SPACE

TEACHER / FACILITATOR PACK

Materials developed on behalf of the Royal Air Force to support Glasgow Science Centre Learning Lab.

Materials appropriate for S1 to S5 pupils.

Lesson objective	To learn about space, space exploration and how humans need to adapt to be able to function in space. To learn about diet and energy consumption, communications across large distances and dealing with no gravity.
Duration	Approximate **total** duration of all activities in this resource pack: 1.5 hours. Indicative timings provided for each component.
Context to set the scene for the session	Space is the vacuum between planetary bodies. It is the physical space that is the infinite three-dimensional place where all of the planets, stars, galaxies, and other objects are found and have relative position and direction. However, modern physicists usually consider space, with time, to be part of a four-dimensional continuum. They call this spacetime. On Earth, space begins 100 km above sea level. This is where Earth's atmosphere is said to stop, and outer space begins.

English curriculum links

This activity provides links to experience and outcomes in a number of subject areas covered by the National Curriculum for England *Science programmes of study: key stages 1 and 2*. Specifically, these include:

Purpose of study The national curriculum for science aims to ensure that all pupils: develop scientific knowledge and conceptual understanding through the specific disciplines of biology, chemistry and physics, develop understanding of the nature, processes and methods of science through different types of science enquiries that help them to answer scientific questions about the world around them, are equipped with the scientific knowledge required to understand the uses and implications of science, today and for the future. **Aims (page 3).**

Plants Identify that most living things live in habitats to which they are suited and describe how different habitats provide for the basic needs of different kinds of animals and plants, and how they depend on each other. **Year 2 programme of study (page 10)**

Animals and humans They might research different food groups and how they keep us healthy and design meals based on what they find out. **Year 3 programme of study (page 17).**

Living things and habitats Identify that most living things live in habitats to which they are suited and describe how different habitats provide for the basic needs of different kinds of animals [humans] and plants, and how they depend on each other. **Year 2 programme of study (page 10)**

Forces carrying out fair tests to determine which designs are the most effective…They might design and make products …and explore their effects. **Year 5 programme of study (page 30)**

Sound Identify how sounds are made, associating some of them with something vibrating. **Year 4 programme of study (page 22)**

Scottish curriculum links

This activity provides links to experience and outcomes in a number of subject areas covered by Curriculum for Excellence. Specifically, these include:

By safely observing and recording the sun and moon at various times, I can describe their patterns of movement and changes over time. I can relate these to the length of a day, a month and a year. **SCN 1-06a (Space)**

By observing and researching features of our Solar System, I can use simple models to communicate my understanding of size, scale, time and relative motion within it. **SCN 2-06a (Space)**

By using my knowledge of our solar system and the basic needs of living things, I can produce a reasoned argument on the likelihood of life existing elsewhere in the universe. **SCN 3-06a (Space)**

I have collaborated in investigations into the effects of gravity on objects and I can predict what might happen to their weight in different situations on Earth and in space. **SCN 3-08a (Space)**

By researching developments used to observe or explore space, I can illustrate how our knowledge of the universe has evolved over time. **SCN 4-06a (Space)**

I understand how scientific and technological developments have contributed to changes in everyday products. **TCH 3-05a (Awareness of technological developments)**

Scottish curriculum links (continued)

I can evaluate the implications for individuals and societies of the ethical issues arising from technological developments. **TCH 3-06a (Impact, contribution, and relationship of technologies on business, the economy, politics, and the environment)**

I can explore the impact, contribution and use of various software applications and emerging hardware in business. **TCH 3-08a (Impact, contribution, and relationship of technologies on business, the economy, politics, and the environment)**

I can apply my knowledge and understanding of engineering disciplines and can develop/build solutions to given tasks. **TCH 3-12a (Application of Engineering)**

I can present conclusions about the impact of technologies on the economy, politics and the environment. **TCH 4-07a (Impact, contribution, and relationship of technologies on business, the economy, politics, and the environment)**

I can apply design thinking skills when designing and manufacturing models/products which satisfy the user or client. **TCH 4-09a (Design and constructing models/product)**

