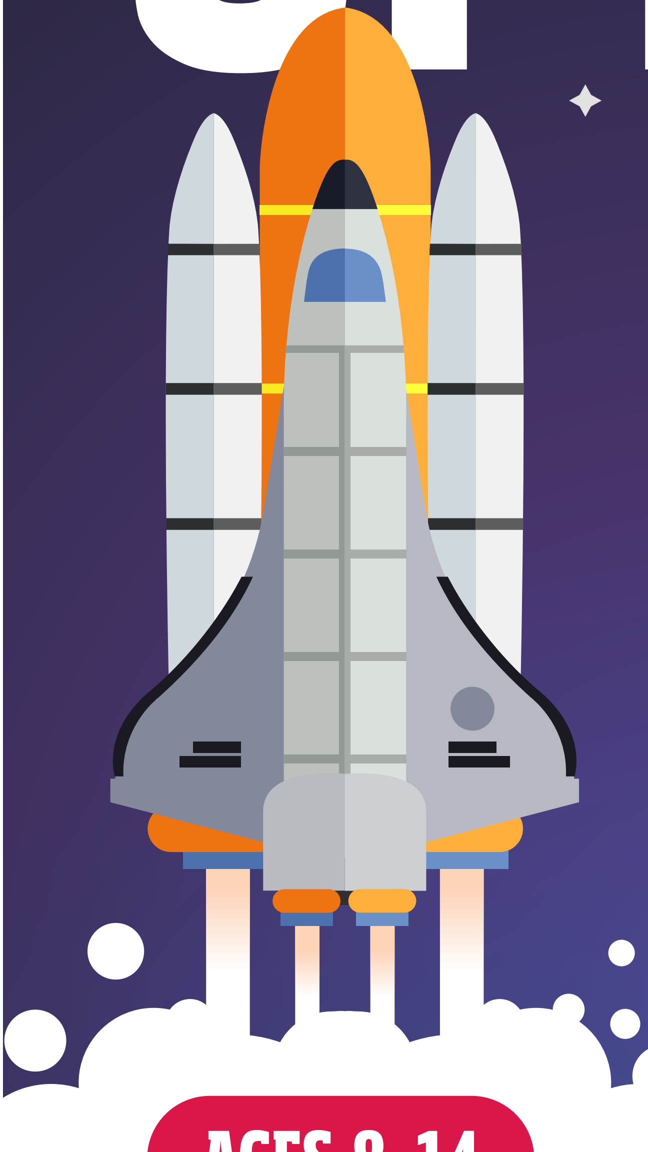
Schools Roadshow 2023

SPACE



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

5 Great Activities Inside

Rocket Launch!

Solar Showcase

Planets: How big are they?

Launchpad

DIY Oxygen

Suitable for those who attended the BAE Systems Schools roadshow or not

AGES 8-14

Developed in partnership with

smallpeice
Dare to imagine

BAE SYSTEMS

ROYAL AIR FORCE

ROYAL NAVY

Introduction

We have an electrifying collection of Space activities for teachers to read, plan, and deliver to students.

These activities support the curriculum for students aged **8-14**

For England and Wales
That's Key Stage 2 Science and Key Stage 3 Physics, and the Curriculum for Wales.

For Scotland
That's the relevant sections for science and physics in the Curriculum for Excellence.

If you're a teacher, please read through the activities carefully – they're designed so you can use the common materials around you, but it's best to make sure you have them all before you start! There is also plenty of career information at the back.

Please complete risk assessments as required by your school.

If you're a student, please be careful and sensible – we want you to have fun, learn about space, and take good care of yourselves.

