In partnership with

UNIVERSITY OF CAMBRIDGE

SPACE TO EARTH CHALLENGE

Space, Sports, Sun and Safety

KS 2/3 Project 4 - Beyond the Rainbow

The aim of this activity is to explore the colours of the rainbow, but also to go beyond visible light and to explore electromagnetic radiation which we cannot see: IR, radio, UV and X-rays.

The colours of the rainbow are produced when sunlight is refracted and reflected by raindrops in the sky. In order to see the rainbow you need to stand with your back to the Sun. These colours are called the 'spectrum' of white (visible) light. The spectrum of colours can be produced in many ways (see .ppt resources), both outside and in the classroom (using a white light torch).

OBJECTIVES

- To explore the spectrum of colours in visible light.
- To find out about Sir Isaac Newton and his experiments with light.
- To learn that sunlight extends beyond the visible.
- To learn about the UV, X-ray, infra-red, IR and radio radiation.
- To find out about Guglielmo Marconi and the first radio communication.
- To learn how to communicate with Morse code
- To explore modern communication, radio, satellites, GPS.
- To learn about space observations of the Sun and stars.

RESOURCES

- White light source (sunlight, lamp or torch), prism, crystals
- CD-ROM, marble, strong glue, template for rainbow colours
- Images from space (some images available in .ppt resources)
- UV beads, card, hole puncher, glitter, felt tips, scissors, star stickers, ribbon
- GPS app on iPad or iPhone
- Morse code dictionary
- Radio transmitter (eg radio-controlled toys)

principia

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Venture Thinking

IF THE IDEAS FOUNDATION

british triathlon foundation trust

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FACT FILE

Sir Isaac Newton, who was born on Christmas day 1642, was fascinated by the nature of light, in particular the colours (spectrum) produced by a prism. He bought a prism in a local market (in Cambridge, where he lived and worked) and did some experiments with light. He let a small shaft of sunlight through a blind and passed it through the prism. This produced the rainbow colours. Then he did something really clever and isolated just one colour (blue or red for example) and passed this back again through the prism, expecting it to turn back to white light. What he discovered was that the blue stayed blue and the red stayed red when it went through the second prism. This showed that white light is made up of the colours, but if you isolate just one colour, it stays that colour, even if you pass it back through the prism again.

In the past, Morse code (see below) was used as a way of communicating by radio, for example people used to get urgent messages in the form of a telegram, when there wasn't time to send a letter. The most urgent call for help. For example from sinking ships, like the Titanic was 'Save Our Souls, SOS, that is 'dot, dot, dot, dash, dash, dash, dot, dot, dot'.

A •–	J •–––	S •••	1 •———–
B –•••	K –•–	T –	2 ••–––
C –•–•	L •–••	U ••–	3 •••––
D –••	M ––	V •••–	4 ••••–
E •	N –•	W •––	5 •••••
F ••–•	O –––	X –••–	6 –••••
G ––•	P •––•	Y –•––	7 ––•••
H ••••	Q ––•–	Z ––••	8 –––••
I ••	R •–•	0 –––––	9 ––––•

On 12 December, 1901, three faint clicks (dot, dot, dot), that is 'S' were sent across the Atlantic Ocean from a cliff in Cornwall, and picked up in Newfoundland (now Canada). This was an extraordinary achievement by the Italian inventor, called Guglielmo Marconi. It was the first time that people could communicate over long distances, something which we now take for granted. He was using a 'wireless', which we now call a radio. The signal bounced off a layer in the Earth's atmosphere (which is charged) called the ionosphere. All modern telecommunications, radio, TV, mobile phones and satellites can be traced back to this moment in time. Much of our telecommunication is now via satellites. Radio telescopes are also used to study the cosmos, for example at Jodrell bank, University of Manchester.

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The GPS (Global Positioning System) is now used to get a very accurate measurement of where we are on Earth, for example for navigation (cars and planes). ESA has been launching its own GPS satellites, called 'Galileo'. GPS also used to track athletes, if they are running, cycling, or indeed playing a game of rugby, to see how well they are performing (how fast they are running etc). With GPS tracking, players wear a small device sewn into a vest under their playing jerseys which collects information about heart rate and position on the field. GPS is used specifically for analyzing fatigue during the game. The astronauts on the ISS still use radio waves to communicate with Earth and indeed to communicate with each other when they are on a spacewalk.

ACTIVITY

The aim of this activity is to encourage the students to explore the spectrum of colours produced by white (visible) light, but to go beyond this. Start by thinking about the colours of a rainbow, and see how beautiful the Earth looks from the ISS. Then extend these thoughts to 'Beyond the Rainbow', to the ultraviolet and X-rays, beyond violet, and to infra-red and radio, beyond the red. Explain how we cannot see beyond the visible, but special cameras can. In order to see the images from these cameras we need to make 'false colour' images. Show some examples for the UV Sun (from SoHO and SDO) and from the Hubble Space Telescope, taken from space.

The students could:

- Explore ways to make a rainbow (eg CD-ROM, bubbles, using a hose…see .ppt slides).
- Draw a picture with the rainbow colours.
- Take a white carnation, put it in coloured water and see colour change.
- Find out about Newton and his studies of colours with a prism.
- Make a Newton's colour wheel, using a CD-ROM, marble, strong glue, template of rainbow colours (see .ppt resources).
- Explore the UV beads - when are they white and when do they change colour?
- Find images of the Sun and stars taken from space.

Other questions to explore

- Have a classroom activity with the children communicating by Morse code. See how long it takes to write and translate a sentence. Compare this with a mobile phone!
- Make a bookmark (as colourful as possible) about space with UV beads.
- Explore which toys are radio-controlled, model airplanes, robots.
- How are tracking devices used to study the movement of animals?
- Make a kaleidoscope.
- Find out about Guglielmo Marconi and the first long distance radio communication.
- How are GPS instruments used in cars and planes?
- Which athletes (swimmers, runners, skiers, cyclists etc) are most at risk from UV radiation?

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- How are GPS receivers used in sports to track runners, cyclists, rugby players etc (HINT: some sports folk wear a GPS receiver on their wrist, others have them inserted in their shirt to track their performance).
- Why do we need satellites in space? (HINT: sending radio signals via the ionosphere is unreliable, in particular if there has been a solar storm)

SAFETY

NEVER LOOK DIRECTLY AT THE SUN.

BOOKS AND WEB LINKS

Sir Isaac Newton
Isaac Newton, by Paul Mason, 'Scientists who made History', 2014, Publ. Wayland

Guglielmo Marconi, the first radio communication across the Atlantic
http://news.bbc.co.uk/1/hi/sci/tech/1702037.stm

Jodrell Bank, University of Manchester
http://www.jodrellbank.net/

ESA's Galileo satellites
http://www.esa.int/Our_Activities/Navigation/The_future_-_Galileo/What_is_Galileo

UV colour change beads are easy to source, one suggested provider is
http://www.stevespanglerscience.com

See short video on Media Space for ideas on producing a rainbow
http://www.mediaspaceuk.co.uk/

See Hubble Space Telescope gallery for beautiful images
http://hubblesite.org/gallery/album/

The Sun Now, images of the Sun from space (Solar Dynamics Observatory)
http://sdo.gsfc.nasa.gov/data/

Sun|trek - information about the Sun, images and movies
http://www.suntrek.org/

How to talk to Tim Peake on the ISS, by radio
https://space.blog.gov.uk/2015/03/27/how-to-make-that-call-talktotim-on-the-iss/