ROAD TO RIAT BLAST OFF

SPACE RESOURCES

Aligned to the National Curriculum,
The Curriculum for Excellence
& The Curriculum for Wales

AGES 11-14 KS3

5 Hands-On Space Activities

- Scale the Solar System
- Sustainable Space Fuel
- Replicating Radar
- Spacesuit Science
- DIY Self-Deploying Satellite

ROYAL AIR FORCE Charitable Trust Inspire

ROYAL AIR FORCE Youth STEM

Developed in partnership with

smallpeice Dare to imagine

Introduction

This resource provides five inspirational, space-themed, hands-on activities for teachers to deliver to students.

These activities are designed to help students contextualise their classroom learning in STEM subjects through an engaging space theme.

Each activity includes a teacher guide and a student worksheet.

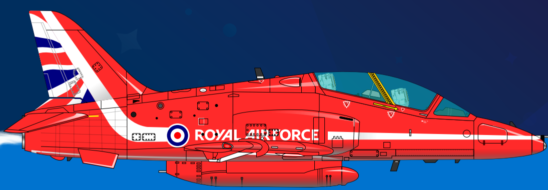
Teachers, please read the resources carefully.
Although the activities are designed to use commonplace materials, ensure you have all necessary items before starting.

Complete risk assessments as required by your school.

These activities support the curriculum for students aged

11-14

They are aligned to the KS3 national curriculum, and curriculum for excellence.



About the RAF Charitable Trust

ROYAL AIR FORCE Charitable Trust Inspire

The Royal Air Force Charitable Trust (RAFCT) exists to inspire young people from 5 to 25 to fulfil their potential in air, space and technology, and to promote the RAF.

THE ROYAL INTERNATIONAL AIR TATTOO

The RAFCT is powered by the Royal International Air Tattoo (RIAT) which in 2024 had over 168,000 visitors. Profits from the show come to The RAFCT to support its objectives of inspiring young people across the UK.

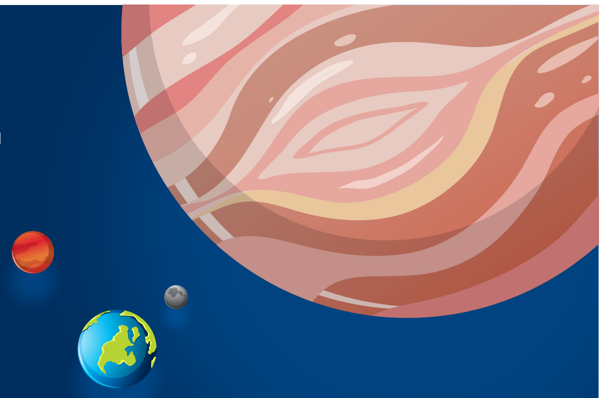
The security of the Nation depends on people who are STEM-aware and are therefore: agile and comfortable with ambiguity; able to think critically; and at ease with science, technology, engineering and maths.

The reach afforded to The RAFCT by RIAT puts it in a unique position to act as a convener; bringing together the defence, aviation and technology sectors with charities and other organisations working to bring the world of STEM, aviation and space to life for young people.

The RAFCT is committed to reaching 500,000 young people with STEM educational engagements by 2026, and 500,000 a year after that, and would love your school to be a part of that journey.

Scale the Solar System

Students will learn about the relative size of space and build the planets in our solar system to scale.



CURRICULUM LINK Ratio and Proportion, Space Physics

EQUIPMENT LIST

Calculators

A3 and A4 Card

Drawing compasses

Pencils

Rulers

Scissors

QUESTIONS FOR STUDENTS

If the diameter of the Sun is 1,393,000,000 km, what would be its diameter in our scale model?
218 cm.

Why do we refer to the Earth's average diameter?
Most planets have elliptical shapes (like a satsuma) rather than a perfect sphere, so we have to take an average.

INTRODUCTION

- Describe what a scale model is and when they are used.
- Explain that the average diameter of Earth is 12,740 km and that students will be making models of Earth with a 2cm diameter.
- Ask the students to work out the scale factor or use the ratio 12,740 km : 2 cm to calculate the scale sizes of the other planets.