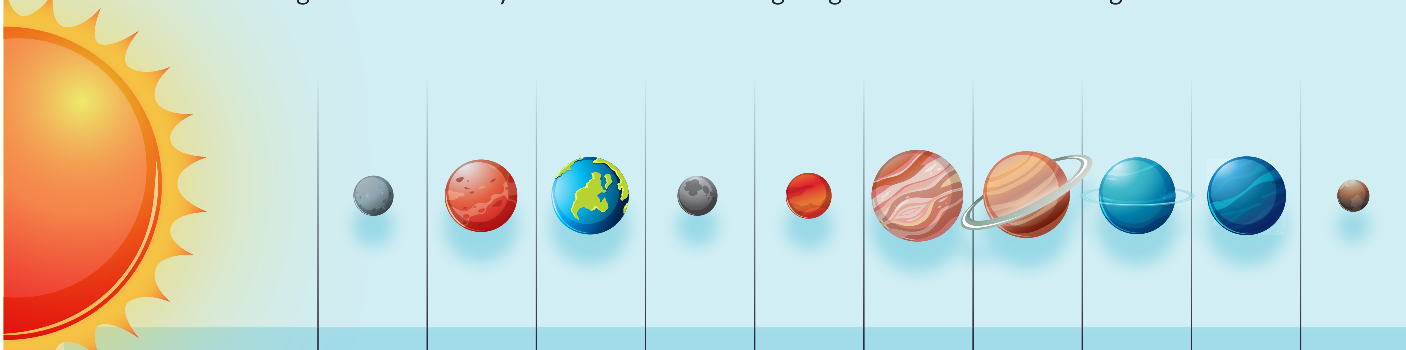
The activities get more difficult as you progress:
You may want to skip to a later activity or stick with the first few – it's entirely up to you.

It's up, up, and away!

Short hops to space, planet-building, and even making your own oxygen!

DON'T GET LOST IN SPACE

A data table that might come in handy for some activities or giving students extra challenge.



Planet	Mercury	Venus	Earth	Moon*	Mars	Jupiter	Saturn	Uranus	Neptune	Pluto*
Diameter (km)	4,880	12,100	12,750	3,470	6,780	139,820	116,460	50,720	49,240	2,380
Scale diameter (cm) 1/603,750× Not useful for scaling distance	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× Not useful for scaling size	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

Rocket Launch!

ACTIVITY 1

Students will design and build their own rocket, testing how far they can launch it.

They will improve the aerodynamics (how smoothly it flies) so that the rocket can travel faster and further, as well as look good.

EQUIPMENT

Coloured card

Plain paper

Scissors

Straws

Tape

QUESTIONS FOR STUDENTS

Why did the rocket need to be airtight at one end?

What was the roll of the fins on the rocket?

How could you improve your rocket to make it go further? faster?

WORK ON

AIMING HIGH

LISTENING

METHOD

- Explain aerodynamics to the students:
  - The fins on rockets guide air past the body, stopping it from rolling
  - A pointy nose helps them fly through the sky with less air resistance than a flat nose
- In pairs, get the students to design their rocket on plain paper
- Once their designs are complete, they can build their rocket using card to make the tube-like body, fins and a nose cone
  - **A third of a piece of A4 card** is enough for the body; roll this into a long tube, trim off about a third, and use tape to hold it in place; students can roll it tightly around a pen to get the right size
  - Use tape to seal one end of the tube, keeping it round at the end (don't squeeze it)
  - Pointy nose cones can be made using a circle of card with a diameter of about 5 cm … students should make a radial cut and fold it around itself until its pointy, then use tape to hold it in place, forming a cone
  - Use tape to attach the cone to the sealed end of the tube
  - Fins need to stick out straight from the base of the tube and follow the direction of travel – 3 is enough, and students can experiment with number and design
- Give a straw to each student; students can launch their rocket by placing it on one end of the straw and blowing through the other
- Discuss with the students how the angle they launch their rocket at could affect the maximum height or time of flight of the rocket

Make sure their tube is airtight at the nose cone end otherwise they won't be able to launch it

EXTENSIONS

- Measure the distance rockets travel
- Measure the maximum height the rockets reach
- Keep a leader board

RELATED CAREERS

Designer

Uses sketching, software, and imagination to communicate how things should look and work.

Aerospace "Rocket" Engineer

Designs rockets, including their engines, bodies, and fuel tanks. They create and test prototypes to make sure that the real things work properly.

