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John Adams

8+

SPACE ScienCe

WARNING! NOT SUITABLE FOR CHILDREN UNDER 8 YEARS. FOR USE UNDER ADULT SUPERVISION. CONTAINS SOME CHEMICALS WHICH PRESENT A HAZARD TO HEALTH. READ THE INSTRUCTIONS BEFORE USE, FOLLOW THEM AND KEEP THEM FOR REFERENCE. DO NOT ALLOW CHEMICALS TO COME INTO CONTACT WITH ANY PART OF THE BODY, PARTICULARLY THE MOUTH AND EYES. KEEP SMALL CHILDREN AND ANIMALS AWAY FROM THESE EXPERIMENTS. KEEP THE EXPERIMENTAL SET OUT OF REACH OF CHILDREN UNDER 8 YEARS OLD.

John Adams Leisure Ltd., Hercules House, Pierson Road, Enterprise Campus, Alconbury Weald, Huntingdon, Cambridgeshire, PE28 4YA. England.
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ADVICE FOR SUPERVISING ADULTS

- Read and follow these instructions, the safety rules and the first aid information, and keep them for reference.
- The incorrect use of chemicals can cause injury and damage to health. Only carry out those experiments which are listed in the instructions.
- This experimental set is for use only by children over 8 years.
- Because children's abilities vary so much, even within age groups, supervising adults should exercise discretion as to which experiments are suitable and safe for them. The instructions should enable supervisors to assess any experiment to establish its suitability for a particular child.
- The supervising adult should discuss the warnings and safety information with the child or children before commencing the experiments. Particular attention should be paid to the safe handling of acids, alkalis and flammable liquids.
- The area surrounding the experiment should be kept clear of any obstructions and away from the storage of food. It should be well lit and ventilated and close to a water supply. A solid table with a heat resistant top should be provided.
- Substances in non-reclosable packaging should be used up completely during the course of one experiment ie after opening the package.
- If any experiment starts to grow mould, dispose of it immediately in household waste and wash your hands.
- Some activities in the kit can stain clothing and furniture. Protect your activity area to avoid damage.

FIRST AID INFORMATION

- In case of eye contact: Wash out eye with plenty of water, holding eye open if necessary. Seek immediate medical advice.
- If swallowed: Wash out mouth with water, drink some fresh water. Do not induce vomiting. Seek immediate medical advice.
- In case of inhalation: Remove person to fresh air.
- In case of skin contact and burns: Wash affected area with plenty of water for at least 10 minutes.
- In case of doubt, seek medical advice without delay. Take the chemical and its container and this leaflet with you.
- In case of injury always seek medical advice.
- Write in the box below the telephone number of your nearest hospital or poison centre that can be contacted in an emergency.

SAFETY RULES

- Read these instructions before use, follow them and keep them for reference.
- Keep younger children and animals away from the experimental area.
- Store this experimental set out of reach of children under 8 years of age.
- Clean all equipment after use.
- Make sure that all containers are fully closed and properly stored after use.
- Ensure that all empty containers and/or non-reclosable containers are disposed of properly.
- Wash hands after carrying out experiments.
- Do not use any equipment which has not been supplied with the set or recommended in the instructions for use.
- Do not eat or drink in the experimental area.
- Do not allow chemicals to come into contact with eyes or mouth.
- Do not replace food stuffs in original container. Dispose of immediately.
- Refer to your local council for safe disposal of unused chemicals.

The Moon hanging in the night sky is quite mysterious and beautiful. Man long-held a dream to reach it, developing various technologies to better understand the moon. As a young explorer, when you look up to see the brightest celestial body in the sky, you probably have lots of questions in your mind. Why is the moon so bright? Does anybody live on it? What is on the moon? Open up your kit and follow the instructions to make some fascinating discoveries.

What you will find in your kit:

- **a** Card sheet (x2 Moon phases cards – a large circular one and a small one with blue strip, month and day calendar cards, Earth and Moon card with small blue strip)
- **b** 2 paper fasteners
- **c** Ping-pong ball
- **d** Rubber ball
- **e** Moon map (not shown)
- **f** Glitter – 7 grams
- **g** Sand – 300 grams Quartz CAS 14808-60-7, Benzethonium chloride CAS 121-54-0
- **h** Corn flour – 112 grams Starch CAS 9005-25-8, Benzethonium chloride CAS 121-54-0
- **i** Ball mould
- **j** Meteorite sand – 10 grams Polyvinyl alcohol CAS 9002-89-5, Quartz CAS 14808-60-7, Glycerol CAS 56-81-5, Benzethonium chloride CAS 121-54-0, colouring
- **k** Lunar rover, lander and astronaut card
- **l** Coffee filter
- **m** Metal washer
- **n** Glow-in-the-dark Moon and stars
- **o** Double-sided adhesive tape
- **p** Foam rocket
- **q** Fishing line
- **r** 6 Rubber bands
- **s** 3 Rocket balloons
- **t** 2 Stir sticks
- **u** 3 Balloon clips
- **v** 4 Pieces of string