METHOD

Students work in pairs or small groups to create a scale model of the solar system using the instructions below:

- Use the scale diameter to calculate the radius of each planet.
- Using a compass, draw and cut out three circle to represent each planet.

NOTE: For some of the smaller planets the compasses may not work so students will need to come up with a different solution (e.g. marking the diameter/radius with a ruler and drawing a circle freehand).

- Cut slits in each circle and assemble the planets as shown in the diagram.
- Put your solar system model in order.

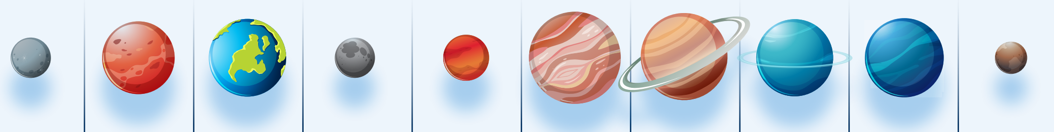
EXTENSIONS

- Ask the students to make models of the Moon and Pluto too.
- If you have space, demonstrate the size of our solar system using the scale distances from the Sun.

This scale factor is 1 trillion (10,000 times bigger than the scale for the model planets)

Mercury: 6 cm, **Venus:** 11 cm, **Earth:** 15 cm, **Mars:** 23 cm, **Jupiter:** 78 cm, **Saturn:** 143 cm, **Uranus:** 287 cm, **Neptune:** 450 cm

PLANETARY DATA TABLE



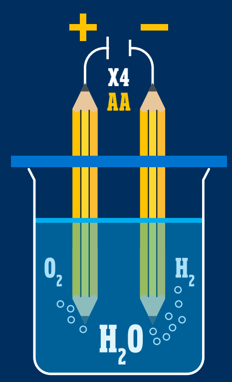
Planet	Mercury	Venus	Earth	Moon*	Mars	Jupiter	Saturn	Uranus	Neptune	Pluto*
Diameter (km)	4,880	12,100	12,740	3,470	6,780	139,820	116,460	50,720	49,240	2,380
Scale diameter (cm) 1/6370×	0.8	1.9	2.0	0.5	1.1	21.9	18.3	8.0	7.7	0.4
Scale distance (cm) 1/1,000,000,000,000×	5.8	10.8	15.0	0.03 (from Earth)	22.8	77.8	142.7	287.1	450.0	591.3

* Pluto and the Moon are not planets, but we've included them here in case interested students ask about them

TIME FRAME = 45 MINS

Sustainable Space Fuel

Students will learn how extracting hydrogen from water using electrolysis can be useful to create sustainable, synthetic fuels.



CURRICULUM LINK Chemical Reactions, Energy, Matter

EQUIPMENT LIST

Large clear container

2 x Graphite pencils (without rubber ends)

Batteries (9V or 4 x AA), including battery holder or battery snap

2 x Wires with crocodile clips

Water (2/3 of your container filled)

Card

Sharpeners

Scissors

Rulers

Blue tac

QUESTIONS FOR STUDENTS

What gases were produced at each pencil electrode?
Hydrogen at negative electrode, oxygen at positive electrode.

Which pencil has more bubbles during electrolysis? Why?
Twice as much H_2 gas will be than O_2 gas. H_2O (water) has twice as many hydrogen atoms as oxygen atoms.

What would be the benefits of using hydrogen-based fuels?
Abundant, easily extracted, non-polluting etc.

INTRODUCTION

Explain that hydrogen and oxygen can be extracted from water and used as rocket fuel. Hydrogen acts as rocket fuel and the oxygen helps it to burn.

METHOD

Students work in pairs or small groups to conduct the experiment below:

- Sharpen both ends of two pencils.
- Cut a circle of card that is larger than the opening of the container.
- From the centre of the circle, measure and mark a point 2 cm to the left and another point 2 cm to the right. This will create two holes that are 4 cm apart from each other.
- Place a piece of blue tac under each point and use the sharp pencils to puncture two holes. Push the pencils halfway through.