ENRICHMENT

CHECK OUT - **www.bit.ly/spt-rocket**

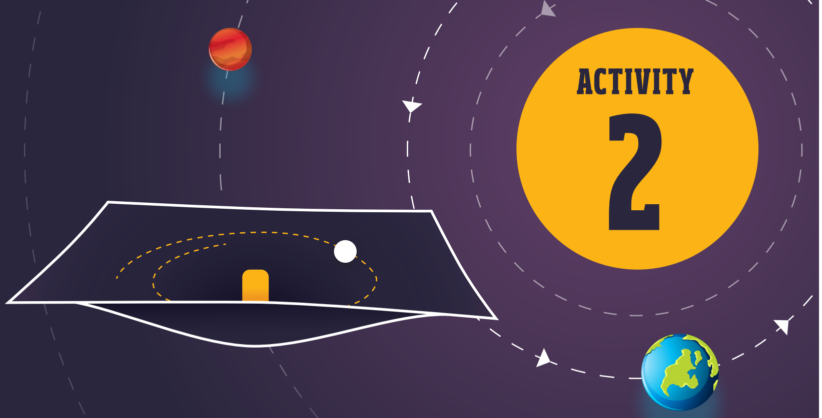
Engineering@Home – Rocket Launcher

DIFFICULTY RATING = 2 of 5

TIME FRAME = **30 MINS**

Solar Showcase

ACTIVITY 2



Students will learn about orbits and model them using everyday materials.

They will explore the different sizes of orbits generated by spherical objects of different sizes and weights.

EQUIPMENT

Balls of different sizes and weights
(e.g., table tennis ball, marble, bead, etc.)

Stretchy fabric
(e.g., sports t-shirt, tea towel, etc.)

Weights

OPTIONAL: **Marker pens**

QUESTIONS FOR STUDENTS

If you think about planets and their orbits, what might the weights in the middle of the fabric represent?

How many orbits can you get from one push?

What changes when the weight increases? decreases?

WORK ON

TEAMWORK

PROBLEM SOLVING

METHOD

- Have two students hold the stretchy material by the corners, pulling it **TAUT** and **LEVEL**, put a weight in the middle, and ask the students to describe what they see
  - Highlight that weights create a dip in the fabric that other objects can fall into
- Take a ball and roll it around the weights, pushing at 90° from the weights – you may need to push quite hard to get some balls to complete a full orbit
- Discuss with the students what happens: the ball should roll around the weight in a spiral motion, aiming to complete at least 1 full orbit
- In groups of 3, students experiment with different weights in the middle, adjusting the tension of the material (how tight or loose they hold it) and different sizes and weights of balls
- Draw attention to the similarity between the balls going around the weight and planets going around a star (e.g., the Earth going around the Sun)

OPTIONAL: Students can draw the orbits on the material with the marker pen and record their experiments

EXTENSIONS

- Explain that in space, gravity holds planets in their orbit and as space is a near-vacuum, planets don't slow down, and don't 'fall in'
- Explain the connection between the balls slowing down with the friction between the ball and the fabric
- Record the best results on the whiteboard "ball, weight, number of orbits"
- If you have a parachute handy, take things out to the playground and make a massive version that everyone can join

RELATED CAREER

Astronomer

Studies the origin and structure of the universe, including its planets, stars, galaxies, and black holes.

ENRICHMENT

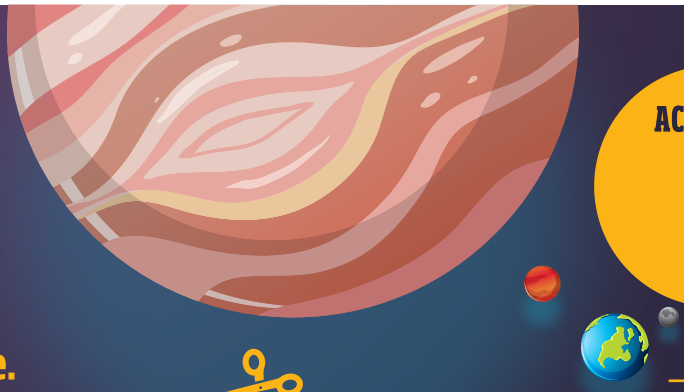
CHECK OUT - **www.bit.ly/spt-3d-solar-system**
3D Solar System - Set it to animate, with 1 second = 1 year