Welsh curriculum links

This activity provides links to experience and outcomes in a number of subject areas covered by the National Curriculum for Wales *Science in the national curriculum for Wales: key stages 2 to 4*. Specifically, these include:

Knowledge and Understanding of the World Children should experience the familiar world through enquiry, investigating the indoor and outdoor environment in a safe and systematic way. They should be given experiences that help them to increase their curiosity about the world around them and to begin to understand past events, people and places, living things, and the work people do. Using all their senses, they should be encouraged to enjoy learning by exploration, enquiry, experimentation, asking questions and trying to find answers. They should learn to demonstrate care, responsibility, concern and respect for all living things and the environment. They should develop and communicate an increasing range of appropriate vocabulary. They should learn to express their own ideas, opinions and feelings with imagination, creativity and sensitivity. The children's skills should be developed across all Areas of Learning through participation in experiential learning activities and through using sources such as stories, photographs, maps, models and ICT **(page 10).**

Careers and the world of work Science contributes to careers and the world of work by enabling learners to study a range of applications of science, medicine and technology in their everyday life and in the wider world. This gives learners insight into how scientists work and also develops experimental and generic skills needed for the world of work **(page 9).**

Developing thinking Learners develop their thinking across the curriculum through the processes of planning, developing and reflecting **(page 6).**

Developing communication Learners develop their communication skills across the curriculum through the skills of oracy, reading, writing and wider communication **(page 6).**

Developing ICT Learners develop their ICT skills across the curriculum by finding, developing, creating and presenting information and ideas and by using a wide range of equipment and software **(page 7).**

Developing number Learners develop their number skills across the curriculum by using mathematical information, calculating, and interpreting and presenting findings **(page 7).**

Pupil resources

- Introductory explainer
- Key terms: Solar system, Orbit, Electromagnetic waves, Gravity
- The planets
- Space Factsheet
- Worksheet: Identify the planets
- Worksheet: Design a space capsule
- Worksheet: Space word search
- Worksheet: Quiz

Students are invited to ask NASA questions at #Ask NASA

Hook into the lesson (10 mins)

Play **INTRODUCTORY EXPLAINER**.

Additional context

The solar system was formed 4.6 billion years ago by the huge gravitational collapse of a modular cloud. It has eight main planets. The four smaller inner planets, Mercury, Venus, Earth, and Mars are composed of rock and metal. The four outer planets are substantially bigger. The two largest planets, Jupiter, and Saturn, are gas giants, being composed mainly of hydrogen and helium. The other two, Uranus and Neptune, are ice giants, composed mostly of substances with high melting points. The planets of the solar system, in order of distance from the sun are Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, and Neptune.

We didn't evolve to live on other planets so for humans to venture out to explore space, they have to adapt to living there. The basic needs of astronauts are oxygen, food, water, and rest. To make living on a planet like Mars possible, we would need a lot of these resources.

Why do we want to live on Mars? We know that it is human nature to push boundaries, break down barriers and explore endless possibilities. We are born to dream. And science is making those dreams achievable. Living on a different planet like Mars would help us to learn much more about the planets than what we see beamed down to Earth from satellites and rovers. Some businesses are also thinking about the income that could be generated from creating an alternative habitat for humans. All that new technology, industry and space to work in and to develop. That's a really exciting prospect.

The greatest threat is lack of oxygen due to the vacuum in space. Space exposure can result in hypoxia (lack of oxygen), and death. Space suits are designed to keep astronauts safe in space. They protect the body from extreme heat and cold. They are pressurised, which means they are full of air to breath and support the body.

Space food comes in tubes, cans, and rehydratable packages. Foods taken into space are pre-planned by the mission team and meet nutritional requirements. Astronauts have three meals a day, plus snacks. They need to consume at least 2500 calories every day. Research shows that energy intake in space is lower than on Earth.

Communicating to, from and in space is challenging. Space communication relies on having both a transmitter and a receiver. A transmitter encodes a message onto electromagnetic waves. These waves flow through space towards the receiver. The receiver collects the electromagnetic waves and decodes the sender's message. Astronauts have devices in their helmets which transfer the sound waves from their voices into radio waves and transmit them to Earth or to other astronauts in space.

