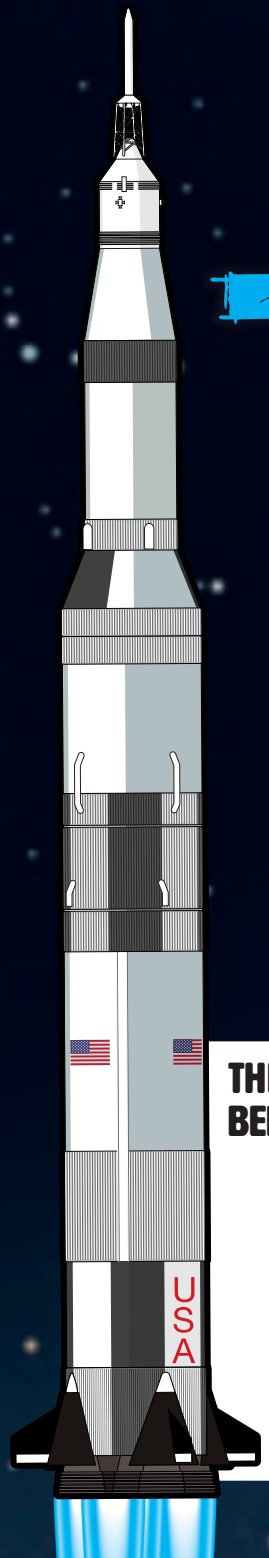
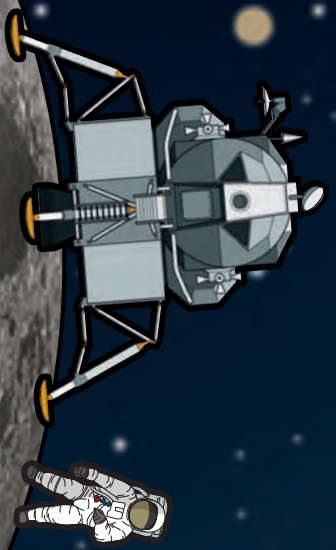
HANDS ON THE MOON

AN EDUCATION RESOURCE FOR 7 TO 11 YEAR OLDS





THIS PACK BELONGS TO:

Science & Technology Facilities Council

HANDS ON THE MOON

Science & Technology Facilities Council

HELLO AND WELCOME TO HANDS ON THE MOON, A RESOURCE THAT HAS BEEN DESIGNED FOR USE WITH PUPILS AGED 7 TO 11. IF YOU WOULD LIKE TO KNOW HOW YOU CAN USE THIS RESOURCE IN YOUR CLASSROOM THEN TAKE A LOOK AT OUR HINTS AND TIPS BELOW.

WHAT IS THIS RESOURCE MADE UP OF?

Six separate sections have been created with each section then further split into two parts; a 'Discover' section and an 'Activity' section. The 'Discover' sections consist of background knowledge and the 'Activity' sections contain activities for students to try out in the classroom.

The six sections are:

1. **The Lunar surface**
2. **How the Moon was formed**
3. **The Moon and Earth**
4. **How we went to the Moon**
5. **Will we live on the Moon?**
6. **How to look at the Moon.**

I AM NOT AN EXPERT IN ASTRONOMY, IS THIS PACK FOR ME?

Absolutely! We are not expecting you to be an expert at all. This pack just provides the framework for you and your students to find out more about the science curriculum in a real world setting using astronomy as a context and to learn about astronomy and space science together.

WILL I NEED LOTS OF EQUIPMENT FOR THIS RESOURCE?

No. We know how difficult it is to source equipment for a class full of students so everything that we have suggested uses things you should already have in your classrooms or can access digitally for free.

DOES THIS DIRECTLY LINK TO THE NATIONAL CURRICULUM?

Yes, within each section. The focus of the resource is on science within a real world astronomy context so therefore links to aspects of the science curriculum. However, the resource also covers cross-curriculum topics such as English, Maths and Computing.

HOW IS IT BEST TO USE THE PACK?

That is completely up to you. If you want to brush up on your knowledge then you can use the 'Discover' sections just for you and use the 'Activity' sections to set tasks for the students. Alternatively you can give your students a whole section to work through independently, so that they may develop their scientific skills.

WHERE CAN I GET INFORMATION TO FURTHER MY KNOWLEDGE OF SPACE?

