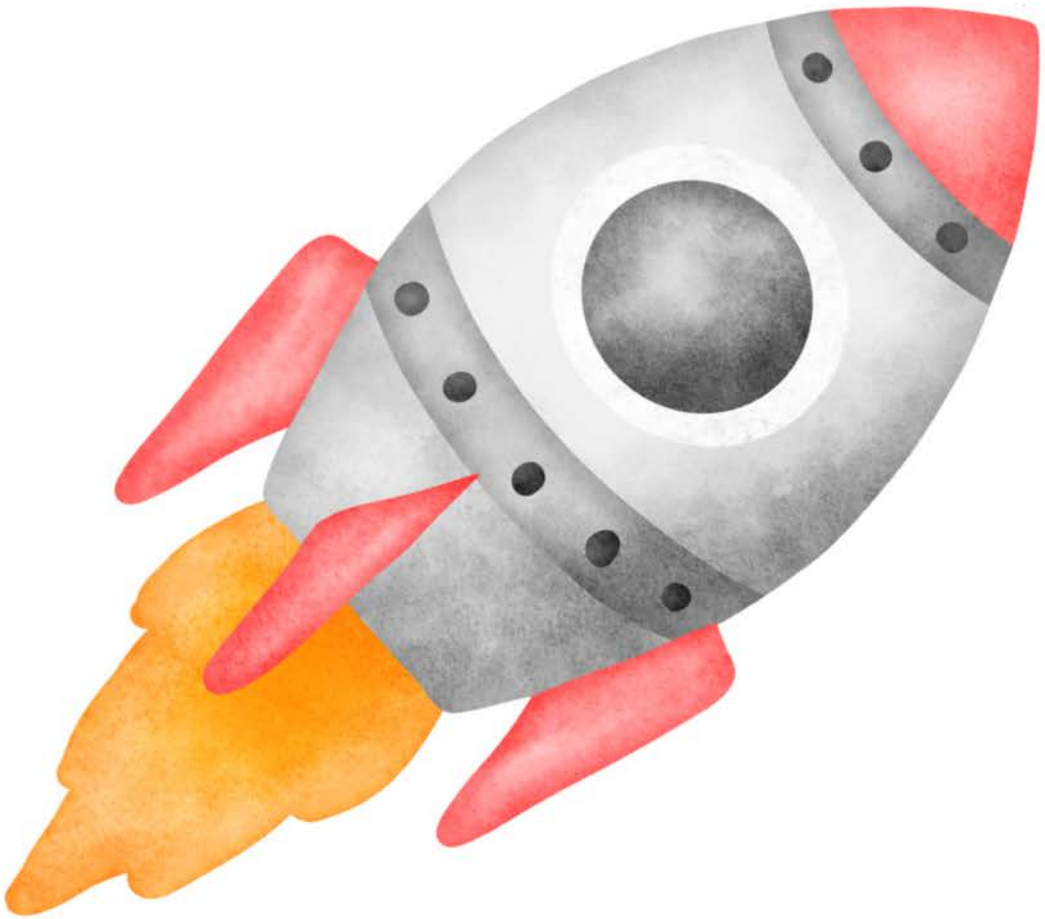
THE SCHOOLS' OBSERVATORY

PROUD TO BE PART OF LIVERPOOL JOHN MOORES UNIVERSITY



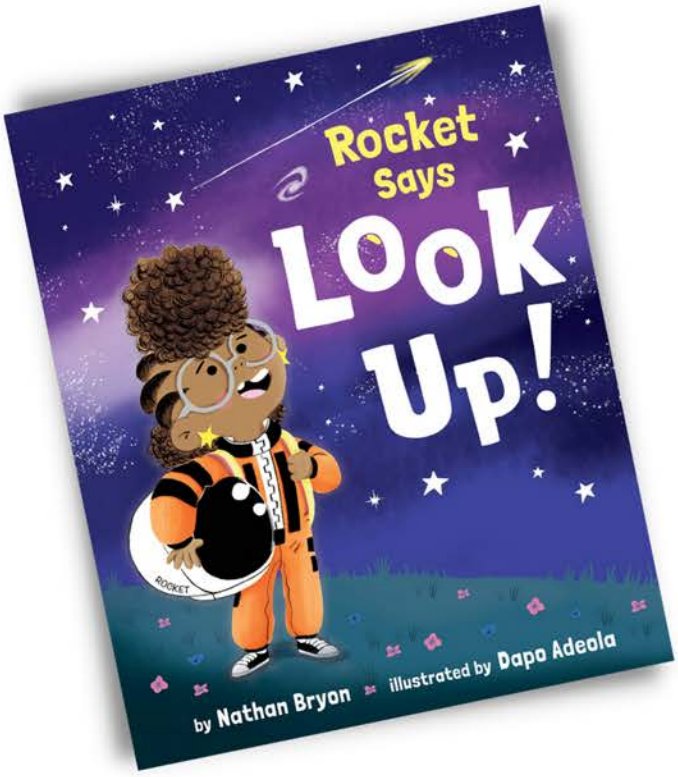
Let's Explore Rockets!

Background information

The Schools' Observatory use the wonders of space to inspire the next generation of scientists, programmers and engineers. They provide resources for schools, support for teachers and free use of the world's largest robotic telescope through their website, schoolsobservatory.org.

The Schools' Observatory is proud to be part of Liverpool John Moores University and are based in LJMU's Astrophysics Research Institute in Liverpool, UK.

In partnership with Durham Book Festival's Little Read, The Schools' Observatory have created packs of themed resources for Early Years Foundation Stage children. These can be used at home or in nursery settings to engage children with the story, "Look up" by Nathan Bryan.