DIFFICULTY RATING = 2/5

TIME FRAME = 15 MINS

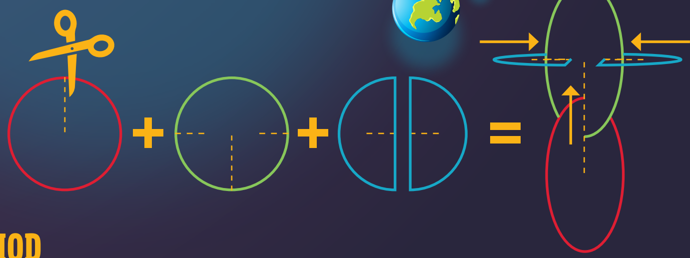
Planets:
How big are they?

ACTIVITY 3



Students will learn about the size of space and build planets to scale.

They will work out the sizes of the planets in our solar system relative to the Earth and use their findings to create a model of our solar system.



EQUIPMENT

- **Drawing compasses**
- **Calculators**
- **Scissors**
- **Pencils**
- **Rulers**
- **Card**

QUESTIONS FOR STUDENTS

Are you surprised at how big our solar system is?

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

218 cm

WORK ON

STAYING POSITIVE

CREATIVITY

METHOD

- Introduce students to the concept of a scale model (e.g., compare the length of a toy car to a real car)
- Explain that the average diameter of the Earth is 12,740 km and that students will be making models of Earth that are 2 cm in diameter, and building the other planets at scale
- Decide whether students will calculate the scale sizes of the planets using the ratio of 1 Earth Diameter => 2 cm, or if you will provide them:
  - Mercury: 0.8 cm, Venus: 1.9 cm, Mars: 1.1 cm, Jupiter: 21.9 cm, Saturn: 18.3 cm, Uranus: 8.0 cm, Neptune: 7.7 cm
- In groups of 3 or 4, students use these scale sizes to build 3D scale models of each planet, including Earth, using coloured card and compasses; **students have the diameters but will use compasses to draw the circles, so they will need to halve the diameters to find the radii and use the compass correctly**
- Students will make 3 scale circles, and cut and assemble them according to the diagram

EXTENSIONS

- Ask students to guess how far apart the planets are as they put their model planets in order
- If you have space, demonstrate a distance scale model; suitable scale distances from the Sun:
  - Mercury: 6 cm, Venus: 11 cm, Earth: 15 cm, Mars: 23 cm, Jupiter: 78 cm, Saturn: 143 cm, Uranus: 287 cm, Neptune: 450 cm
  - Here the scale factor is 1 trillion! Which is 10,000 times bigger than the scale used to make their planets. Can you do the same calculations for Pluto? The Moon?

RELATED CAREER

Planetary Scientist

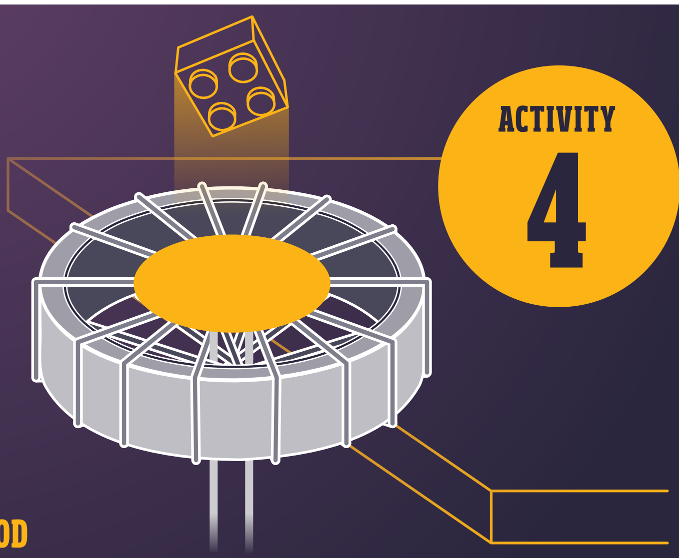
Studies planets within our solar system and outside it. This includes many of the planets' features, including their geology, chemical composition, climate, and potential for life.

