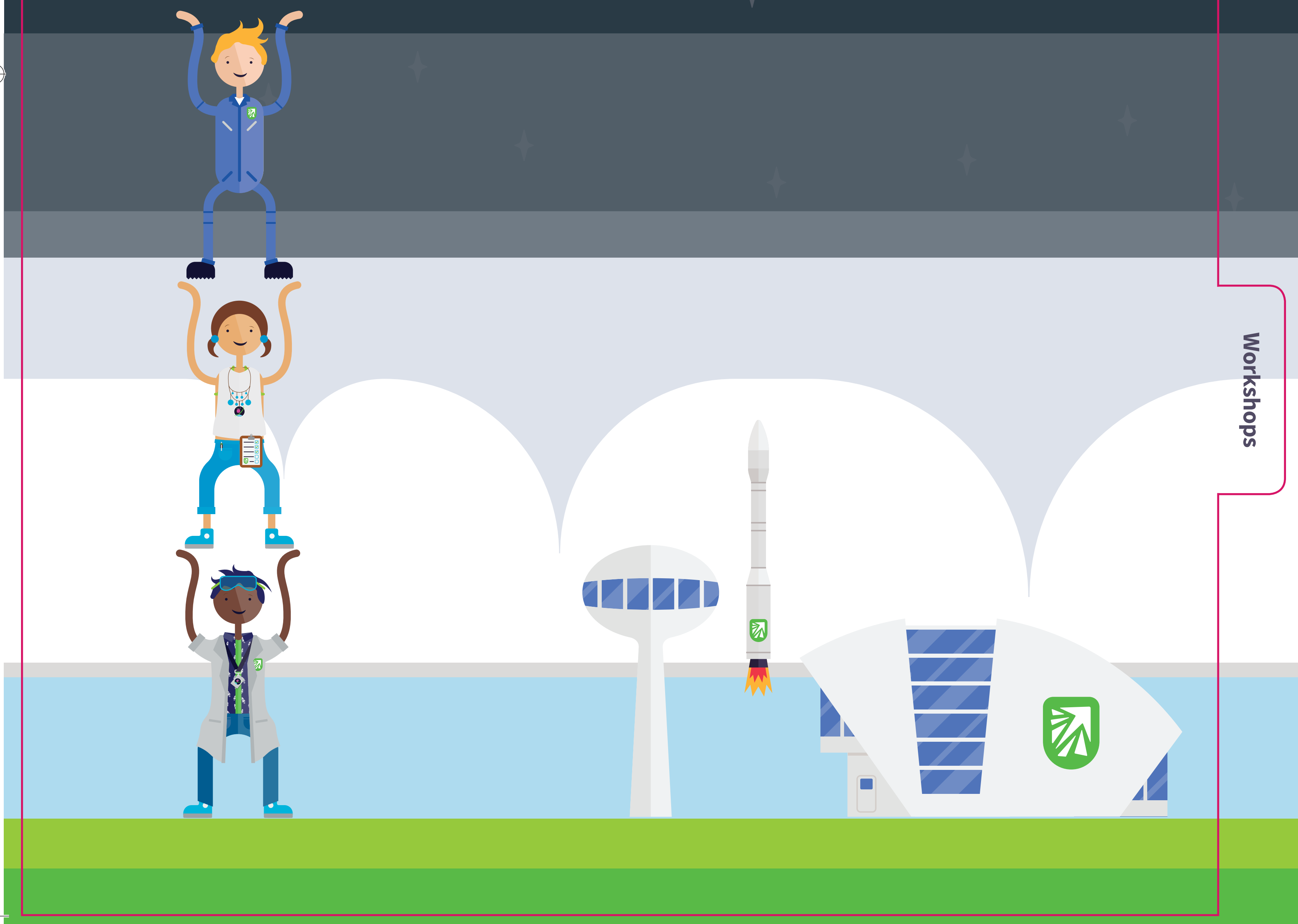
DESTINATION SPACE!