The main character in "Look up" is Rocket. Rocket is going to be the greatest astronaut, star-catcher, space-traveller who ever lived! Rocket is totally prepared for her future. She has "defied gravity... captured rare and exotic life forms... and built a ship to the stars!".

This pack of activities focuses on the topic of rockets and spaceships. Rocket refers to these as "a ship to the stars".

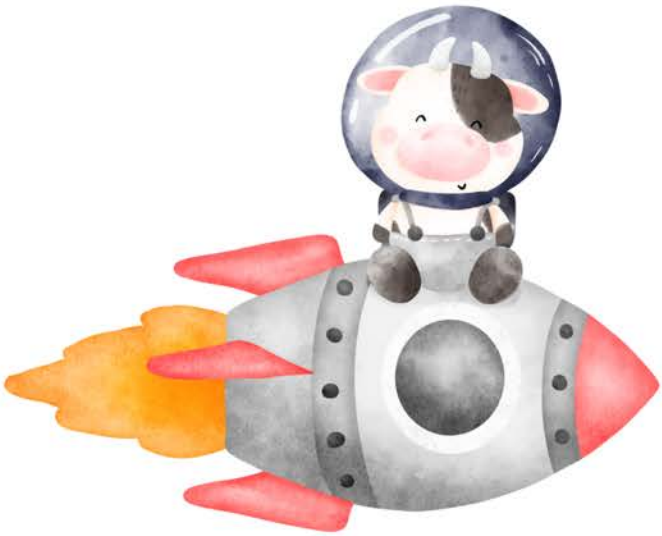
This booklet has astronomy information for you on pages 3 to 6, ideas for activities to do with the children on pages 7 to 14 and finally additional resources and weblinks we think you might be interested in on pages 15 to 16.

Rockets: Contents

Please note: the images used in this document are not to scale.