You will also need:

Water, food colouring, newspaper, mixing bowl, tablespoon, cup, scissors, tape, paper, large plastic bag, bicarbonate of soda, white vinegar, 500ml drinks bottle (empty), measuring beaker

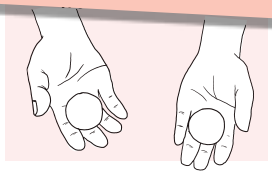
Note to adult helper:

It is recommended that you assist your child with this kit. Go through the information provided together and share what you think your child can understand. Ask lots of questions and encourage creativity and experimentation. This kit will provide a great beginning for a lifetime of scientific exploration!

Note to children: If you want to be a scientist, you will need to be very observant, and love to explore and try new ideas and methods, just like real scientists do. Pay attention to what's going on around you in daily life. In your experiments, do each of them carefully and pay attention to the what's happening and be patient until you get the correct result. Show family and friends what you've discovered with this kit – and don't forget to share your scientific thoughts and ideas.

1. Feeling gravity

What you'll need from the kit:
Ping-pong ball, Rubber ball



Why are some items heavy while others are light? Why you can pick up some objects, where others are impossible to lift? Is this gravity at work? If so, what is gravity? Let us explore…

Hold the ping-pong ball in one hand and hold the rubber ball in the other hand. Can you feel that one is light, the other heavy?

Holding the rubber ball, throw it up in the air or against a wall. Where will it land? Does it always land on the ground, no matter where you have thrown it? Throw the ping-pong ball in the same way. Do you notice any difference?

TIP: *While we understand that there is gravity on Earth, what about the Moon? The Moon does indeed have gravity, but it is only one-sixth of Earth's gravity which means that something from Earth will have a different weight when it's on the Moon. So, for example, if you were to weigh 60kg, once you are on the Moon, you would only weigh 10kg.*

Compare the weights of the ping-pong ball and the rubber ball. If you were to take the rubber ball with you to the moon it would weigh the same as the ping-pong ball.

SCIENCE SECRETS

Why do each of the balls fall down to the ground? The answer is that the Earth has a powerful attraction to any object. Gravity is a force that attracts objects towards each other. The larger an object is, the greater its force of gravity. So, no matter which direction you throw the ball in, it will always fall to the ground. Just like you – no matter how high you jump you will always land on the ground. The effect is known as universal gravitation.

Gravity keeps all of the planets (including Earth) in orbit around the Sun. It also keeps the Moon in orbit around the Earth.

FUN FACT

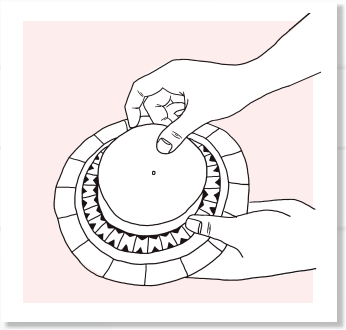
This is the story of how universal gravitation was first discovered. In 1726 Sir Issac Newton was sitting on a bench beneath an apple tree in the orchard at his family home when a falling apple prompted him to think about why it had fallen straight to the ground. After much research and hard work, Newton devised the law of universal gravity. It's one of the most enduring legends in the history of science. Newton's discoveries changed the way scientists understand the universe.

2. The light from the Moon

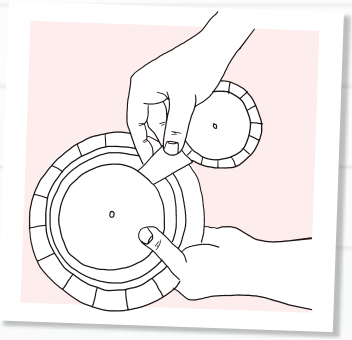
What you'll need from the kit:
Large circular Moon phases card, small Moon phases card with blue strip, Month calendar card, day calendar card, a paper fastener

Our Moon appears to have a different shape at different times of the month. What is referred to as the Moon's phase is the bright section that's visible when we look at it at night. Here we'll explore the rules that define the different phases of the moon.