OPTIONAL: Dipping the ends of the pencils in washing up liquid will help the bubbles to form during electrolysis.

- Fill the container approximately two thirds full with water. Place the card over the top, like a lid. Adjust the pencils so they have the same amount submerged in water.
- Using the wires, connect the lead of one pencil (anode) to the positive battery terminal and the other (cathode) to the negative battery terminal.

WARNING: **Ensure the batteries and wires do not come into contact with the water and follow school safety measures.**

DISCUSSION

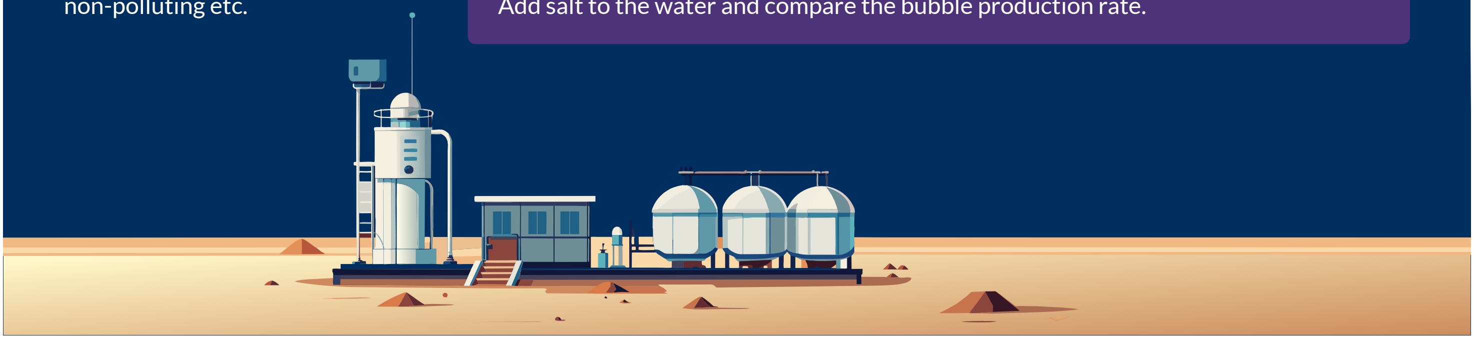
Discuss what the students can see and link to the process of electrolysis.

Discuss how you could represent the chemical reaction.

$$2H_2O \rightarrow 2H_2 + O_2$$

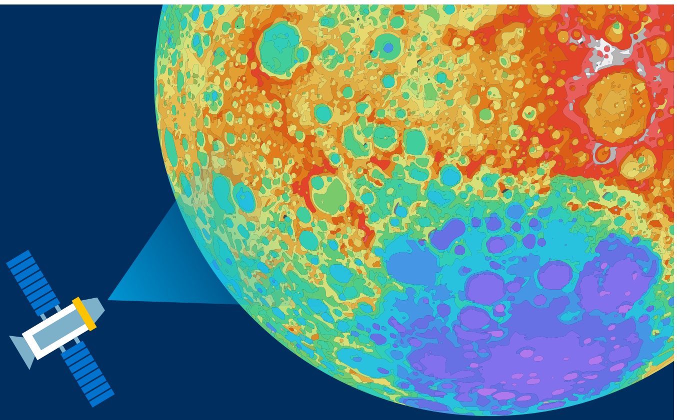
EXTENSIONS

Add salt to the water and compare the bubble production rate.



Replicating Radar

Students will explore how radar can be used to create a topographical map of unseen surfaces.



CURRICULUM LINK Waves

EQUIPMENT LIST

Box/Container (not see through)

Masking Tape

Ruler

Dowel (stick)

Materials of different heights to create landscape

Colouring pencils or pens

QUESTIONS FOR STUDENTS

How can you make your map more accurate?
Using smaller ranges in the key.

How does this technology work in real life?
Radio waves reflect off unseen surfaces. Measuring the return time can tell us the distance.

