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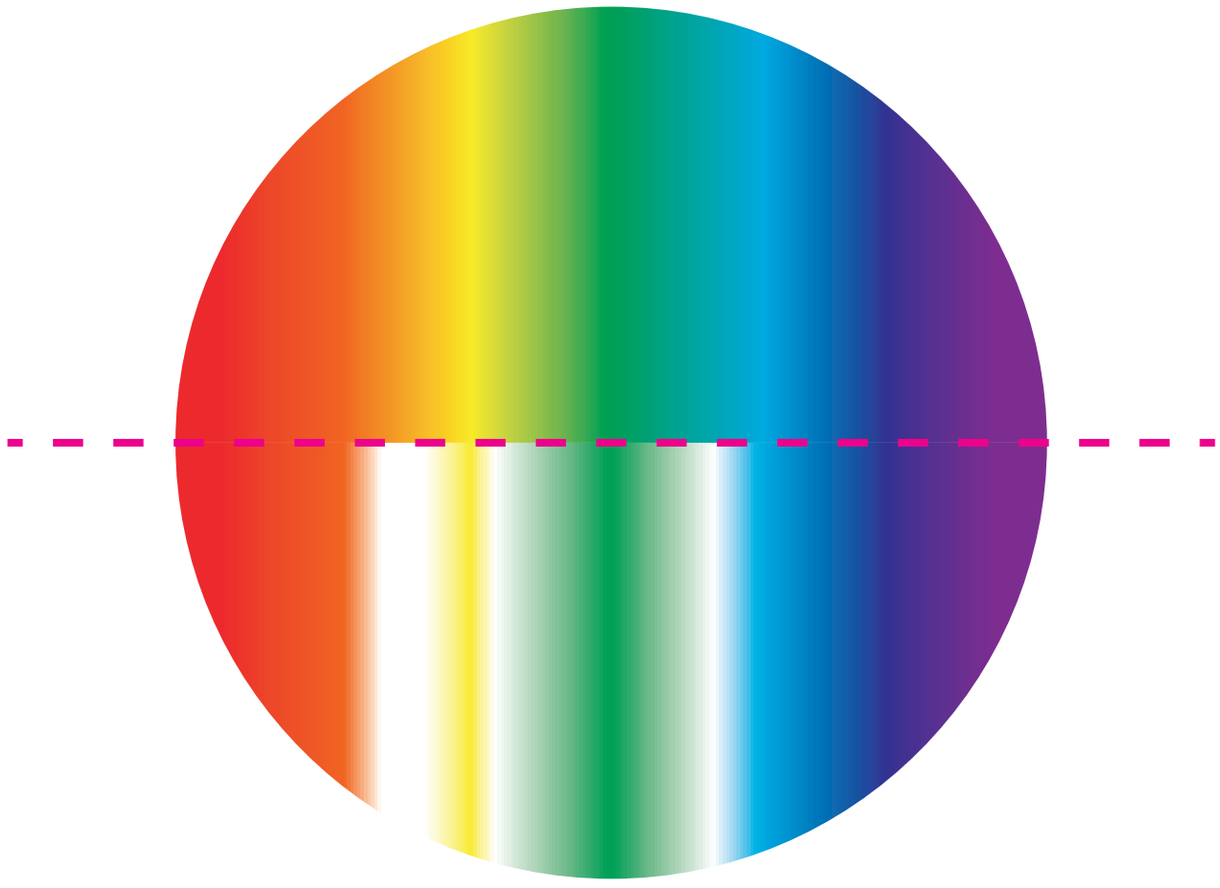
Primary Lessons based on the Twinkle Project



Advancing
Astronomy and
Geophysics

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The Spacelink Learning Foundation is a not-for-profit, private-sector UK registered charity, dedicated to improving science education in schools and thereby helping to increase the supply of scientists and engineers and the public understanding of science and space.