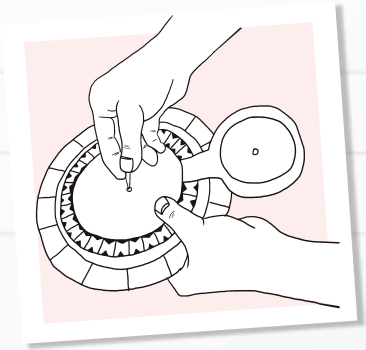
1. From large size to small, stack the large circular Moon phases card, day calendar card and month calendar card on top of each other.



2. Insert the small end of the blue strip of the small Moon phases card between the day calendar card and the month calendar card.



3. Align all these pieces so that the hole in the middle of each line up, then use the paper fastener to fix them together. You have now made a Moon phases disc.



4. Turn the month calendar card and the day calendar card align with today's date. Now turn the small Moon phases card so that the blue strip covers today's date.
5. Turn the outer large Moon phase disc so that you can see a picture of the current Moon shape inside the small cut out window.
6. By looking at the pictures around the edge of the Moon phases card, you will be able to see what the shape of the Moon will be for each day in the current month. Check to see each night whether you are correct.

TIP: *To achieve the best results, do this activity on a bright evening.*

SCIENCE SECRETS

The Moon appears to change shape almost every night. On some nights it might look like a thin crescent. On other nights it might look like a bright circle, while on other nights you might not be able to see it at all. The different shapes of the Moon that we see at different times of the month are known as the Moon's phases.

The Moon does not produce its own light. The only source of light in our solar system is the Sun. Without the Sun, our Moon would be completely dark. What you may have heard referred to as 'moonlight' is actually just sunlight reflecting off the Moon's surface.

The Sun's light comes from one direction and it always lights up one half of the Moon – the side of the Moon that is facing the Sun. The other side of the Moon is dark.

The lunar phases gradually change over a period of about 29.53 days (referred to as a synodic month) as the Moon's orbital position changes.

FUN FACT

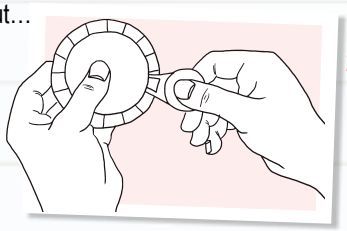
Look at the images of the Moon and you will notice that some parts of it are bright, while some parts are dark. This is because the Moon's surface is rugged and uneven. The brightest parts on the Moon are high areas and mountains. The dark parts are low wide plains and craters. When the Sun shines on the Moon, the highest parts reflect the sunshine. The Moon has light-coloured rock which also looks brighter. In contrast, the low areas that are covered with black molten materials, look dark.

3. How do the Earth and the Moon work together?

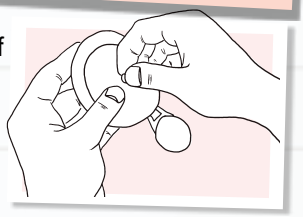
As the positions of the Earth and the Sun change, the Moon phase alters too. Do you know when the Moon will have a different shape? What about the position of the Moon in relation to the Earth? Let's find out…

What you'll need from the kit:
Moon phases disc (made in activity 2), Earth card, Moon card, a paper fastener.

1. Place the Earth card on top of the Moon phase card. Place the blue strip of the small Moon card in between them.



2. Line up the holes of each of the three cards. Insert the paper fastener through the hole and fix them together.



3. Rotate the blue strip so that tonight's Moon shape can be seen through the small window that is cut into it.
4. Using the month calendar card to represent the position of the Sun, you will now be able to see the relative positions of the Sun, Earth and Moon.

SCIENCE SECRETS

Do you know where the year, the month and day on the calendar originate from? Here's how to work it out…
The Earth is a planet in our solar system. It turns (orbits) around the Sun. Besides orbiting, the Earth itself also turns. This movement is called rotation. The Moon is the Earth's satellite, which means it will orbit around the Earth.
A year is the length of time it takes for the Earth to orbit the Sun. A month is the length of time the Moon takes to complete a circuit of the Earth. A day is the time it takes for the Earth to complete a complete rotation. The parts of the Earth that are lit by the sun experience daytime, while the side furthest from the Sun will be experiencing night time.