What else could radar be used for in space?
Detecting objects in space (e.g. asteroids and comets).

INTRODUCTION

Ask students if they know about radar and its uses.

Explain that radio waves penetrate thick atmospheres and reflect off hard surfaces, allowing us to map unseen surfaces. A spacecraft sends radio waves to a surface and measures the return time to determine the distance. Radar data can map the heights and depths of surface features, useful for studying the topography of obscured surfaces like Saturn's moon, Titan.

PREPARE BEFORE

Place items of varying heights into a box to create a landscape.

Using masking tape, create a grid on the top of the box with small gaps in between the strips, large enough for your dowel/stick.

NOTE: The student worksheet has space for a 10x10 grid.

METHOD

This could be done as a demonstration, or small group activity:

- Mark and label each cm along the dowel.
- Insert the dowel through each hole until it meets the surface.
  Record the depth of each square in the grid.
- Create a colour key for the different depths and fill in a grid to create a topographical map.

EXTENSIONS

- Record a line of results on a graph to see a cross section of the landscape and compare this with the map.
- Students can make landscapes for other teams to map.

EXAMPLE KEY

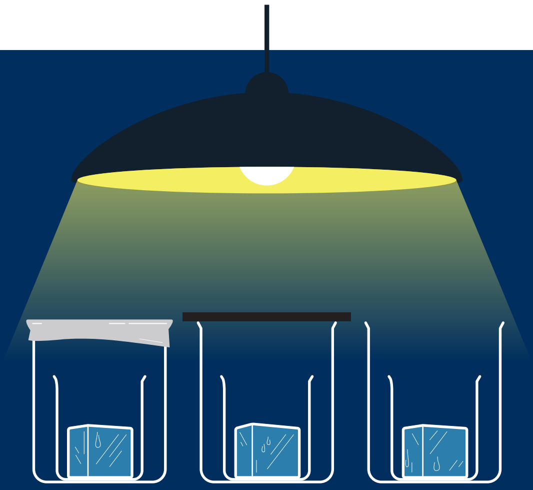
Depth (cm)	Colour
30 - 26	
25 - 21	
20 - 16	
15 - 11	
10 - 6	
5 - 1	

30	30	28	14	13	14	29
28	28	16	15	12	28	29
27	16	14	12	9	22	24
24	21	14	7	6	19	12
24	21	15	4	5	18	17
22	20	10	11	9	9	12
21	18	14	12	10	9	8

TIME FRAME = 45 MINS

Spacesuit Science

Students will conduct an experiment to investigate the thermal insulating and reflective properties of various materials, then apply their findings to design an effective space suit.



CURRICULUM LINK Energy, Waves, Working Scientifically

EQUIPMENT LIST

3 x Small beaker

3 x Large beaker

Aluminium foil

Black card

Ice cubes (or thermometer)

Lamp

Timer

Tray

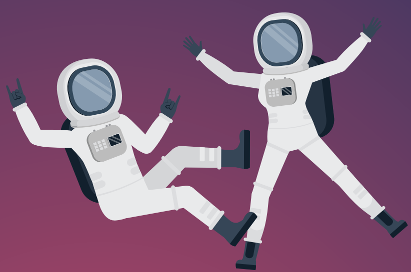
Insulation materials (e.g. Bubble wrap, newspaper, cotton wool)

QUESTIONS FOR STUDENTS

How do the reflective properties of the materials impact the ice cube?
Heat and light is reflected, slowing down the melting process.

What difference does the insulation make?
Insulation slows down the process of heat conduction, slowing down the melting process.

Why do spacesuits need to be reflective and insulated?
To protect astronauts from the extreme temperatures in space. They reflect sunlight and to help regulate body temperature.



INTRODUCTION

- Discuss the conditions in space: temperature, atmosphere, radiation.
- Ask students what spacesuits are designed to do (e.g. life support, pressure regulation, radiation shielding).
- Explain they will conduct an experiment to understand insulation and reflective properties required for spacesuits.