Workshops



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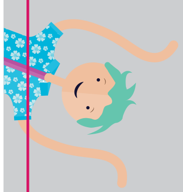


ExoMars workshop 7-11 year olds

This one-hour workshop is aimed at 7 to 11 year olds (KS2 in England and Wales). Students will take on the role of the ExoMars rover, drilling into analogues of Martian soil to take samples that they will then test for pH. Using their results, students can decide which kind of organisms scientists may be looking for on Mars in the future.

Note: a document with the presentation slides, notes and suggested scripting is provided in your training resources.

Introduction

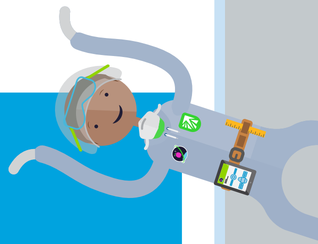
Begin by introducing Mars and the ExoMars mission. This is a good place to emphasise the UK's involvement in the mission and to show the video of the ExoMars test rover in use at Airbus Defence and Space in Stevenage.

Explain that ExoMars is going to be searching for signs of life on Mars.

Discuss with the students what they think they would be looking for on Mars in order to find signs of life. Use the presentation slides to discuss evidence that there has been water on Mars.

Show the video of the ExoMars drill in action and ask the students why they think it is important to look for life below the surface of the planet.

Explain that, due to the radiation conditions on Mars, any life on the surface would probably be destroyed.



Equipment needed

For each group (in trays, ready to hand out):

- Three pots of Mars soil analogue (Pots 1 and 3 containing sand type A doped with bicarbonate of soda. Pot 2 contains sand type 2, plain sand).
- Three pieces of indicator paper
- Three Mars sample corers (modified syringes)
- One beaker of water
- One pipette
- One laminated colour copy of the investigation instruction sheet
- One set of extremophiles cards
- One Mars surface sheet

Per student:

- A copy of the 'Looking for Life on Mars' worksheet
- Pen or pencil

Optional/if time:

- One beaker of hot water
- One beaker of dry ice or cold water
- One glowstick per student

Investigating the soil

Explain to the students that they are now going to take on the role of the ExoMars rover. Talk them through the entry, descent and landing video. You could act it out with the students, getting them to imagine that they are the rover crashing through Mars' thin atmosphere after a long 6 to 9 month trip.

1 Hand each group a tray of equipment and get them to place their soil samples on the correct spot of the Mars map.

2 Demonstrate how to obtain the core sample by carefully screwing the modified syringe into the soil, gently withdrawing it and then pushing the plunger to place it on the laminated investigation sheet in the right spot for that sample.

3 Students will carefully take the lower layer (the beige base sand) and place it into the small sample pot with a lid. Using a pipette, students will add enough water to fill the pot two thirds full before screwing on the lid.

4 The pot needs to be well shaken, for about half a minute, and then left for a few seconds so that the sand can settle.

5 Students then take a piece of pH paper and dip it into the water. Comparing its colour to the pH scale on the laminated investigation sheet, students can note down the results on their worksheets.

6 Once everyone has completed their test and filled in their worksheets, groups can compare their results.

What are we looking for?

Using the presentation slides, explain that an extremophile is a type of organism that lives in extreme environments and go through the examples on the slide.

7 Students take the extremophile cards and look at the information on preferred pH and temperature to decide which type of organism scientists should be searching for in future Mars missions based on their soil test results.

8 They then make their recommendations to the European Space Agency on their worksheets and present their decisions.

The effect of temperature

Ask students if they know what a chemical reaction is. Explain that a glow stick contains two different chemicals, one inside a glass tube and the other outside. The two chemicals mix when the tube is cracked. Crack a glow stick to demonstrate the light that is produced by the chemical reaction.

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Explain that, since the light is produced by the chemical reactions, the amount of light being given off is a direct indicator of the number of reactions taking place per second, or the rate of the reaction. Ask the students to investigate the effect of temperature on the amount of light produced.

9 Give each student a glow stick and place a beaker of hot (but not boiling) water onto their tables. Ask them to crack the glow stick and observe how bright it is.