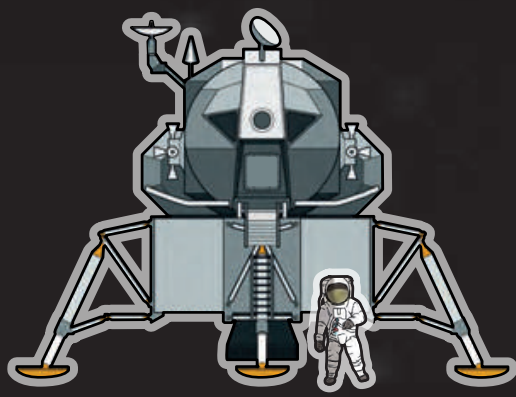
The National Space Academy works directly with teachers to support subject knowledge enhancement, confidence building, and curriculum development - from one-day courses for individual teachers to full consultancy for new schools looking to develop an exciting STEM offer.
They have experience in supporting GCSE, A Level, Scottish Standards and Highers and International Baccalaureate curricula within the UK and other national curricula overseas. Developing subject knowledge and understanding with memorable hands on activities is a mainstay of their student programmes.

WHAT CAN I USE AS A FOLLOW ON FROM THIS ACTIVITY?

If you are looking for even more resources including classroom activities, videos, podcasts and vodcasts then check out the National Space Academy website. You can also find information here about how to come and visit – an excellent follow up to this resource.

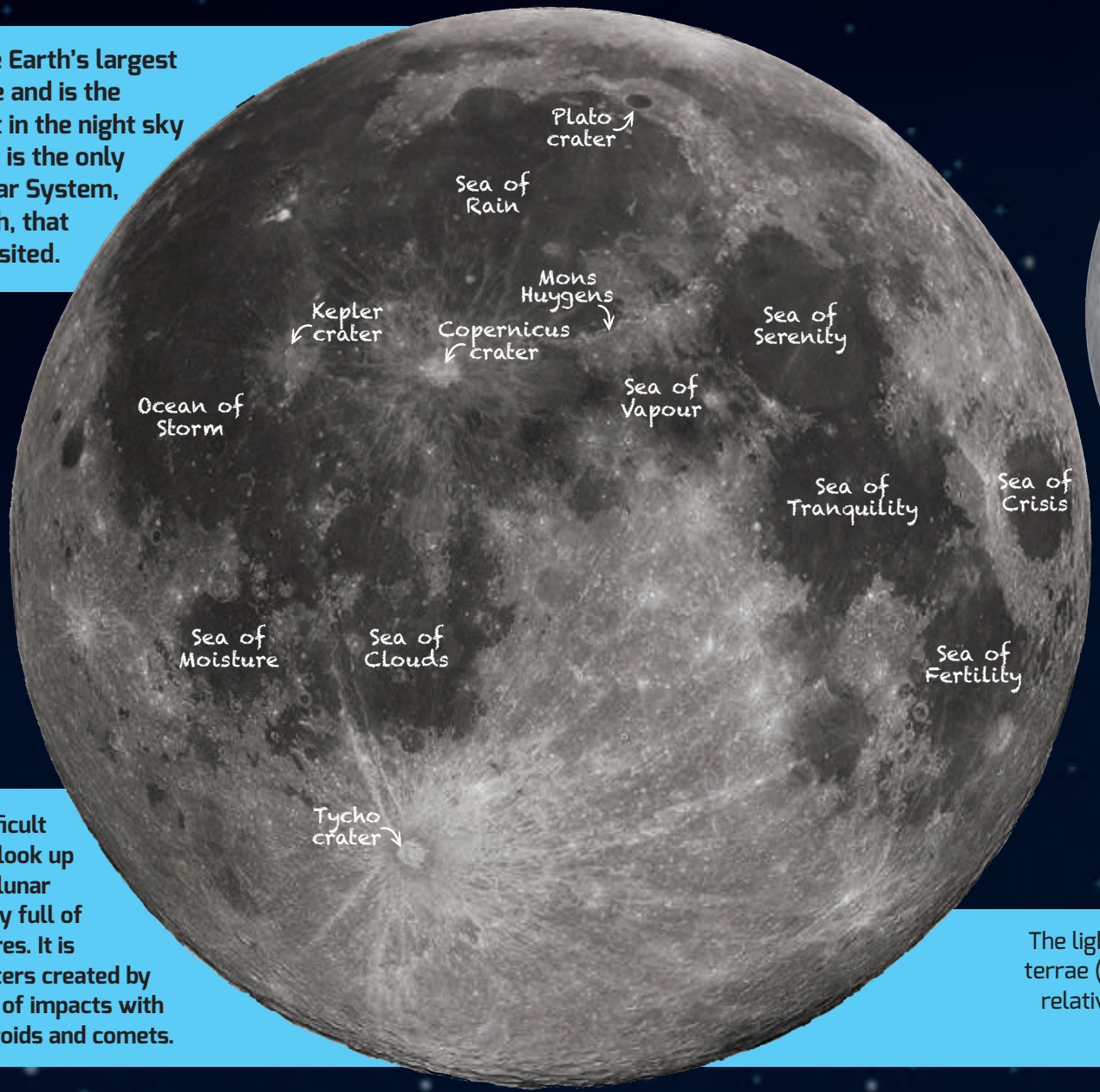
IS THERE A WAY TO SHOW STFC THE WORK THAT IS PRODUCED AS PART OF THIS RESOURCE?