METHOD

Students work in pairs or small groups to conduct the following experiment:

- Place an ice cube into each small beaker, then each small beaker into a large beaker.
- Cover the top of one of the large beakers with foil and another with black card. Leave one as a control.
- Place the beakers under a lamp (or in the sun) for 10 minutes.
- Either observe how each ice cube has changed and photograph or make a small hole for a thermometer to measure at regular intervals.
- Repeat the experiment, but add a layer of insulation between the two beakers. Make sure to use the same amount in each.
- Compare your results.

DISCUSSION

Discuss what the results show about the properties of materials and what this means for spacesuit design e.g. material colour.

DESIGN ACTIVITY

Ask students to draw conclusions from what they have learnt about insulation and reflection and how this can be used within their spacesuit design.

EXTENSIONS

Have students write up their scientific experiment, including a hypothesis, variables, equipment list, method, results and conclusion.

TIME FRAME = 45 MINS

DIY Self-Deploying Satellite

Students will build a self-deploying model satellite.

CURRICULUM LINK Energy

EQUIPMENT LIST

Straws

Dowel

Lollipop stick

2 x Elastic bands

Cardboard

Paper cup (alternatively toilet roll tube/card)

Scissors

Masking Tape

Pencil

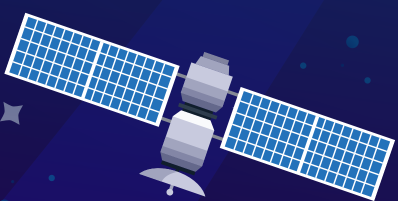
QUESTIONS FOR STUDENTS

Why do the satellite arms open?
The elastic bands stretch when the arms are closed, then snap back when released.

What kind of energy is being used?
Kinetic into elastic potential energy, into kinetic.

Why do satellites need solar panels?
To convert the sun's energy into electricity to power their systems.

Why are solar panels deployed in space?
To protect them during transit when launched into space.



INTRODUCTION

Discuss what satellites are used for in space
(e.g. communication, weather and climate monitoring, GPS).

METHOD

Students work in pairs or small groups to build their model satellite following the instructions below:

- Use a pencil to safely pierce holes opposite each other about halfway up the paper cup.
- Poke the lollipop stick through the holes so there is an even amount on each side.
- Create your satellite solar panel arms by sticking about 12 cm of dowel into a rectangle (5cm x 8cm) of corrugated cardboard. Repeat. You could decorate them to make them look like solar panels.
- Cut 2 x 5cm lengths of the straw.
- Flatten and fold back 2cm at the end of the straw piece. Insert the end of the dowel (solar panel arm) into the open end of the straw and secure with masking tape. Repeat for the other arm.
- Lay your arm on top of the lollypop stick, with the folded straw tab facing upwards at a right angle. Using masking tape, stick the flattened tab to your cup just above the lollipop stick. Repeat for the other arm.
- Cut your elastic bands in half so you have two pieces of "elastic string".
- Using a pencil, safely pierce a hole in your solar panels (cardboard), 1cm away from the end, and thread one end of your elastic through it. Secure it with masking tape.
- Stick the other end of your elastic to the lollipop stick – make sure you do not tape it to the straw. Repeat for the other arm.
- To launch, fold the arms up and throw into the air. The arms will deploy themselves.

NOTE: Do not throw satellites without an adult's permission.

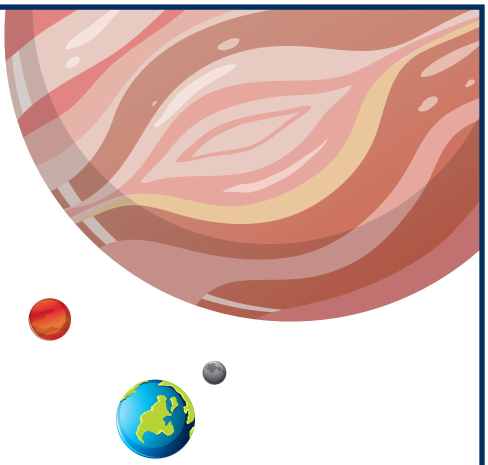
EXTENSIONS

Ask students how they could improve their designs.