ENRICHMENT

CHECK OUT - **www.bit.ly/planets-to-scale**
Animation of planets and other objects, to scale, in order of size

DIFFICULTY RATING = 3 of 5   **TIME FRAME =** 45 MINS

Launchpad



ACTIVITY 4

Students will learn about elasticity and how energy is stored and released to launch rockets into space.

They will build their own launchpad and see how varying the pull on the elastic bands affects the maximum height of the launch.

EQUIPMENT

Plastic bricks	**Cardboard**
Elastic bands	**Rulers**
Rolls of tape	**String**

This activity is designed to reduce the risk of students making catapults – students should not make buckets that will hold the bricks in place on the launchpad, and they should keep the launcher horizontal at all times; please factor in the risk from flying objects in your risk assessment.

QUESTIONS FOR STUDENTS

What would happen if you changed the number of elastic bands?

What type of energy is the elastic potential energy converted to when you release the string? Kinetic

How is this relevant to getting rockets into space?

WORK ON

METHOD

- Show the students a video of SpinLaunch and explain that this is an exciting new way to launch satellites into space **www.youtube.com/watch?v=yrc632oilWo&t=53s play to 2:10**
- In pairs, students build their own launchpad by wrapping elastic bands around a large roll of tape
- Students cut a circle out of card, making sure it's smaller than the hole in the roll, and attach it to the centre of a 20 cm piece of string with tape
- Students thread the ends of the string through the centre of the elastic bands on **both sides** and make sure the cardboard pad sits in the centre
- Student place the lip of the roll on the edge of the table, so they can still pull the string, supporting the other side with their hand
- Students place a plastic brick on the launch pad and they pull the string **directly down** until the two sides of elastic meet, and then release and see how high the brick goes
- Draw parallels between the energy released when rocket fuel burns, or SpinLaunch releases a payload, and the energy released when letting go of the string: more energy ➡ rocket goes higher
- Students can measure this using slow-motion video, or a ruler
- Students repeat the process, pulling back more or less , seeing how the extra pull increases the energy stored in the elastic and how this affects the height of the brick

EXTENSIONS

- Create a competition between teams to see who can launch a brick the highest; students could adjust their design and the number of elastic bands

ENRICHMENT

CHECK OUT - **www.spinlaunch.com**

Learn about the exciting SpinLaunch projects

RELATED CAREER

Material Scientist

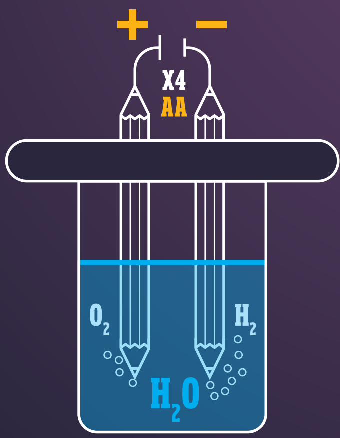
Researches and studies the structures and chemical properties of natural and synthetic materials, including metals, alloys, rubber, ceramics, semiconductors, polymers, and glass.

DIY Oxygen

ACTIVITY 5

Students will explore how astronauts get oxygen to breathe in space.

They will learn about electrolysis and the need to have water to extract oxygen from.



EQUIPMENT

Large, clear containers (glass, plastic, etc.)

Graphite pencils (without rubber ends)

Lollypop sticks

Masking tape

Crocodile clips

Batteries

Water

Wires

OPTIONAL: **Marker pens**

QUESTIONS FOR STUDENTS

What gases were the bubbles around each pencil?

Hydrogen around negative, oxygen around positive

Which pencil had more bubbles around it? why?

Negative, as hydrogen is positively charged so is attracted to the negatively charged pencil, and water contains twice as many hydrogen atoms as oxygen atoms (H_2O), and they form H_2 and O_2, so there's twice as much gas being produced at the negative end than at the positive end

What could the hydrogen be used for in space?

Is there a better way for astronauts to get oxygen in space?