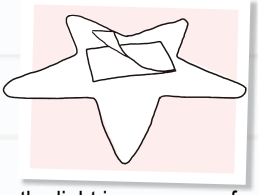
FUN FACT

Solar eclipse explained: As the Moon orbits the Earth, sometimes the Earth, Sun and Moon are aligned with the Moon in the middle. When this happens, the Moon prevents light from shining on the Earth, which means the Moon's dark shadow falls across the Earth. This is a solar eclipse. There are four types of solar eclipse: partial solar eclipse, total solar eclipse, annular eclipse, total-annular eclipse. It is dangerous to look directly at solar eclipse because our eyes are unable to handle the brightness.

4. Your own starry sky

A clear night sky can be mysterious and dreamlike. Wouldn't it be wonderful to experience the starry sky in your own room? Here's how you can do it…

What you'll need from the kit:
Glow-in-the-dark stars and moon, double-sided adhesive tape.



1. Attach tiny pieces of adhesive tape to your glow-in-the-dark stars and moon.
2. Apply them on a wall to make your own constellation

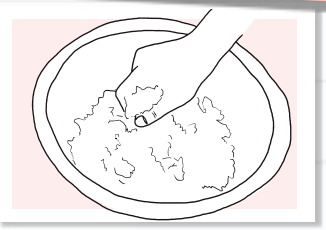
3. When evening comes, turn on the light in your room for several minutes to allow the stars to absorb light. When you turn off the light, they will glow like a starry sky.

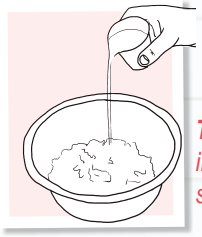
5. Making Moon sand

It is fascinating to learn about the Moon's terrain. In this project you can make your own moon sand and make a three-dimensional map. Let's get creating…

What you'll need from the kit:
Sand, corn flour, glitter, Moon map.
You will also need:
Mixing bowl, a tablespoon, water, newspaper, food colouring (optional)

1. Put the sand, corn flour and glitter into the mixing bowl.





2. Gradually add up to 7 tablespoons of water, stirring constantly to ensure the mixture is free from lumps.

TIP: You can also add food colouring in the mixture to make colourful moon sand.

3. Use your finger to shape the mixture into a workable lump. If you would prefer to have wet sand, simply add some more water.
4. Open the Moon map and grab a sheet of newspaper. Pour all of the Moon sand onto the newspaper. Now you can start to make a replica of the Moon's surface

***NOTE:** Keep the Moon surface you have made as you will use it later on in Activity 11.*

FUN FACT

The surface of the Earth constantly changes as a result of erosion by both air and water. Tough rocks, for example, will eventually be worn down to become soil.

On the Moon there is no water or air, however, there are other elements that erode its surface. Until recently, it was thought that the Moon had no atmosphere, in fact it has been discovered that it does have an atmosphere which is made up of a variety of gases.

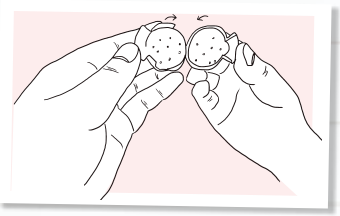
Temperatures on the Moon are extreme, ranging from incredibly hot to freezing cold, depending on where the Sun is shining. These temperature differences are the reason that the Moon's rocks fracture. Objects from space, including meteors, regularly bombard the Moon's surface and dust from other planets lands on the Moon. Over time all of these factors have changed the Moon's appearance.

The surface of the Moon is covered in a powdery dust known as lunar soil. It covers the whole of the Moon apart from the surface of mountains and large rocks. Although it is called lunar soil, it is as soft as flour and it is unsuitable for the growing of plants.

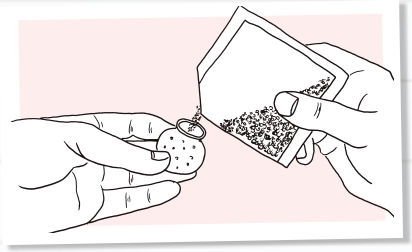
6. Meteor craters on the Moon

The craters in the Moon's surface are circular hollows caused by the impact of asteroids colliding with it. A dark area on the Moon is called a mare. A group of these dark areas are collectively known as maria – which is Latin for seas. They are not actually seas, instead they are extremely large craters formed following volcano eruptions. Let's experiment and find out more about meteor craters…

What you'll need from the kit:
Ball mould, meteorite sand.
You will also need:
Water, a cup.



1. Press the parts of the ball mould together to form a ball shape.



2. Pour in the meteorite sand.

3. Half fill a cup with water, then put the ball mould containing the sand into the water.

4. After 1 minute, pick up the ball mould and put it to one side to dry for 5 minutes.
5. Now open the mould.
6. When the ball is properly dry and not sticky, you can play with it.
7. Let it drop to the ground. Does it bounce?
8. Drop the meteor ball into the moon sand. Does it create a lunar mare?