Ask students to research the use of satellites in space.

TIME FRAME = 30 MINS

Scale the Solar System



You are going to create scale models of the solar system.

The average diameter of **Earth** is **12,740 km**.
You are going to make a model of Earth with a **2cm diameter**.

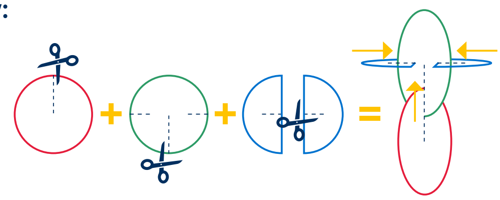
Write the ratio and work out the scale factor we are using in the space below.

Now, calculate the sizes you need for each planet using the same scale factor. **Round your answers to 1dp.**

Planet	Mercury	Venus	Earth	Mars	Jupiter	Saturn	Uranus	Neptune
Diameter (km)	4,880	12,100	12,740	6,780	139,820	116,460	50,720	49,240
Scale diameter (cm)			2.0					

Now create your model of the solar system following the instructions below:

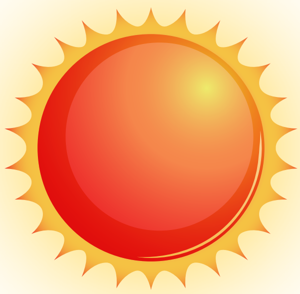
1. Use the scale diameter to calculate the radius of each planet.
2. Using a compass, draw and cut out three circle to represent each planet.
3. Cut slits in each circle and assemble the planets as shown in the diagram.
4. Put your solar system model in order.



CHALLENGE

Create scale models for the moon and Pluto too.

Celestial Body	Moon	Pluto
Diameter (km)	3,470	2,380
Scale diameter (cm)		



If the diameter of the Sun is 1,393,000,000 km, what would be its diameter in our scale model?

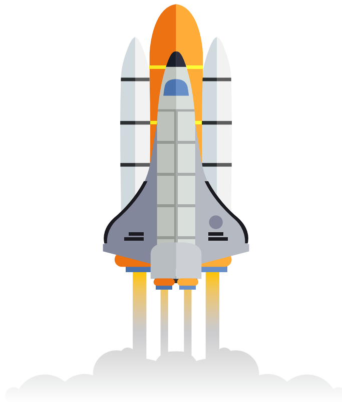
CAREERS IN SPACE

I'm an Astronomy Education Officer at the Royal Observatory Greenwich. My job is to engage students with astronomy through planetarium shows, workshops, and lots of other events. I love it as I get to talk about space every day, and I constantly learn new things; either as new discoveries are made, or after students ask really difficult questions!

To get my job I had to be a confident presenter and have plenty of knowledge about astronomy. My advice to my teenage self is to be open to trying things out. For me, I didn't know this was the right career until I tried it, and I'm so glad I did!

Jessica Lee | Astronomy Education Officer | Royal Observatory Greenwich

Sustainable Space Fuel



Conduct the electrolysis experiment following your teacher's instructions.

Draw an image of your experiment and label what you notice happening.

KEY WORDS

- Anode
- Cathode
- Electrical Current
- Gasses
- Hydrogen
- Oxygen
- Water
- Power Source

Which pencil has more bubbles during electrolysis? Why?

Represent the chemical reaction:

What else could the oxygen be used for in space?

CAREERS IN SPACE

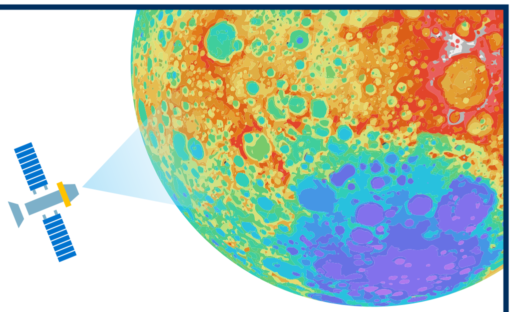
Within my role at NNL, I have been involved in various projects. One project in particular, the Space Battery Programme, took me to the UK Space Conference in Belfast in 2023. This brought about great opportunities and experiences, taking me out of my comfort zone and allowing me to grow and network in the science sector.