WORK ON

PROBLEM SOLVING

SPEAKING

METHOD

- Students sharpen both ends of the pencils
- Using tape, they attach them in parallel to the lollypop stick about 2 cm apart, with 3 cm from the tip of the pencil to the stick; use another lollypop stick to sandwich the pencils, and tape the two lollypop sticks together
- They attach a wire to the tip of the short end of the pencil and the other end to the positive battery terminal, then they attach the other wire to the other pencil and the negative battery terminal (see picture);
  a minimum of 6 V (e.g., 4 AA batteries in series) is recommended

OPTIONAL: Dip the other pencil tips on the long end in a little bit of washing up liquid – this will help bubbles form

- Ask students to fill their containers between half and ¾-full with water and place the long end of the pencils in the water; if the wires are too short, ask them to support the battery on a stand so that it doesn't pull on the pencils

WARNING: Keep the batteries and wires out of the water and follow school safety measures

- Discuss with the students what they can see happening

EXTENSIONS

- Add salt to the water or increase the voltage of the battery (bubble production rate should increase)

ENRICHMENT

CHECK OUT - **go.nasa.gov/3OkjDAF**
Breathing Easy on the Space Station (NASA)

RELATED CAREER

Astronaut Scientist

Conducts scientific experiments that cannot be performed on the ground; in reduced gravity, things behave differently, so astronauts do all kinds of physics, chemistry, and biology experiments.

DIFFICULTY RATING =

TIME FRAME = 45 MINS

After leaving university, I joined a **graduate scheme** in Naval Ships at BAE Systems. Now, I'm an **automation tester**; I make sure the software we make works as it should. I **write code to test our systems**. For example, if a user logs in, I make sure they are logged in successfully, rather than seeing an error page!

I solve a lot of problems in this job. When a developer creates code for me, it might not be right first time. I check new parts of software, as well as the parts that have already been made! Sometimes that can be quite tricky. When I run my tests, some of them might fail; I have to try to work out what went wrong! The developer and I work together to make sure that everything works before delivering the finished product.

Hello! I'm Xanthe...

I am an **Automation Tester** at **BAE Systems Digital Intelligence**

Hi! My name's Umer...

I am a **Test Engineer** at **BAE Systems Air**

I was fortunate to join BAE Systems when I was just 16, on the **Advanced Engineering Apprenticeship Scheme**. I was extremely excited to learn engineering hands-on, and gain qualifications and work on real-life problems.

I now work with the Aircraft Test Team, supporting the Eurofighter Typhoon jet fleet, and I worked with Qatar to get their jets ready for the World Cup. I'm also studing for a degree part-time.

My role revolves around teamwork - it's essential! I regularly test aircraft antennas to make sure pilots get the right information. We work as a team by splitting the task between us: some prepare the aircraft for testing, some operate the test equipment, and we all work together to understand and analyse the results and fix things.

www.baesystems.com/apprentices • www.rafyouthstem.org.uk
www.raf.mod.uk/recruitment/apprenticeships

WHERE DO YOU GO FROM HERE?

STUDYING AT SCHOOL

If you study physics, you'll learn about space – and you'll learn a lot more than what we had time to teach. Maths is also a really useful skill, because rockets, planets and lots of space objects behave in interesting ways that are easier to understand using maths.

APPRENTICESHIPS

You can do an engineering apprenticeship once you're 16 or older. This gets you out into the wider world, learning everything from how to service an RAF aircraft to writing the software that guides the Royal Navy aircraft carrier underneath it.

A-LEVELS, SCOTTISH HIGHERS & T-LEVELS

Being 16 years' old might feel like a long way away, but that doesn't mean you can't plan for it.

Engineering, Physics, Maths, and even Chemistry, are great choices if you want to be an engineer.

DEGREES & DEGREE APPRENTICESHIPS

Degrees, just like apprenticeships, will give you a wider view of the world, focusing more on the theory. Degree apprenticeships are a blend of the two: you have a hands-on job and also do university work.

Throughout the activities, you've seen just a few of the careers connected with space. There are so many more...

We hope you learned a lot about space.

Engineers use all these skills. If you enjoy solving problems, being creative, or working as a team, maybe you'd like to be an engineer.

Ravenscroft, T.M. (2020), Skills Builder Universal Framework of Essential Skills, London: Skills Builder Partnership at www.skillsbuilder.org/framework