Hook into the lesson (continued) (10 mins)

Astronauts feel weightless in space when there is nothing opposing the force of gravity. This is because there is no ground or normal force to counteract the force of gravity. The sensation of weightlessness, falling or zero gravity happens when the effects of gravity are not felt. The International Space Station is in permanent freefall above the Earth, but because its forward motion is equal to the speed of its "fall" toward the Earth this means that the astronauts inside are not pulled in any particular direction so they just float. Not having to bear weight on your feet sounds relaxing, but in the long term there are many health problems associated with it. Bones and muscles weaken, and other changes also take place within the body.

So, the journey begins. Human beings will one day discover if the dream of living on other planets will become reality.

Provide pupils with a copy of **Space FACTSHEET.**

- Ask pupils to name some differences about Earth compared to other planets (such as water, life, temperatures etc).
- Ask pupils to think about space missions they have seen or heard about.

Activity (20 mins)

Provide pupils with a copy of **Worksheet: IDENTIFY THE PLANETS.**
Pupils will need to conduct their own online research in order to identify the size of each planet. As an alternative, they could indicate 'small, medium, large, or huge' in order to identify their sizes.

Play **THE PLANETS**.

Play **KEY TERMS**. This outlines:

Solar system - the collection of eight planets and their moons in orbit round the sun, together with smaller bodies in the form of asteroids, meteoroids, and comets.
Orbit - the path that an object takes in space when it goes around a star, a planet, or a moon.
Electromagnetic waves - are created as a result of vibrations between an electric field and a magnetic field and are used to transmit messages.
Gravity - the force of attraction that pulls together all matter. The more matter something has, the greater the force of its gravity.

- Ask pupils if they think it is important to explore space and why.

Activity (20 mins)

Provide pupils with a copy of **Worksheet: DESIGN A SPACE CAPSULE.**

Pupils should design and draw the inside of a space capsule just big enough for two astronauts. They should write a list of the things they will need for their journey to another planet - food, water, navigation equipment, fuel, communications, oxygen, light, heat, entertainment, sleeping quarters etc. Pupils should be encouraged to provide justifications for their choice of equipment and provisions in their illustrations.

- Ask pupils to think about reasons not to explore or live on other planets.

Activity
(10 mins)

Ask pupils to think about planning for food supplies in space. Ask them to solve this puzzle:
(1) It takes three days to travel to the moon.
(2) An astronaut needs to consume 2,500 calories a day.
(3) Each pack of dehydrated space food has 100 calories.

How many packets would an astronaut need if travelling to the moon and back?
(Answer: 25 packets x 6 days = 50 packets).

Provide pupils with a copy of **Worksheet: SPACE WORD SEARCH.**

Activity
(20 mins)

Ask pupils

Provide pupils with a copy of **Worksheet: QUIZ.**

ANSWERS:
Q1: What is the name of the NASA space mission to see if astronauts can live on Mars?
Artemis.

Q2: How many years ago was the solar system formed?
4.6 billion years ago.

Q3: Which of these planets are gas giants?
Saturn and Jupiter.

Q4: Which planet is closest to the sun?
Mercury.

Q5: According to NASA, what are the four basic needs of astronauts?
Oxygen, food, water, and rest.

Q6: How many calories a day do astronauts need?
2,500.

Q7: What is zero gravity?
The state or condition of weightlessness.

Q8: Which planet is furthest from the sun?
Neptune.

Q9: When does NASA hope to achieve their mission to put astronauts on Mars to live?
By 2024.

Q10: The eight planets orbit around what?
The sun.

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CONTEXT AND EXAMPLES

ROYAL AIR FORCE

THE RAF AND PROJECT ARTEMIS

Known as Project Artemis, this transatlantic space programme will see small satellites launched from a rocket beneath a plane's wing.

The modified plane, called Cosmic Girl, carries a rocket attachment beneath its left wing which will be fired into space once the plane reaches cruising altitude.