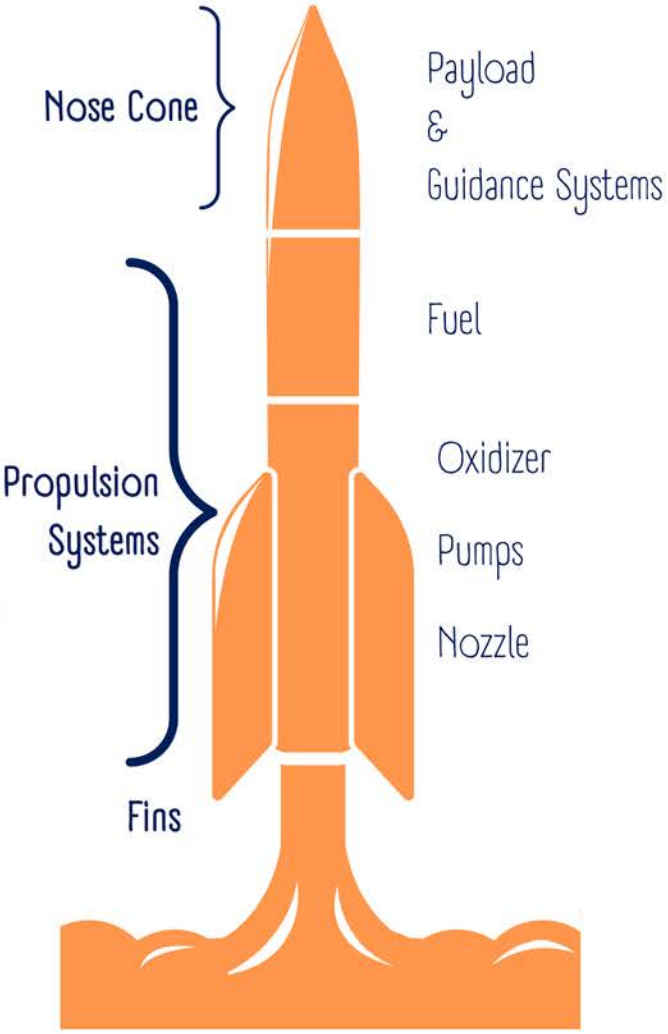
What are rockets and spaceships?

Rockets are machines which help power people and things into space. Precisely, they are any spacecraft or aircraft which is powered by a rocket engine. A rocket engine works like an engine in a car – burning fuel to create motion. In a rocket engine the fuel is set on fire, and this produces hot gas. The hot gas comes out of the bottom of the rocket, pushing it upwards. A way to demonstrate this is by letting the air out of an inflated balloon. As the air is pushed out of the balloon, the balloon moves in the opposite direction.



Spaceships or spacecraft are slightly different. These are where we store the things we want to get to space. It's sat right at the very top of the rocket. We often think of this being where people sit when travelling into space, but we don't always send people, sometimes only equipment or robots. The spacecraft controls its own flight once it has reached space. Once the spacecraft is in space it is free from gravity, and everything floats around. We have lots of resources looking at life in space in our Astronaut Activities for EYFS pack. When it's time for the spacecraft to come back to Earth, it falls through our atmosphere. When it gets close to Earth it opens a parachute and splashes down into the ocean.

What makes a rocket?



Rockets are split up into several parts. There are four main parts of a rocket. The first is called the structure and this is the main body of the rocket which everything else sits within. Rocket structures have a familiar shape. A long cylinder with a pointy top and fins on the bottom. The bottom part of the rocket is all called the propulsion system, which is basically the rocket engine. This is where all the fuel lives ready to be mixed and set alight. There is also a small guidance system near the top. This tells people on the ground where the rocket is pointing. People on the ground can then change its direction using computers on board the rocket. The last part of a rocket sits right at the top and makes up the pointy bit, usually called the nose cone. It's called a payload, but we often think of this bit as the spacecraft. It has inside it everything important which you want to make it to space, and usually back to the Earth!

What rockets exist today?

There are a lot of rockets in use today. Most are quite small and are designed to get satellites into orbit around the Earth. There are some larger rockets which have been designed to get payloads further into space. The ones used most often are called Ariane 5 (Europe), Proton-M (Russia), Falcon-9 (US) and Long March (China). Many other countries have working rockets, or new ones planned to come out over the next 10 years. These counties include India, Japan, New Zealand, Israel, and South Korea. There are no rockets in used today which could get humans to the Moon, Mars or anywhere further than the International Space Station.

What technology would we need to travel to another planet?

NASA and SpaceX, a private US company, are developing rockets which could get humans to Mars. They are not expected to be ready until 2026. These rockets are much harder to make because you need much more fuel to travel so far in space. The Moon is 1000 x further away from Earth than the International Space Station. Mars is about 600 x further away than the Moon! The more fuel, the heavier the rocket and this means it's harder to get them off the ground.