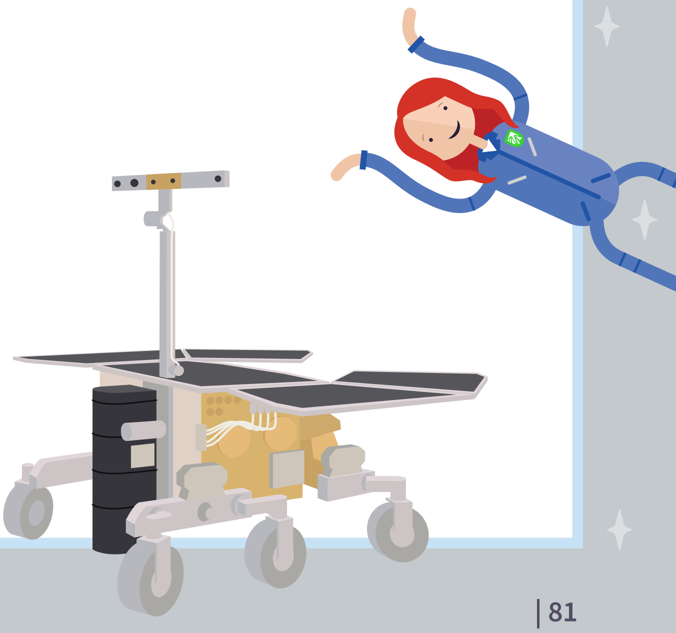
10 Students should then place their glow sticks into the hot water and observe what happens to the brightness (it should increase due to the increased rate of reaction).

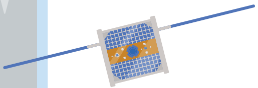
11 Ask the participants to predict what they think would happen if we were to simulate the temperature on Mars by using dry ice or ice water to create very cold conditions.

12 Place a beaker of dry ice or ice water onto each desk or workstation and get the students to repeat the experiment. They should find that the glow stick stops glowing, since the rate of the reaction drops to nothing.

13 Ask students to suggest what would happen to their glow stick on Mars (with an average temperature of -60ºC) and explain that living things use chemical reactions to produce energy from their food. This would be a problem if we are looking for living things on Mars.

Finish off by showing the image of an earlier Mars and evidence that it was more Earth-like in its history. Although life may struggle to survive in current conditions, life may well have existed in the past. If ExoMars or any future missions were to find evidence of life past or present, it would be a huge scientific discovery and create discussion for years to come.





Satellites workshop 7-11 and 11-14 year olds

In this one-hour workshop, the school group splits into teams who work together to test and investigate different areas of science and engineering in order to select the components for a satellite mission.

Combining hands-on science with discussion, decision-making and budgeting, the level and complexity of science covered can be differentiated for 7-11 or 11-14 year olds.

Introduction

Explain that the UK government is currently looking to build a number of space ports in the UK which will allow UK rockets to launch UK satellites.

Ask the students what a satellite is and use the slides to introduce some of the different types of satellite. Explain that they all share some basic components, and that the main body of a satellite is basically a computer box onto which you can attach other sensors and experiments.

Equipment needed

Microgravity team:

- Camera
- Microgravity box
- Water holder
- Candle in jar and lighter

Thermal teams:

- Strips of different materials
- Heat pipe
- Candles
- Infrared camera

Propellant team:

- Spirit burner and tripod
- Drinks can
- Thermometer
- Bottle rocket and track
- IMS, butanol and lighter

Imaging team:

- Near-IR camera
- Fake plant
- Real plant
- Plastic leaves
- Real leaves

Rocket design team:

- Compressed air rocket launcher
- Card and materials for model rockets

Tell the group that they will be working as a satellite design team, investigating some of the engineering and science behind satellite missions, choosing which experiments and cameras to send, working out how big the solar panels need to be, and selecting the right fuel for the launch.

Go through the team briefing slides, briefly explaining each team's role and checking for understanding of the key science terms that they will be encountering.

The activity

The class will be split into six groups. You might want to send the group descriptions to teachers before the session and have the class pre-grouped by the teacher. Some of the activities are more mathematical and require a higher degree of science understanding, so it can be useful for the teacher to decide groups first.

Microgravity research team

This team has the job of using the microgravity box and accompanying activities to understand what microgravity is, what they can study and to choose which microgravity experiment to do.