I began my journey at NNL through the apprenticeship scheme. My current role is varied, including practical work as well as theory, research and technical report writing. I enjoy that every day is different as it brings new tasks and challenges.

Jessica Gunning | Laboratory Technician | National Nuclear Laboratory

TIME FRAME = 45 MINS

Replicating Radar



Conduct the radar experiment.

- **Mark and label each cm along your dowel.**
- **Insert the dowel through each hole until it meets the surface. Record the depth of each square in the grid.**
- **Create a colour key for different depths then fill in a grid using the space below to create a topographical map.**

Depth (cm)	Colour

QUESTIONS TO CONSIDER

How could you make your map more accurate?

How does this demonstrate radar?

How is radar different from what you have done?

CAREERS IN SPACE

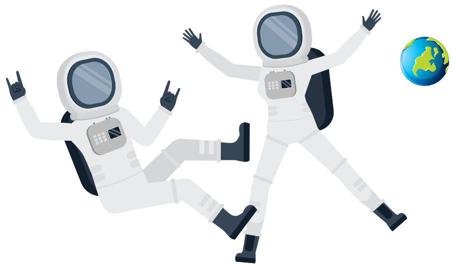
As the Crew Commander at RAF Fylingdales, I get the unique privilege of working as part of a team that contributes to the UK's monitoring and protection of space. Our aim is to ensure space's continued use and development for all, in everything from phones, the internet to weather forecasts!

Still early in my career, the RAF has allowed me opportunities I would have previously thought impossible. This includes representing the UK in our delegation to the Space and Defence Seminar in Marseille, where parties across NATO collected to share knowledge and ideas about the future of the space domain.

Flying Officer Harry Thompson | D Crew Commander | RAF Fylingdales

TIME FRAME = 45 MINS

Spacesuit Science



Embark on Your Design.

Use this space to design your space suit. Draw and label your key features.

QUESTIONS TO CONSIDER

What properties will your materials have?

What features are needed within a spacesuit to protect the astronaut from radiation, extreme temperatures, the lack of atmospheric pressure and micrometeoroids (tiny meteorites)?

What additional features will the suit have?

CAREERS IN SPACE

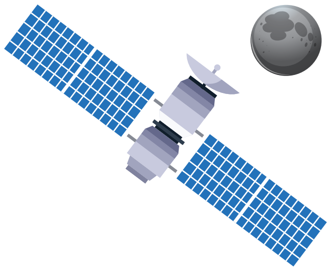
We had an unusual route into the space industry: we both studied Textile Design, with an interest in technical textiles, at Central Saint Martins. We have already utilised the technical skills learned on our course in all areas of antenna manufacturing, designing textiles to withstand the extremes of space. Follow what you're passionate about; you never know where it may lead.

Sophie Hanrahan & Kate Winning

Textile Technicians | Oxford Space Systems

TIME FRAME = 45 MINS

DIY Self-Deploying Satellite



Launch Your Design.

Use the space below to draw your model satellite and label its parts.

Use the space below to draw the stages your satellite goes through as it is deployed. Label any key features.

SATELLITE DEFINITION

Satellites are objects that orbit around planets. They can be natural, like moons, or artificial.

QUESTIONS TO CONSIDER

Why does your satellite deploy automatically?

What are satellites used for in everyday life?

CAREERS IN SPACE

I have wanted to be a space engineer since a trip to the Kennedy Space Centre aged six. I am currently a Systems Engineer at MDA UK working on LiDAR sensors for lunar landing and spacecraft rendezvous and docking. Previous to my work at MDA UK, I completed a degree in Aerospace Engineering at the University of Nottingham, where I undertook an internship at Spaceport Cornwall in my 3rd year.

Jack Wells | Systems Engineer | MDA Space

TIME FRAME = 30 MINS