What about travelling to another star?

Space is incredibly big and there is an awful lot of stuff in it. The problem is that everything is also really far away from each other. Most of space is... empty space. So, for example, the next closest star to Earth (after the Sun) is called Proxima Centauri. Proxima Centauri is over 40 trillion km away from us! If we could travel at the speed of light (300,000 km each second) it would take us over 4 years to get there. A much more realistic speed for a spacecraft with humans on can be taken from the Apollo missions in the 1960s – about 40,000 km per hour. At this speed it would take about 115,000 years to reach the star.

What is it like to live on a spaceship?

It's very different living on a spaceship compared to the Earth. This is mainly down to one thing – the lack of gravity. It means that simple tasks like drinking, brushing our teeth and getting around, become much harder. The lack of gravity also has effects on our bodies – muscles weaken, and the calcium leaves our bones. There are changes to the blood flow in our bodies and to the pressure in our eyes. These are explored more in the Astronauts Activities for EYFS Pack

What training do astronauts need to do to fly on a spaceship?

Currently, astronauts need to have a degree in a science or engineering subject. This means they have technical skills and can carry out experiments and maintenance on board a spacecraft. It takes about 3 years to train to be an astronaut. This training includes flying the spaceship and learning about the space suit. It involves learning about any experiments which will be carried out on the mission and learning another language. English and Russian are spoken on board most missions today – and astronauts must learn to speak both. There's more information on astronaut training in the Astronauts Activities for EYFS Pack.

Feedback

We welcome feedback from practitioners. If you want to let us know how much your children have enjoyed our activity or how we could improve it, please send us some feedback using the details below:

Share your out-of-this-world creations with The Schools' Observatory!
Email **SchoolsObs@ljmu.ac.uk** or tag **@SchoolsObs** on social media.

How to introduce the topic of rockets and spaceships

- Use the 'Look Up' story – ask the children what they think ships to the stars are?
- Ask children what they know about rockets and spaceships.
- Put out any books you have featuring rockets.
- Show a video of a rocket launch. Some good examples are listed in the Additional Resources.

Activity 1 - Make and launch a model rocket

There are several ways you can make and launch simple rockets with children – some examples are below:

Junk rocket creation:

- Use trash/recycling to make a model rocket trying to create the important parts – a long cylinder, a point top and fins on the sides.
- Decorating these is also a lot of fun!

Stomp rockets:

- You can buy simple stomp rockets – which use air to launch the rockets too.
- Most come with foam rocket included but you can also create your own using a similar technique to the straw rockets – you just need to make sure that the size of the cylinder fits quite tightly to the launcher (but not too tight!).
- The main difference here is that you launch up rather than horizontally. Just be careful that the students are far enough away from the launch zone!

Bottle rockets:

- Make paper rocket to fit on top of plastic bottle.
- Ensure the lid is taken off the bottle and then place your rocket on top.
- Clap hands together on sides of bottle to squash it and release the air.
- Rocket goes up!

Straw rockets:

- Use a piece of paper wrapped around a pencil to create a cylinder for your rocket.
- You can tape this together and then add fins to the bottom – or stick a cut out drawing of a rocket to the side.
- Fold the top edge of the paper around the point of the pencil and tape it shut.
- Slide out the pencil and replace it with a straw – you can then blow down the straw to launch the rocket!
- You can make this more scientific by measuring the distance the straw rockets travel and recording the data.
- You can also talk about what might have failed, or what might have made the rockets better – this is an important part of science – improving your experiment!
- See this NASA example which can be simplified: www.jpl.nasa.gov/edu/learn/project/make-a-straw-rocket

Bicarb and vinegar:

As a rocket demonstration practitioners can make a bicarb and vinegar bottle rocket. This is easy and effective – it gives a real wow moment!

- Required resources:
  - Empty bottle
  - Baking soda
  - 3 pencils
  - 1 bottle cork
  - Tape
  - Sheet of kitchen roll
  - White vinegar
  - Scissors
- Optional: ruler, tablespoon, measuring jug.