Internal thermal team

This team must investigate different materials, including heat pipes (as used in real satellites) for thermal conductivity. They will use the infrared camera to find which material is best for conducting heat away from the warm processors inside the satellite. They will have to make a decision about which materials to use, based on both their thermal conductivity and their density. In the space industry, compromises must often be made.

External thermal protection team

This team are responsible for choosing the material to place on the outside of the satellite in order to prevent the side in the Sun from getting too hot. To do this, they use the infrared light activity along with an additional material strength activity to determine the best material to use. This team's big problem will be cost – can they provide enough coverage for the satellite within their allotted budget?

Propellant team

This team have the responsibility of selecting the right fuel to get the rocket into orbit. They will test three different fuels to see which produces the most energy as it is burnt, and will also make a mini Whoosh rocket to demonstrate the principles of rocket motion.

Imaging team

The imaging team has the responsibility of selecting which imaging activities the satellite will do. They will use the near-infrared web cam to investigate plant health and complete the visible imagery activity to find out about Earth observation. They will then need to make a choice of whether to go with a visible or near-infrared imaging platform and present their arguments for this.

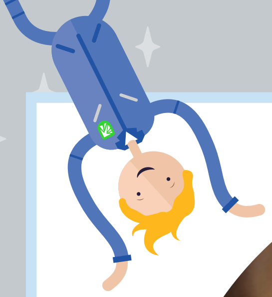
Rocket design team

This team has the responsibility of designing the rocket that will launch the satellite into space. Using the compressed air rocket launch, and after reading through the guide cards, this team must design and test three different rocket designs to be launched vertically. The design that has the longest time of flight is the winner and the team must explain their design features to the rest of the group.

Reporting back

Once all of the teams have completed their activities (and once everyone has watched the launch of the three test rockets) each team must briefly feed their findings back to the rest of the group. The class then selects their chosen components and constructs their satellite. They must then add up the total power cost of each component and calculate which of the solar panels are needed for it to function.

The workshop finishes with a video of 'their' satellite launching into orbit and the discovery of whether they have been successful or not.



Webb workshop 11-14 year olds

This one-hour workshop is aimed at 11 to 14 year olds (KS3 in England and Wales). Using the context of the James Webb Space Telescope, students will learn about waves and the electromagnetic spectrum (EM). They will take on the role of thermal engineers to test different materials for their thermal properties and select the best material to construct a heatshield for the Webb Telescope.

Note: a document with the presentation slides, notes and suggested scripting is provided in your training resources.

Introduction

Begin by introducing the James Webb Space Telescope. This is the biggest telescope that humans have ever launched into space. Explain that it is not like a normal telescope and that the Webb Telescope will not be looking at visible light, but rather at another type of light called infrared.

Excitingly for us, one of the main instruments on this telescope, the Mid-Infrared Instrument (MIRI) had significant UK contributions

Ask if students know what light is and use the slinky spring to discuss what we mean by a wave (a way of transporting energy without transporting matter). Use the slinky spring to set up a transverse wave and discuss what we mean by wavelength (the length of one full wave) and frequency (the number of full waves that pass a certain point per second).

Show the image of the EM spectrum and discuss the different types of wavelength. Ask students to point out the infrared part of the spectrum and describe how its wavelength compares to visible light.

Explain that infrared is a type of light given off by warm things, and that while our eyes cannot see infrared, we do have one way of sensing it and that

Equipment needed

For each group:

- One infrared lamp (plugged in)
- One peg
- A ball of Blu Tack
- A metre ruler
- Three material test squares
- One stopwatch
- One hand-held infrared thermometer
- A copy of the worksheet for each student

For demonstrations:

- One infrared camera
- One bin bag
- One can of deodorant or compressed air
- One Mylar blanket

is via our skin. To properly understand infrared and heat, we can use a special camera that, just like the James Webb Space Telescope, can sense in IR and convert it into images for scientists to analyse.

Demonstration: IR with the IR camera

Choose a selection of the demonstrations you can do with an infrared camera.

Make sure you include the bin bag dust cloud demo and explain that this is one the the things that the Webb telescope will be able to do, to image stars obscured in clouds of dust and gas. You might want to show the IR nebula board at this point too.

Explain that since the telescope is trying to pick up extremely faint thermal signatures, it needs to be very cold. MIRI needs to be much colder than the rest of telescope, so it has a space fridge.