FUN FACT

Meteoroids are the result of asteroids smashing together, causing rocky pieces to break off. They can range in size from small grains to one-metre-wide objects.

When they get close to the Earth, meteoroids are attracted by Earth's gravity. They break up in Earth's atmosphere, turning into meteors – streaks of light in the sky. This sight is sometimes referred to as shooting stars, however meteors are not actually stars.

Sometimes meteoroids don't vaporize completely in the atmosphere. If they survive their journey and land on the surface of Earth, they are referred to as meteorites.

7. Finding a landing location on the Moon

Are you intrigued by the Moon's appearance? As knowledge has increased, scientists have been able to draw up maps of the Moon. Would you like to know what is on the map? Let's have a look…

What you'll need from the kit:
Moon map.

Open the map and take a look at the surface of the Moon. You will notice the surface of the Moon is rugged. The areas marked by numbers in circles on the map were the landing points of each Moon mission.

If you had the chance to land on the Moon, which location would you choose and why?

FUN FACT

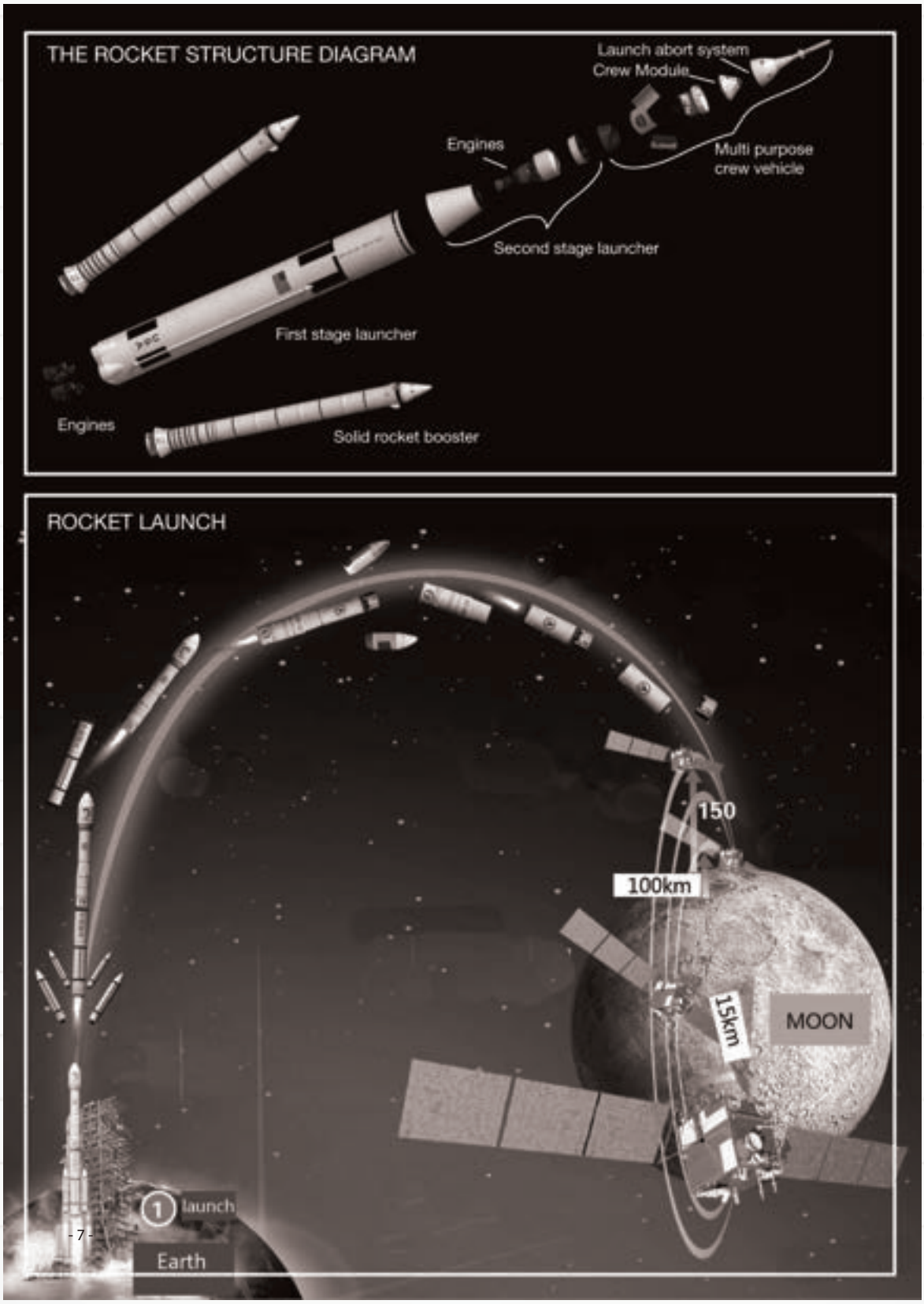
We can see that the Moon has lots of large craters which were formed by volcanoes. It also has vast mountainous areas. When we look at the Moon from Earth, these different areas cast different levels of shadow so the surface seems to be covered in different shapes and patterns.