Primary Lessons based on the Twinkle Project

This group of lesson plans has been prepared to support primary school teachers in delivering exciting lessons based around Project Twinkle - revealing, for the first time, the chemical composition, weather and history of a large population of worlds orbiting distant stars.

Lean more about the mission at www.twinkle-spacemission.co.uk

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Additional support materials for these lessons can be found on the Spacelink website http://spacelink.org (menu>Teachers zone>resources zone)

These 5 lessons can be taught as a sequence or on their own.




Advancing Astronomy and Geophysics

These lesson plans have been made possible by the generous co-funding of the Royal Astronomical Society.

Primary Lessons based on the Twinkle Missions

Lesson 1 – Build a Satellite

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Background

A satellite is a moon, planet or machine that orbits a planet or star. For example, Earth is a satellite because it orbits the sun. Likewise, the moon is a satellite because it orbits Earth. Usually, the word "satellite" refers to a machine that is launched into space and moves around Earth or another body in space.

National Curriculum Links UKS2

Pupils should be taught to:

- compare and group together everyday materials on the basis of their properties, including their hardness, solubility, transparency, conductivity (electrical and thermal), and response to magnets
- give reasons, based on evidence from comparative and fair tests, for the particular uses of everyday materials, including metals, wood and plastic

Prior Learning

Children need a basic understanding of materials and their different uses.

You will need:

For each group...

10 x Plastic straws

10 x Sheets of A4 paper

1 x Small roll of sticky tape

1 x Raw egg (unbroken)

1 x Pair of scissors

Find out more about satellites:

NASA
https://www.nasa.gov/audience/forstudents/5-8/features/nasa-knows/what-is-a-satellite-58.htmlb

ESA
http://www.esa.int/esaKIDSen/SEMPX7BE8JG_OurUniverse_0.html

TWINKLE
http://www.twinkle-spacemission.co.uk/

Introduction

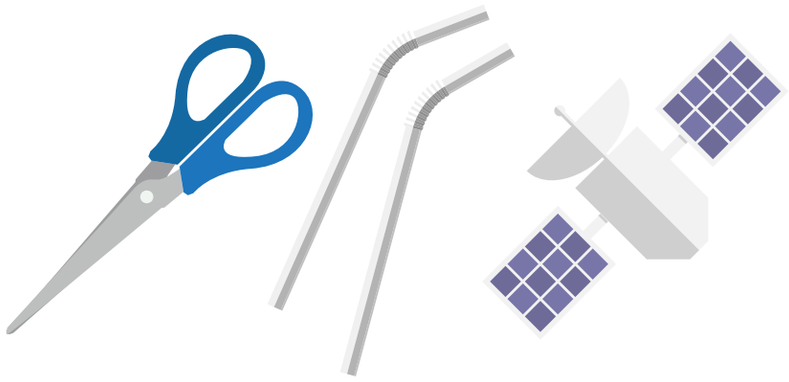
As a whole class discuss:

What is a satellite?

> an artificial body placed in orbit round the Earth or another planet in order to collect information or for communication.
>
> a celestial body orbiting the Earth or another planet.

Explain that the largest satellite of the Earth is actually the Moon. The satellites that we send in to space are called artificial satellites. There are thousands of satellites orbiting the Earth, doing a variety of jobs.

How do satellites affect our lives? Discuss how without satellites there would be no mobile phones or GPS.



Activity – Design and build your own satellite!

When building a satellite a strong but lightweight structure is essential. It must withstand the huge g-forces and vibrations at launch and have a low mass to minimise the fuel needed for launch.

Your task is to build a spacecraft that can hold a raw egg as a payload and undergo a shock test by dropping the spacecraft 1 metre from the ground. Your egg must not be taped to the structure and must be removed after the test. If your egg survives unbroken then you have passed the test.

Primary Lessons based on the Twinkle Missions

Lesson 2 – What materials should a satellite be made out of?