To demonstrate this, take a can of compressed gas (deodorant will do) and focus the camera on the nozzle area of the can. Press the nozzle and watch as the expanding gas cools, leaving a dark area on the image. Explain that the Cryocooler on the Webb Telescope will keep MIRI cold.

Activity: Investigating the thermal properties of materials

Participants investigate which material will do the best job of stopping heat from the Sun warming up the sensitive detectors on the Webb Telescope. In this demonstration, the IR lamp represents the Sun, and the IR thermometer represents the telescope.

At this point, older or high-ability students can be given the equipment and asked to plan their own acitivity, giving particular priority to making it a fair test and controlling variables. Younger students can follow the directions on the sheet:

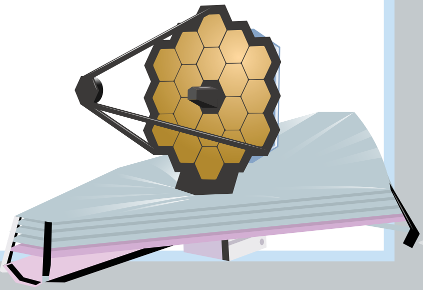
1. Set up the equipment as shown in the diagram, selecting one of the material cards to go in the holder.
2. Turn on the lamp and start the stopwatch at the same time. Hold the thermometer so it directly faces the material that is being tested. Keep the button held down so that you get a real-time view of what is happening to the temperature. Note down any observations, such as the temperature rising rapidly, reaching equilibrium, or dropping off.
3. After two minutes have passed, note down the final temperature, turn off the lamp, and set up the next material for testing. (The lamp may get hot or need time to cool).
4. Older students should repeat the experiment to obtain an average of their final temperatures.
5. Working together in groups, students should decide which material would be best to make the heat shield and explain the thermal properties of the materials that were tested in terms of absorbing, reflecting, and conducting thermal energy.

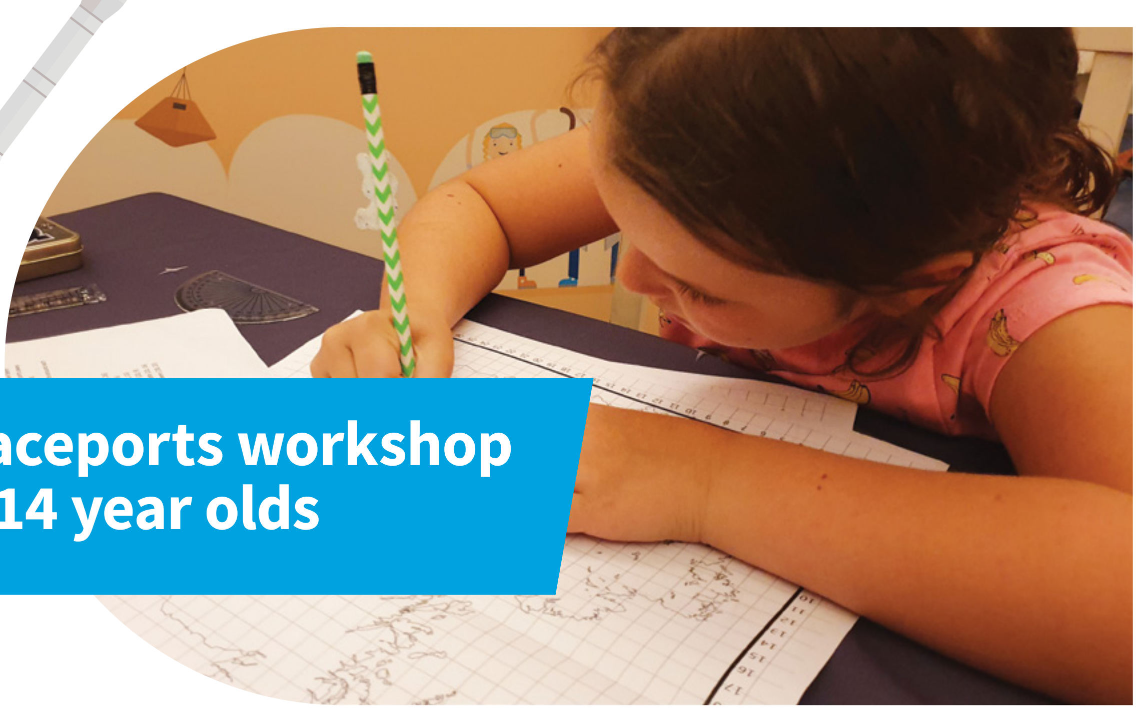
Health and safety!