The moon's surface is changing over time as its interior continues to cool, bringing about cracks in its surface which cause moonquakes.

One of the deepest craters on the Moon is the Newton crater named after Sir Isaac Newton, the British mathematician, physicist and astronomer who we mentioned earlier in Activity 1.

8. It's rocket science

Every rocket that has ever put anything into space has been a multistage rocket. Every payload that has been carried has needed an extra kick of thrust to overcome the weight of the rocket and payload to get it into space.



It's a tricky balancing act. It's not just the payload that has mass we need to cancel out with thrust against the downward force of gravity. The rocket's body has mass as well, as does the fuel on board. The payload is typically the smallest portion of mass on a launch. The propellants — the fuel and oxidizer — weigh the most.

This is where staging comes in handy. Because the propellant is heaviest, as it burns the mass of the whole rocket goes down. That means that the rocket structure becomes dead weight, which needs more fuel to keep lifting it, which means the overall mass goes up… it compounds from there. Staging is a way of getting rid of dead weight so the energy of the burning engine is transferred to the payload so it gets into orbit! Getting rid of dead weight is done via staging, the process of discarding spent rocket stages, and there are a few ways this can be done.

Serial staging uses stages attached one on top of another. When the countdown to lift-off begins at Ground Control, the primary, first stage rocket will fire and burns through its fuel until its propellants are gone. Now spent, the useless first stage is detached and falls away. The second stage ignites and takes over. Depending on the rocket, the second stage could get the payload into orbit or a third or fourth stage will ultimately be the one to deliver it to space. It depends on the individual rocket and mission.

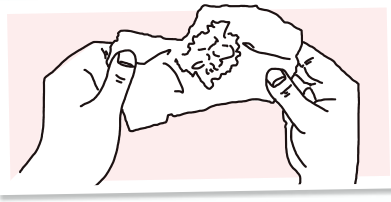
9. Rocket launch

What you'll need from the kit:
Foam rocket.
You will also need:
White vinegar, measuring beaker, 500ml drinks bottle (empty) that the foam rocket will fit snugly into the neck of, tablespoon, bicarbonate of soda, paper towel.

"Three, two, one…we have lift-off!" A space rocket launches skyward, engines roaring with exhaust flames beneath it. Every type of rocket, including small launch vehicles, guided missiles and launch vehicles, work on exactly the same principle. They make use of action and reaction forces. The action force is the effect of the exhaust being pushed out of a rocket's engine down towards the ground. The reaction force is the rocket moving in the opposite direction, lifting off the ground. Here's how you can launch your own rocket at home…

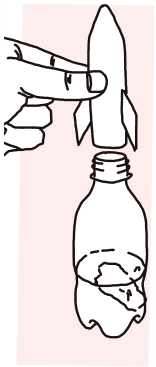
TIP: *You'll need to be quick with this experiment, so gather all of the components together so you have everything ready.*

1. Measure 100ml white vinegar and pour into the plastic bottle.



2. Place 1 tablespoon of bicarbonate of soda on the paper towel and wrap the towel around it. Make sure that the bicarbonate of soda is wrapped in one layer of paper towel, which you can roll into a long strip, so it can easily be put into the neck of the bottle.

3. Insert the rolled-up paper towel into the bottle. Now quickly place your foam rocket just inside the opening of the bottle. Stand back and watch it take off!



NOTE: THIS EXPERIMENT IS MESSY. ONLY PERFORM OUTSIDE!

SCIENCE SECRETS

Here's an explanation behind the invisible force which has propelled your rocket skyward. The bicarbonate of soda is alkali and the white vinegar is acid. When they meet, they react with each other and produce a lot of carbon dioxide. The force created when the carbon dioxide builds up inside the bottle is enough to push the small rocket away from the top of the bottle.