The RAF Artemis team will collaborate to build, launch, and operate a series of satellites - all from the UK.

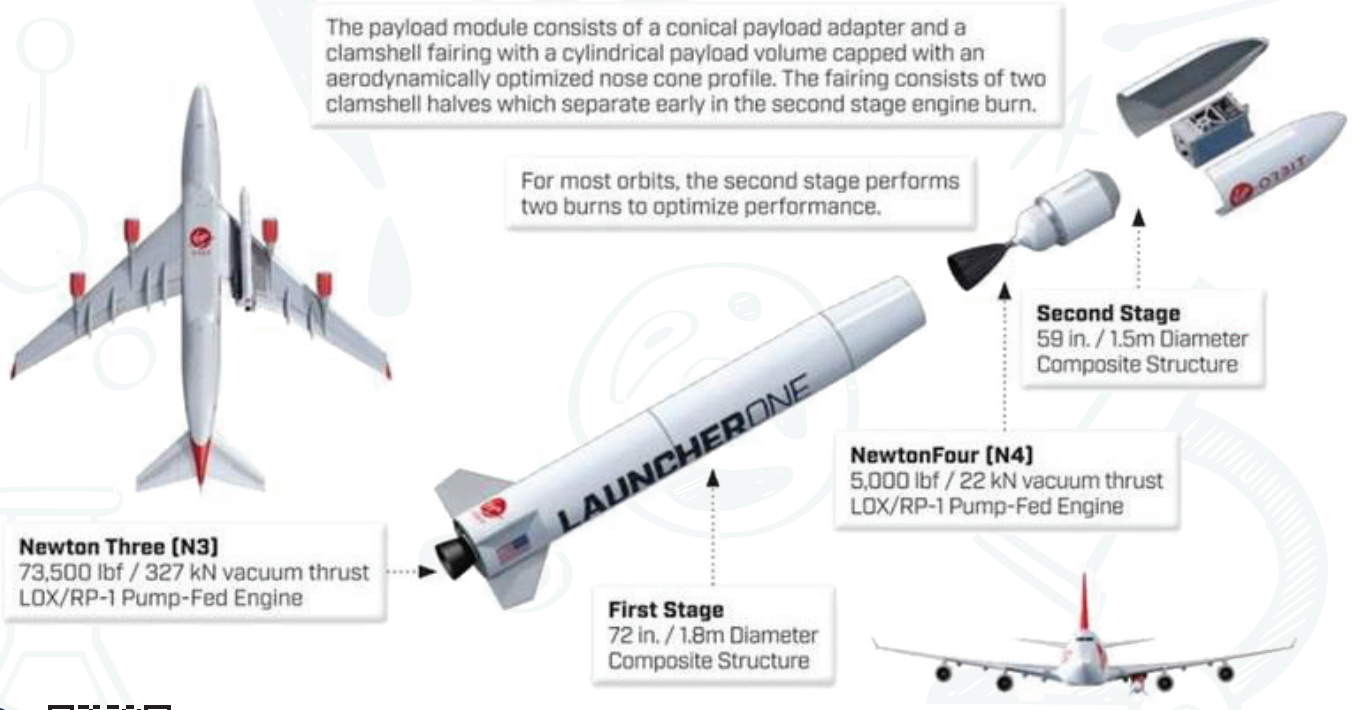
A Virgin Boeing 747 showing the launch system for RAF Project Artemis

SPACE EXPLORATION

The Artemis mission is NASA's space exploration programme to put astronauts on Mars. First NASA are going to send space engineers to practice living on the moon. They are using the moon as a learning environment to see if humans can live there and ultimately live on other planets. They will practice flights, building habitats and monitor how humans cope. NASA is hoping to achieve this by 2024!!

More about the Artemis mission in this short video: NASA Artemis mission.

SCAN ME



SCAN ME

Virgin Orbiter test flights.

SPACE

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CONTEXT AND EXAMPLES

ROYAL AIR FORCE

KEY TERMS USED WHEN EXPLORING IN SPACE

SPACE STATION A large artificial satellite used as a long-term base for manned operations in space.