Students should not look directly at the infrared lamps but should observe from the side.

Review

Discuss the results of each group and ask the students what other qualities a material would need to survive in space. Ask them if they would still use the material they have chosen to protect their spacecraft. Show the video of the James Webb Space Telescope heat shield deploying and tell the students that if any of them are thinking of going into space science or astronomy in the future, they may well be analysing the data that this huge, ambitious telescope will be sending back.





Spaceports workshop 11-14 year olds

In this workshop, 11-14 year olds will consider the placement of the UK's future spaceports. They will consider several factors to help them decide where in the UK might be suitable for future launch sites. They will then present their findings to their colleagues and discuss the pros and cons of each potential site.

Introduction

Start the workshop by introducing the idea that the UK Space Agency are planning to build new spaceports in the UK. Take the opportunity to introduce what a spaceport is and the types of missions that will launch from the UK. Explain that this is a very exciting opportunity that will see UK-made rockets launching satellites into space. Use this opportunity to introduce some of the UK organisations working on building rockets for use at these spaceports. Although there are plans for these rockets, they aren't ready just yet. Ask the participants if they would like to see our demonstration with a rocket that is ready.

Rocket demonstration

Explain the basic principles of how a rocket works and explain what will happen during the demonstration. For additional information on this demonstration, check the 'Whoosh rocket' page.

Equipment needed

- Magnetic map of the UK

For each group:

- 'Map of UK' worksheet
- 'Where to put a spaceport' worksheet
- Compass
- Ruler
- Spaceport magnet

For ethanol rocket demonstration:

- Ethanol bottle rocket
- Measuring cylinder
- Ethanol
- Lighter
- Drain pipe rocket track

For orbits demonstration:

- Inflatable Earth attached to a hat
- Torch

For finale launch:

- Compressed air rocket launcher
- Ready-made cardboard rockets
- Marker pen

Types of orbit

Explain that spaceports in different locations will be useful for launching things to different orbits. Use the different orbits demo to explain a what a low Earth orbit, geostationary orbit and polar orbits are, and ask students which type of orbit the UK will be best placed for launching to. You could use the drywipe globe to help explain this.

Launch-site investigation

Explain to the students that they have been asked to work in small groups and think about where to place a UK spaceport. Explain that they have been given a map of the UK as well as some factors to consider. Using the 'Map of the UK' worksheets, they should investigate these factors, looking at existing infrastructure, proximity to population centres and airports etc. Once they have marked all of these on the Map, they need to make a decision on where to site the spaceport. Then they will have an opportunity to discuss their thoughts with some other groups before presenting their chosen locations.

Student proposed sites

After giving the students some time to complete the activity encourage them to work with several other groups to discuss their own findings with others. Get the students to explain why they picked each site and the pros and cons of each selection. Once the groups have had a small amount of discussion time, get each of the small groups to come up and place a magnet on the UK map. Get them to give a short explanation about why they have picked that site.

Plenary

Once each group has placed a magnet on the board, get the groups to discuss any similarities or differences in the sites selected. Help the students explore how they arrived at their decisions. Encourage them to highlight any additional factors they considered or ideas that they had.

Once their suggestions have been talked about, point out the current proposed spaceport sites. The students can then talk about how these sites compare to their suggestions.

Finale

Since the students have now selected their launch site, it is time to launch a rocket. Have a selection of premade cardboard rockets available with space on them for each group to write their team name. Some can have a wider nosecone, bigger fins, be heavier etc. Teams need to select one based on the rocket that they think will work best for a particular function. If you have outdoor space, this could be launching them vertically and seeing which has the longest flight time. If you do not have the outdoor space, you could fire them through a box with the mission being to cause as much damage as possible.