FUN FACT

There are all sorts of different rockets. Rockets can be powered by a variety of different fuels – there are chemical, nuclear, electric and photon-powered rockets. Chemical rockets can be divided into three different types: liquid propellant rocket, solid propellant rocket and hybrid propellant rocket.

Rockets are used for all sorts of different tasks. They can be used to launch satellites or even lay mines. There are meteorological rockets, anti-hail rockets and various military rockets.

Some rockets have a controlling device inside and some do not.

Rockets can also be graded as single grade rockets or multistage rockets. According to the launch range of the rocket, it can be either a short distance, middle distance or far distance rocket.

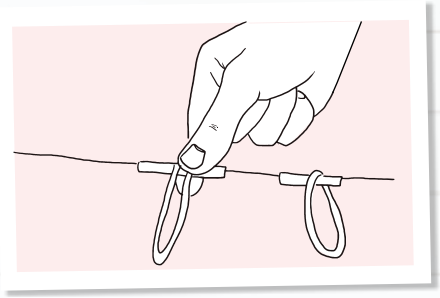
Even though there are different kinds of rockets, their working principles are almost exactly the same. Most rockets are either powered by liquid propellant or solid propellant.

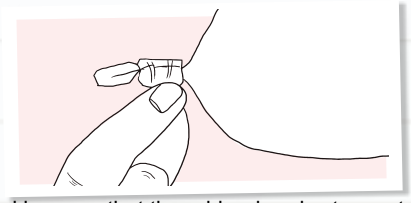
10. Multi-stage rocket

What you'll need from the kit:
Fishing line, rubber bands, 2 rocket balloons, 2 stir sticks, 2 balloon clips.
You will also need:
Outdoors: 2 trees several metres apart OR Indoors: 2 chairs several metres apart.

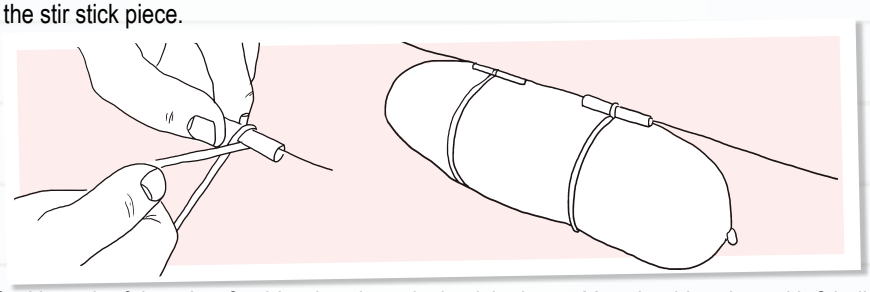
A fascinating aspect of rockets is the great distance they can cover and their tremendous speed. The science behind them is so interesting it's no wonder many young people are inspired to become engineers and work in the space industry. If you are inspired to do this yourself, you will need to start at the beginning and learn the basics. Here's how you can build a simple multi-stage rocket…

1. **ASK AN ADULT** to cut one of the stir sticks into 4 small pieces, each around 2cm long.
2. Head outdoors and find a tree or another sturdy object, like a fence post to fix one end of the fishing line to.
3. Thread the other end of your fishing line through the 4 stir stick pieces and 4 rubber bands. Push them so they are a few centimetres away from the end of your line.
4. Now tie that end of your line to another sturdy object, making sure the line is level.

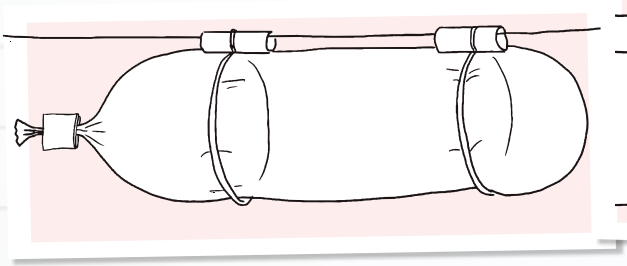


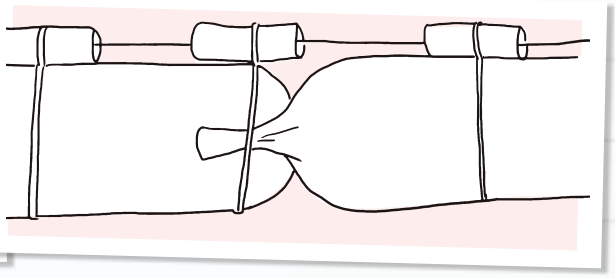


5. To help blow up the balloons, insert the other stir stick into the mouth of a balloon. Once each balloon is inflated, remove the stir stick, twist the end of the balloon and clip it tightly with a plastic clip.
6. Making sure that the rubber bands stay on top of the stir stick pieces, twist each rubber band so that it forms a figure 8. Stretch the lower part of the figure 8 to make enough room for the inflated balloon while the top part fits tightly around the stir stick piece.