Yes please do, we would love to see it. You can do this by using the social media tag #STFC_HOM or emailing us on STFCPublicEngagementTeam@stfc.ac.uk



1 DISCOVER THE LUNAR SURFACE

The Moon is the Earth's largest natural satellite and is the brightest object in the night sky after the Sun. It is the only place in the Solar System, other than Earth, that humans have visited.



THE HIDDEN SIDE OF THE MOON

The Moon takes 27.3 days to revolve once – the same amount of time it takes for the Moon to orbit the Earth. This is why we only ever see one side of the Moon. Spacecraft have seen its hidden side and it looks very different from the Moon we are used to seeing!

Although it is difficult to see when you look up at the Moon, the lunar surface is actually full of interesting features. It is covered with craters created by millions of years of impacts with meteorites, asteroids and comets.

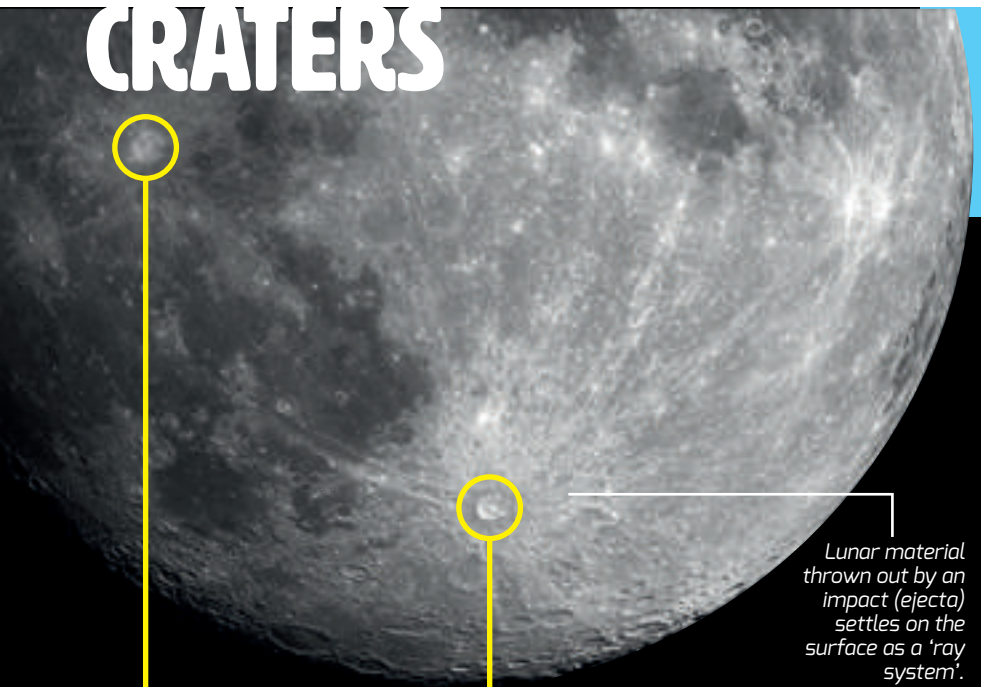
The lighter coloured areas are the lunar highlands, called terrae (which means 'land' in latin) and the dark areas are relatively flat plains, called maria (which means 'sea'), that are actually ancient flows of lava.