Rockets - Acivities

1. Tape the pencils to the outside of the bottle, make sure the bottle is stable and the nozzle of the bottle is at least 10 cm from the ground.

2. Optional - if your cork is too big, using a pair of scissors carefully shape the cork so that it fits the bottle nozzle (ask an adult if you need help). The cork shouldn't be loose but not too tight

3. We are now going to prepare the 'fuel packets'. Take a single piece of kitchen roll and place 2 tablespoons of baking soda in a line down the middle. Then fold in the edges and roll the kitchen roll up to contain the baking soda.

The end result is a long thin roll of paper containing the baking soda. This should be narrow enough to fit into the bottle, though for now keep it to one side. Pour some of the vinegar into the bottle, around 200 ml is ideal.

4. Slide your 'fuel packet' into the bottle and quickly push the cork into place. Stand the rocket up (nozzle pointing towards the ground) and MOVE WELL AWAY from the rocket. DO NOT return to the rocket even if nothing appears to be happening.

5. The soda and vinegar react to create a lot of carbon dioxide gas. The gas is trapped in the bottle. The pressure will build and build until it is too great. The pressure forces the cork down and out of the nozzle. When the fuel and cork go down, the bottle goes up! This may only take a few seconds.

IMPORTANT NOTES

This activity is weather dependent. Wind severely impacts the rockets' ability to stand up and could direct the rocket towards those watching.

The size of the bottle, amount of vinegar and bicarbonate of soda used, and the tightness of the cork will affect the results.

These rockets should be launched outdoors – do not place the bicarb of soda in with the vinegar until you are outside and ready to launch.

When launching move at least 2 metres away from the rocket once you have started the reaction. The children should stand even further away.

If the rocket fails to launch an adult should go back to check it. This can happen if the cork is pushed in too tight, but this means that the bottle will be highly pressurized. Take care retrieving the bottle and removing the cork.

We have a full risk assessment, but this is based on students carrying out the making themselves:
www.schoolsobservatory.org/sites/default/files/discover/stemclubs/primary/NSO-Primary-Bronze-Leader-S5-Rocketships-RiskAssessment.pdf

Activity 2 - Mission control desk

Create a Mission Control role play area.

- This could include lots of 'computers' with buttons for communicating.
- You can add some walkie talkie to simulate communication between Mission Control and the spacecraft.
- It will likely have a big map of the Earth to show where the spacecraft currently is.
- It might also have information about the astronauts and how they are feeling.
- Everyone in Mission Control has their own specific job but they must work together as a team.

Mission Control Says

Use your Mission Control space to play a game of Mission Control says – like Simon says.

Space Jobs

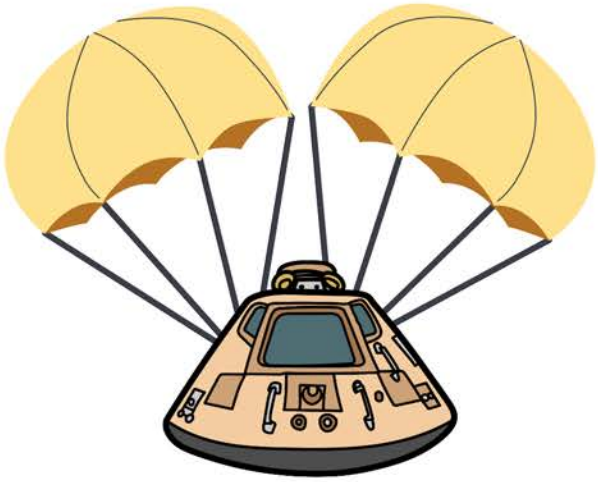
You could have the children play different space jobs:

- doctor (to check the astronauts are OK)
- engineer (to check the rocket is OK)
- spacecraft operator (who controls the rocket during launch)
- CAPCOM (who speaks directly to the astronauts)
- ground controller (who checks the rocket is going the right direction)
- flight director (who leads the team and makes sure everything is OK).

Activity 3 - Create a parachute for a space lander

When astronauts return to Earth, they splashdown in the ocean like this: Dragon capsule splashdown www.youtube.com/watch?v=nHi0KNLUw5Q. To land safely they must be travelling very slowly when they reach the water and so most spacecraft have parachutes which open to help them float down.