7. Repeat Step 6 with each of the other 3 rubber bands and stir stick pieces. You should end up with 2 balloons as shown. As you will see, the inflation section of the front balloon is held under the rubber band which is wrapped around the balloon behind it.





8. Now your balloon rocket is ready to launch! Release the clip on the rear balloon! Your rocket will fly at an amazing speed. As the back rocket stage deflates, it releases the front balloon (second stage).

NOTE: *Take care that people and pets are clear of your rocket before you set it off.*

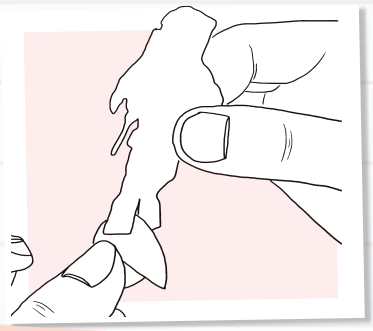
Additional activity: Can you make 3 stage (balloon) rocket?

11. Landing on the Moon

Astronauts landing on the Moon have discovered that it is deserted and there is an endless amount of dust in space. Their findings have inspired scientists to want to know more about the origins of the Moon. Now let us experience landing on the Moon…

What you'll need from the kit:
Moon sand, astronaut card, lunar rover card, lander card, Moon map.
You will also need:
Newspaper.

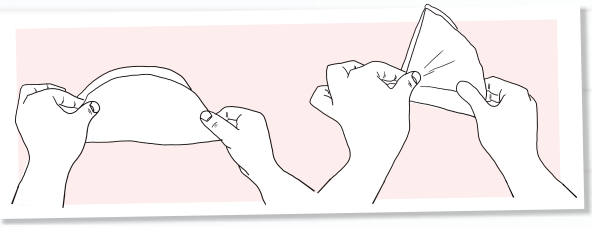
1. Open your Moon map and prepare a sheet of newspaper. Pour the moon sand (made in activity 5) onto the newspaper mould it to represent the surface of the Moon.
2. Following the illustration opposite, slot the lunar rover, astronaut and Moon lander models together and place them onto your Moon model where you decide your mission will land.



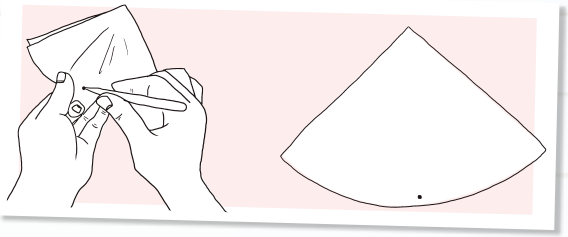
12. Returning back to Earth

When the astronauts have finished examining the Moon, they will return back to Earth. Do you know how they return? Let's research a rocket's route back to Earth…

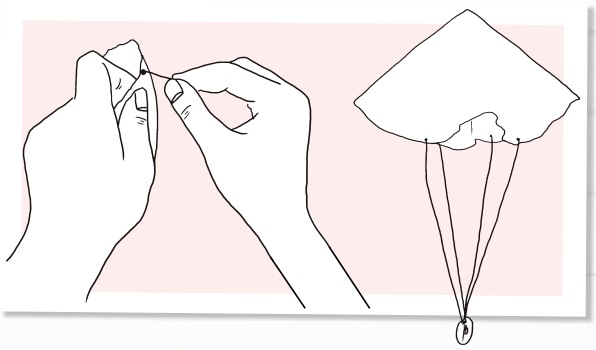
What you'll need from the kit:
Metal washer, coffee filter, 4 pieces of string.
You will also need:
Large plastic bag, pencil.



1. Fold the coffee filter in half, then fold it in half again.



2. Using the tip of the pencil, careful poke a small hole in the bottom edge of the coffee filter, going through all 4 layers as per the image below.



3. Thread the string into each hole and tie the ends to the washer. The washer represents the capsule the astronaut used to return to Earth. The coffee filter is the parachute.
4. Now throw the astronaut into the sky and see how it lands.

ADDITIONAL ACTIVITY: Try turning a large plastic bag into a parachute and carry out the same experiment to see if there any difference in the speed of landing.

Notes and observations