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Background

Satellites need to be made of materials that are able to withstand very high temperatures. They need to be good at transferring heat, via thermal conduction: from the hot side pointing towards the Sun, to the cold side facing out into space.

National Curriculum Links UKS2

Properties and changes of materials
Pupils should be taught to:

- compare and group together everyday materials on the basis of their properties, including their hardness, solubility, transparency, conductivity (electrical and thermal), and response to magnets
- give reasons, based on evidence from comparative and fair tests, for the particular uses of everyday materials, including metals, wood and plastic

Prior Learning

Children need a basic understanding of materials and their different uses.

You will need:

10 jars with lids

A big jug of hot water

Thermometer

A selection of potential insulating materials - use any of the following or choose your own: a cotton sock; a pair of woolly gloves; a pair of sheepskin gloves; any other types of material paper; shredded or crumpled; aluminium foil; cling film; soil; bubble wrap; plastic foam; cotton wool; a plastic bag; cardboard.

Find out more:

BBC
http://www.bbc.co.uk/bitesize/ks2/science/materials/heat/read/1/

Introduction

As a whole class discuss:

What is a satellite?

an artificial body placed in orbit round the Earth or another planet in order to collect information or for communication.

a celestial body orbiting the Earth or another planet.

The Twinkle Space Mission is going to use a satellite to study the atmosphere of Exoplanets and find out what gases they're made of. From this information scientists will be able to work out what the weather is like on the planet and whether it might be able to support life.

Explain that satellites need to be made out of materials which are good thermal conductors (see the background section).

Which materials are good at letting heat pass through them? Which aren't?

Activity – Which materials are good thermal conductors?

1. Fill each of the jars with hot water and measure and make note of the temperature (all the jars should be the same). Make sure you tightly replace the jar lids.
2. Quickly wrap each of the jars with a different type of insulation, leaving one jar unwrapped as a control, and place them somewhere cold.
3. After 30-40 minutes, remove the insulation and re-measure the temperature of the water within each of the jars.
4. Compare the temperatures and work out which materials are the best thermal conductors and insulators.

Extension

What other properties of materials do you think would be important on a satellite? Why do you think satellites aren't made of very heavy materials? How would you investigate this theory?

Lesson 3 – Make your own Spectroscope

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Background
White light from the sun or from other light sources (like a light bulb) is a mixture of other colours. It is possible to split this white light up into the different colours that make it using a simple device called a Spectroscope.

National Curriculum Links UKS2
Pupils should be taught to:
- recognise that light appears to travel in straight lines
- use the idea that light travels in straight lines to explain that objects are seen because they give out or reflect light into the eye
- explain that we see things because light travels from light sources to our eyes or from light sources to objects and then to our eyes

*To support the teaching of the above children could sketch and explain how their Spectroscope works. This will involve: explaining that light travels in straight lines; light travels from light sources.

Prior Learning
Children should have a good under-standing of the basic properties of light and how it travels.

You will need:
A cereal box or something similar
A CD
Tin foil
Sellotape

Introduction

As a whole class discuss the following:

That things which make light (light sources) are called luminous.

What natural light sources can you think of?

What man-made light sources can you think of?

Is the Sun/other stars light sources? Why? Why not?

Is the moon a light source? Why? Why not?

Explain that the Twinkle Space Mission is going to:

Launch a satellite into space that will analyse the light coming from distant stars.

This light will have passed through the atmosphere of any planets that are orbiting those stars.

These are called Exoplanets because they are outside of our own Solar-System.

By studying this light, Twinkle will be able to find out what gases an Exoplanet's atmosphere is made out of and what their weather might be like.

Explain that the children are going to make their own piece of equipment to analyse light, called a Spectroscope or a Spectrometer.

Activity – Make your own Spectroscope!