- Demonstrate what parachutes do by dropping an object without a parachute and then with one.
- Parachutes can be made very easily using material or paper with string tied to the edges and attached to the object you're dropping.
- Let the children experiment by creating their own parachutes using different materials:
    - Different types of fabric
    - Paper
    - String
    - Craft sticks
    - Straws
    - Sellotape/masking tape
    - Rubber bands



- A large part of science is also recording the results – why not time how long it takes the object to fall to the ground from a set height?
- If something goes wrong use this as an opportunity for discussion – what happened? Which part failed? Is the object OK?

Activity 4 - Make a rocket soundscape

Create a sound scape of a rocket launch and landing – you may want to use videos to demonstrate this. The main stages of a rocket launch and spacecraft landing are outlined below – can you get the children to create a soundscape to reflect the journey?

- At launch there is a count down.
- Then when the engines start there is a lot of noise – see the videos in Additional Resources (page 16) for examples.
- Once the spacecraft reaches space there is no noise at all. Sound needs to travel through a medium, like air, to move. In space there is no air and so there is no sound.
- When a spacecraft comes back down to Earth to land there is a lot of noise again as it passes through our atmosphere. The spacecraft is traveling really fast and starts to burn on the outside.
- Then when it's close to the ground the parachutes open and the spacecraft gently falls down to Earth.
- The final stage is splashdown – when spacecraft splashes down into the ocean and the astronauts are picked up by boat. Here's an example: www.youtube.com/watch?v=nHi0KNLUw5Q

Communication, Language, Emotions

There are a range of BSL and Makaton signs for words which appear in this topic. A handy video has been made by the Lightyear Foundation www.youtube.com/watch?v=MXpM5k8uUM0&t=102s which shows Makaton signs including:

- Space
- Rocket
- Astronaut
- Earth
- Moon

Art & Design ideas

You can display pictures of different rockets launching from, and returning to, Earth. You could also explore some of the destinations of astronauts on rocket launches, this is primarily space stations right now (International Space Station or Tiangong Space Station) but in the future could include returning to the Moon or exploring Mars.

Additional to the Mission Control desk children could also create a space station – this idea is expanded upon in the Astronaut Activities for EYFS pack.

Word Bank

astronaut	fuel	payload
atmosphere	land	record
computer	landing	rocket
count down	launch	scientist
cylinder	Mars	space trash
Earth	measure	space
engine	mission	spacecraft
engineer	Moon	spaceship
fin	parachute	splashdown

Rocket Inspiration

Some good rocket launch videos are listed below. These videos also show a good variation of rockets which could be used to help the children in their own rocket designs.

Apollo 11 rocket launch from 1969: www.youtube.com/watch?v=OSPyXTjIrnk

Space Shuttle launch from 2007: www.youtube.com/watch?v=fhYMh6KTJMQ

Arian 5 (European) launch from 2021 (with countdown and commentary in French): www.youtube.com/watch?v=t4m7dmfwG8s

Falcon 9 rocket launch and landing from 2015: www.youtube.com/watch?v=ANv5UfZsvZQ

This video of Falcon 9 represents the most cutting-edge rocket technology today. It is now 'normal' for the company SpaceX to launch a rocket and then re-land and reuse the rocket. It also shows all elements of the rocket separation. This is a good conversation about waste and recycling. Most other rockets are used once and then discarded in space – leading to a lot of trash floating around the Earth. And a lot of wasted money.

Falcon heavy launch and landing from 2018: www.youtube.com/watch?v=AOFZIwabctw

This was a more advanced rocket which sent a car with a pretend astronaut out towards Mars. The main stage rocket missed it's landing and crashed into the sea, but the two booster rockets successfully landed back down in tandem.

You may find the next video interesting but consider whether to show it to your children. This is the number of failures that SpaceX had prior to having a successful rocket landing. It tells a lesson of perseverance in science, and life. Things don't always go to plan first time. Please note that none of these rockets had living things on board.
www.youtube.com/watch?v=bvim4rsNHkQ