainbow accurately?
7. Why do you think the colours are so different from the pens and crayons, compared with the rainbow you saw?

Going further:

Equipment:

- clear glass bottle with screw top lid, full of water
- good torch with a strong white beam of light

Method:

Set the water bottle on a table and shine the flashlight at a sharp angle down through the bottle until the light beam is split into its colours.

Take turns to hold the sheet of white paper where the rainbow appears and to draw the rainbow on to another piece of white paper.

Questions:

1. Which rainbow is strongest; the one made by the spray of water or the one made by the bottle of water?
2. Why do you think there are differences in the two rainbows?

Theory:

If we split **white light** into its component parts, known as the **spectrum** we get **seven colours** that form the colours of the rainbow. They are **R**ed, **O**range, **Y**ellow, **G**reen, **B**lue, **I**ndigo and **V**iolet sometimes written as **ROYGBIV** which can be remembered as a mnemonic '**R**ichard **O**f **Y**ork **G**ave **B**attle **I**n **V**ain', see Fig 1. Indigo is a blue violet colour and often hard to determine so in some diagrams, as below, we see blue and then violet.

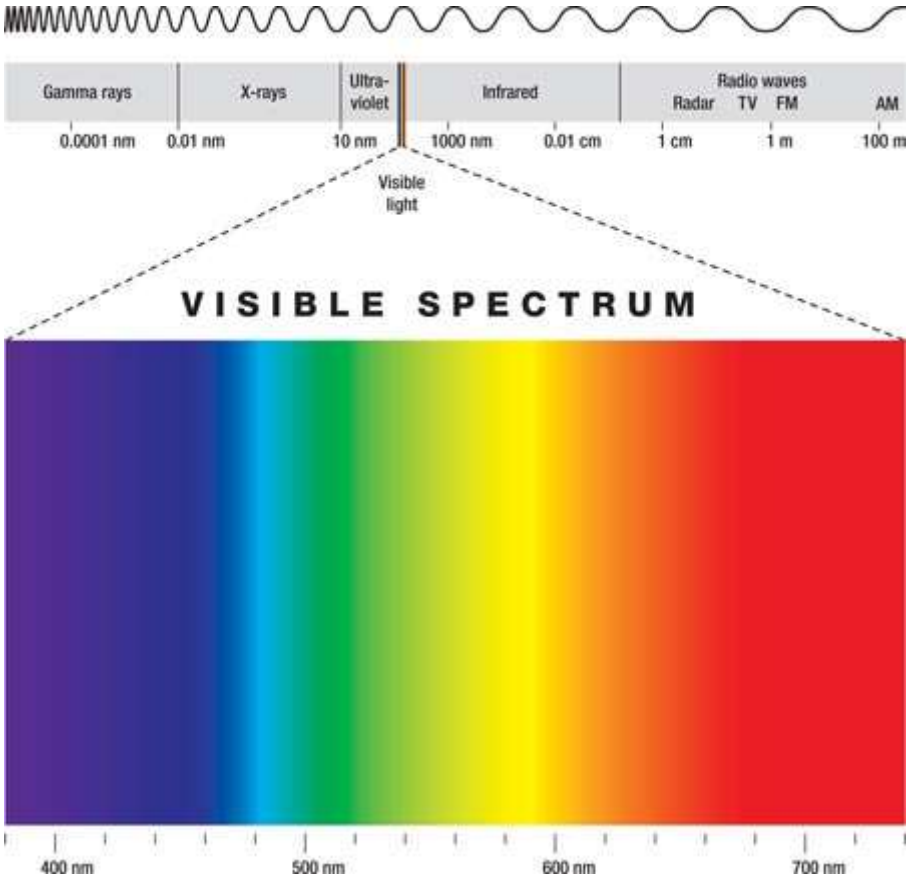

Figure 1: The Electromagnetic Spectrum. © Shutterstock

The rainbow is formed as the sun hits the **arc** of falling water droplets which act as **prisms**. The white light is bent and split, or **refracted**, into the component colours or **spectrum.** The light hits the other side of the water droplet and is **reflected** off the surface back through the water drop to be refracted again as it leaves the drop. **Red** light is **refracted less** than the violet light so it appears on the **top** of the **rainbow** spectrum. The colour pattern of a rainbow is less distinct than that from a glass spectrum, and the colours are less saturated.

Light is made of all the **colours** in the **rainbow**. When it hits a coloured object, most of it is 'soaked up' or **absorbed** and only one colour is 'bounced off' or **reflected**. A red object, for example, absorbs almost the full **spectrum** of light and reflects the red light only.

Our eye is able to see the colour because of **light-sensitive photoreceptor cells** called **rods** and **cones** that are in the **retina,** a layer of **tissue** in the back of the eye.

Rods and cones are stimulated by the different **light waves** reflected off surfaces. The rod or cone cells send **signals** to the **brain**. If no light is reflected, all the colours are absorbed and the surface will look black. If no light is absorbed but all the light is reflected, the object will appear white.

Primary colour is defined as the lowest number of colours that can be used to make the largest range of colours. In art, artists mix the **primary colours of red, yellow, and blue**, but **scientists** use a **different set of primary colours** when talking about the **visible light spectrum**: **red, green, and blue**. These colours can be used to explain how the entire spectrum of colours mixed together makes white light.

When **two primary colours of light** are mixed together, a **secondary colour** is created. For example, red and green light mix to make yellow light. If you mix all three primary colours of light (red, green, and blue) on a single spot on a screen, they form white light. This is called **colour addition. Colour addition** involves combining **different colours of light** to form a new colour of light. The new colour is made by adding different colours of light together.

When an artist **mixes red and green paint** the mixture is closer to **brown** than to **yellow**. This is because **paint colours** combine by **colour subtraction. Colour subtraction** is the process of **filtering out colours**. For example, **red paint filters out (subtracts) green light** and **green paint filters out (subtracts) red light**, so when you mix red and green paint the mixture becomes a muted drab colour, close to brown. As more colours of paint are mixed in, more colours are subtracted, and the mixture becomes darker, eventually becoming black.