Make a Spectroscope in advance to help you model the process. This video explains how to make a simple Spectroscope using a cereal box and a CD:

www2.physics.ox.ac.uk/lab-camera-action/make-your-own-cd-spectrometer

Point the lens (slit in the tin foil) at the side of your Spectroscope towards light sources around you. Look through the viewing window (at the top) to see the different colours in each light source. Record what you see in a table.

Light source 1 is ...	
Write the colour(s) you see here	Colour the colour(s) you see here

Light source 2 is ...	
Write the colour(s) you see here	Colour the colour(s) you see here

Light source 2 is ...	
Write the colour(s) you see here	Colour the colour(s) you see here

Is white light truly white? Based on the children's findings, discuss that white light from the sun or from other light sources (like a light bulb) is a mixture of other colours. It is possible to split this white light up into the different colours that make it – that is what their Spectroscopes have just done.

We see rainbows when it is sunny and rainy at the same time. Raindrops in the air split white light from the Sun into lots of colours, in a similar way that Spectroscopes do. What colours do you see when you look at a rainbow?

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Lesson 4 – Design your own Exoplanet

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Background

Exoplanets are planets beyond our own Solar-System. These worlds come in a huge variety of sizes and orbits. Some are gigantic planets hugging close to their parent stars; others are icy, some rocky. The first Exoplanet was discovered in 1992. Since then, nearly 4000 Exoplanets have been discovered and more are being found on a regular basis. Astronomers now believe that most stars have Exoplanets orbiting them.

National Curriculum Links UKS2

Pupils should be taught to:

- describe the movement of the Earth, and other planets, relative to the Sun in the Solar-System
- describe the Sun, Earth and Moon as approximately spherical bodies

Prior Learning

Children should have learnt about our Solar-System and the different planets within it.

You will need:

Paper

Colouring pens/pencil

Find out more about Exoplanets:

NASA
https://exoplanets.nasa.gov/the-search-for-life/exoplanets-101/

BBC
http://www.bbc.co.uk/science/space/universe/sights/extrasolar_planets

School Observatory
http://www.schoolsobservatory.org.uk/

Planetry
http://www.planetary.org/explore/projects/exo-planets/

Sky and Telescope
http://www.skyandtelescope.com/astronomy-news/exoplanets/

Introduction - What is an Exoplanet

As a whole class discuss the following:

What is our Sun? What is a star?

What is a planet?

What planets are there in our Solar-System?

Play 'rocky' or 'gaseous'. Display a picture of each planet – children write on their whiteboard if the planet is 'rocky' or 'gaseous'. Do you spot any patterns?

Play 'hot', 'warm' or 'cold'. As above.

Exoplanet – a planet that orbits another star. Share the definition and following Exoplanets with the children:

Kepler – 16B https://exoplanets.nasa.gov/alien-worlds/strange-new-worlds/

Kepler – 22b https://exoplanets.nasa.gov/alien-worlds/strange-new-worlds/
Explain that the habitable or 'Goldilocks' zone is the region around a star where orbiting planets similar to the Earth can support liquid water. It is neither too hot, nor too cold. For life to exist on a planet there must be liquid water.

Kepler – 7b https://exoplanets.nasa.gov/alien-worlds/strange-new-worlds/

55 Cancri e https://exoplanets.nasa.gov/alien-worlds/galaxy-of-horrors/

Explain that the Twinkle Space Mission is going to study the atmosphere of Exoplanets and find out what gases they're made of. From this information scientists will be able to work out what the weather is like on the planet and whether it might be able to support life.

Activity – Design your own Exoplanet!

1. Decide if your planet is going to be rocky or gaseous.
2. Decide if your planet is going to be close to its star or far away. What effect will that have on the temperature of your planet? Will it be in the habitable zone or not? Will it be covered by oceans or deserts?
3. How big will your planet be? Similar to Earth? Smaller than Mercury? Larger than Jupiter?
4. What is the weather like on your Exoplanet?
5. Give your Exoplanet a name.
6. Draw what your planet looks like.
7. Draw what the surface of your planet looks like.
8. Create a fact-file/poster about your Exoplanet.