NASA National Aeronautics and Space Administration. NASA is a U.S. government agency that is responsible for science and technology related to air and space.

OBSERVATORY a building housing an astronomical telescope and other scientific equipment for the study of outer space.

SPACE ROCKETS IN SCOTLAND!

The UK government has committed to launching a space rocket from Scotland by 2022. Work is already well underway to make that happen.

In August 2020, the Scottish Highland Council granted planning permission for a £17.5m facility in Scotland called Space Hub Sutherland. The site is expected to launch up to 12 small satellites a year. These satellites are generally used for Earth observation, including vegetation, weather, cloud cover, ice cover and so on. Much of the science to monitor and understand climate change is enabled by satellite data.

The site will create jobs for the following areas: mechanical and electrical engineering; weather monitoring; control room operations, ground services, rangers, security, fuel services, marketing, management, housekeeping and administration. There will also be posts working with launch and satellite companies.

More information on Space Hub Sutherland website. SCAN ME

Take a video tour of the space hub here. SCAN ME

A NEW FORCE OF NATURE?

Even scientists are learning all the time - a recent discovery might lead the way to a new force of nature which will impact on everything we do, including space travel.

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CONTEXT AND EXAMPLES

ROYAL AIR FORCE

Watch the short interview here:
Jonathan Webster-Jones

SCAN ME

Q&A FLIGHT LIEUTENANT JONATHAN WEBSTER-JONES AND HIS ROLE IN THE UK SPACE AGENCY

ROYAL AIR FORCE

Q: What did you want to do at school?
A: I have changed my jobs a lot but all my career paths have been Science, Technology, Engineering and Maths based.

Q: How many careers have you had so far?
A: At first I thought I wanted to join the RAF. But I changed my mind and went to university to study microbiology instead. It was a short career in microbiology because I changed my mind again. I decided to become a science teacher for secondary schools. Then I changed my mind again and finally decided to join the RAF as a Battle Manager.

Q: What does an RAF Battle Manager do?
A: A Battle Manager monitors UK airspace and ensures there are no threats or suspicious behaviour.

Q: What did you do next?
A: I went into the Space Operations Centre. We monitoring international missile launches and monitor satellites in space. It involves lots of international travel. As a result of my experience I got invited to work at the UK Space Agency.

Q: What do they do?
A: They are involved in lots of missions, projects and programmes. These include launching satellites and telescopes into space from the UK. And we clear up space debris, rubbish that is floating around in space.

Q: What is your role at the UK Space Agency?
A: The programme I am working on is developing a GPS system for the UK. GPS is how mobile phones use satellites for navigation. We are hoping it will play a huge part for autonomous driving in the future. That is cars that can drive themselves.

Q: How do these projects with space interact with us here on Earth?
A: A lot of daily interactions on Earth are heavily dependent on space. We rely on satellites to tell us about the weather for example. This is vital information for farmers and sailors.

Flight Lieutenant Jonathan Webster-Jones talks about his role in the UK Space Agency

Q: Is working in the space sector enjoyable?
A: Yes, the speed it is developing is really exciting. The space race between SpaceX and Amazon is making things move quickly.

Q: What is the big ambition?
A: We want to go back to the moon within the next decade, then to Mars in the near future.

Q: Do you have any advice for students who want to work in the space industry?
A: The space sector is one of the fastest growing sectors within the UK. Think about what kind of job they might like. There are so many jobs. Just looking at satellites as one example, you can go into designing, launching, steering or flying satellites. Look at lots of different companies, such as the governments UK Space Agency or the RAF for example. Find out the qualifications you need. But don't worry too much as not all career paths go in a straight line. Mine didn't.

Q: Any other advice for students?
A: Keep up to date in what is going on in this sector on websites or follow someone like Elon Musk on Twitter.

Q: What are your aspirations for the future?
A: I'm looking forward to working abroad in the space sector with other nations. It's exciting being able to witness projects coming, like going back to the moon and then going to Mars. And I want to continue developing my own space knowledge.