Extension

Does your Exoplanet have moons? How many? What are they called?

Is there life on your planet? Do plants grow there?

Primary Lessons based on the Twinkle Missions

Lesson 5 – Design your own Multi-planetary System

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Background

Exoplanets are planets beyond our own Solar-System. If more than one Exoplanet is orbiting a star then you have a multi-Planetary System. There are a total of 620 known multi-planetary systems, or stars with at least two confirmed planets, beyond the Solar-System. About 280 of these have only two confirmed Exoplanets, but some have a significantly larger number. The star with the most confirmed planets is our Sun with 8 confirmed planets, while the stars with the most confirmed Exoplanets are Kepler-90, HD 10180, HR 8832 and TRAPPIST-1, with 7 each.

The TRAPPIST-1 multi-planetary system consists of seven Earth-sized planets orbiting a single star. Three of these planets are within the stars 'habitable' zone where life is considered a possibility.

The habitable or 'Goldilocks' zone is the region around a star where orbiting planets similar to the Earth can support liquid water. It is neither too hot, nor too cold. For life to exist on a planet there must be liquid water.

National Curriculum Links UKS2

Pupils should be taught to:

- describe the movement of the Earth, and other planets, relative to the Sun in the Solar-System
- describe the Sun, Earth and Moon as approximately spherical bodies

Prior Learning

Children should have learnt about our Solar-System and the different planets within it.

You will need:
Paper, colouring pens/pencil

Find out more about multi planetary systems:

www.trappist.one/
www.space.com/35806-trappist-1-facts.html
https://exoplanets.nasa.gov/trappist1/
www.bbc.co.uk/news/science-environment-39034050

Introduction

If this lesson is being taught in conjunction with Lesson 4 'Design your own Exo-Planet' then recap what an Exoplanet is before introducing the Trappist 1 system.

If this lesson is being taught on its own begin by discussing as a whole class:

What is our Sun?

What is a star?

What is a planet?

What planets are there in our Solar-System?

Exoplanet – a planet that orbits another star. Share the definition and explain that some stars have more than one Exoplanet orbiting them – just like our own star.

Introduce the Trappist 1 Multi-planetary System.

TRAPPIST-1 is a planetary system, located 39 light years from our Solar-System. Around a star which is only slightly larger than the planet Jupiter, there are at least seven planets in orbit.

The planets are similar in size to Earth and Venus. Some are within the star's habitable or 'goldilocks' zone.

Explain that the Twinkle Space Mission is going to send a satellite into space that will study the atmosphere of Exoplanets and find out what gases they're made of. It will also be able to discover what their weather is like and if they might be able to support life.

Activity – Design your own Multi-planetary System!

1. Decide how many planets you're going to have in your Multi-planetary system.
   a. Will they be rocky, gaseous or a mixture (like our own Solar-System)?
   b. How big will they be? Some could be larger than Jupiter or smaller than Mars.
2. How closely will your planets orbit the star? Will you have some close and others far away? How will this affect their temperature and weather? Will some be hot, desert planets while others are frozen icy worlds? Will any be within the habitable or 'goldilocks' zone? If so, will they be watery worlds with vast oceans like Earth?
3. What will your planets be called? Will you have a naming system (all of the planets in our Solar-System, apart from the Earth, are named after Roman and Greek Gods and Goddesses)?
4. Draw what each planet looks like.
5. Create a fact file or poster about each of your planets.

Extension

How long does each planet take to orbit the star in your multi-planetary system? Do planets closer to the star have longer or shorter orbits? For comparison, you could research the length of orbits of planets in our Solar-System.

What shape orbits will your Exoplanets have? Circular or elliptical?

What will the star at the centre of your multi-planetary system be like? Research the different types of star to help you decide. Will you go for a Red Dwarf or a Supergiant?