1.2 DISCOVER THE LUNAR SURFACE

CRATERS

The Moon is famous for its craters and for being made out of cheese. OK, so the Moon is not actually made of cheese, but its surface *is* covered in craters – in fact there are more 3 trillion (3 million million) of them!

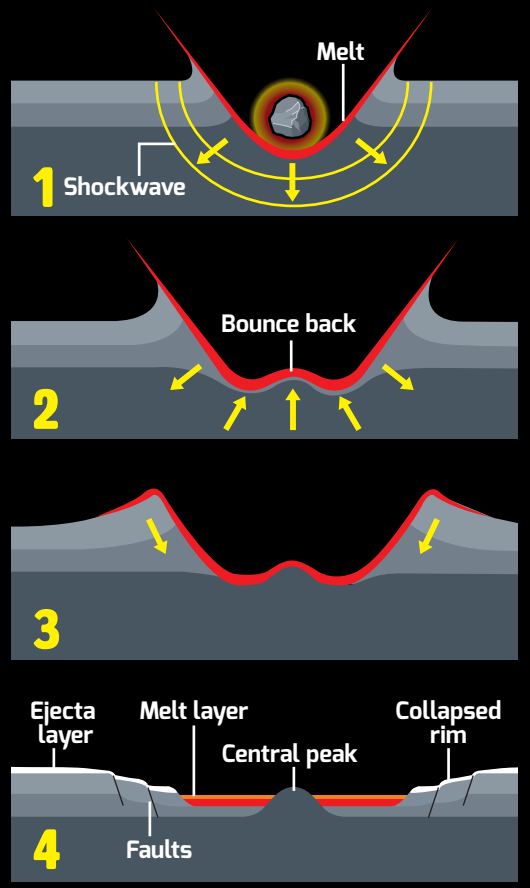
Most craters are formed by asteroid/meteor impacts. Some are tiny (little more than tiny dents in the lunar regolith) and were formed by small meteoroids. Larger craters were made by impacts with objects big enough to disturb the lunar bedrock.



Lunar material thrown out by an impact (ejecta) settles on the surface as a 'ray system'.

HOW CRATERS ARE FORMED

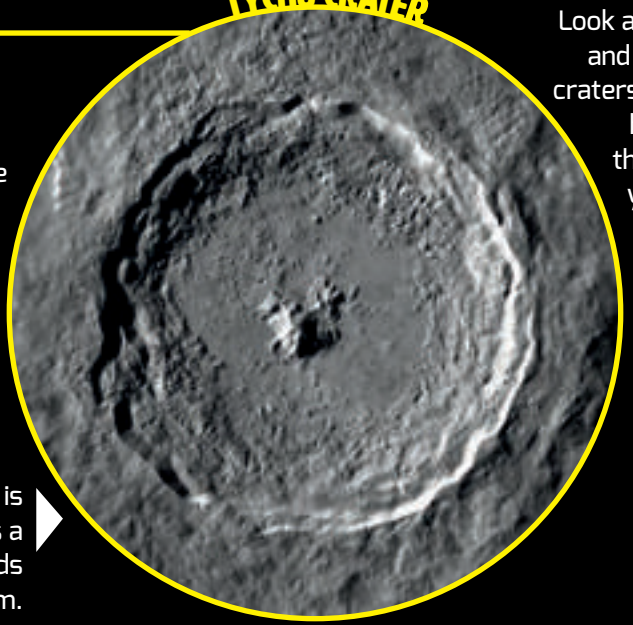
1. A large space rock impacts the surface and explodes. A large amount of lunar material is melted and thrown outwards. The crust beneath and around the impact site is squashed downwards.
2. The crust 'bounces' back up – forming a peak in the middle of the crater.
3. The peak and rim collapse.
4. As it settles back down, the melted lunar rock levels out, cools and cracks – forming faults.



COPERNICUS CRATER

The Copernicus crater is 93km wide and is visible with the naked eye from Earth. It was formed about 900 million years ago by an asteroid up to 10 kilometres across.

TYCHO CRATER



The Tycho crater is 86km wide and has a ray system that spreads out as far as 1,500km.

Look at the Tycho and Copernicus craters and notice how similar they are. Can you identify any of the features?

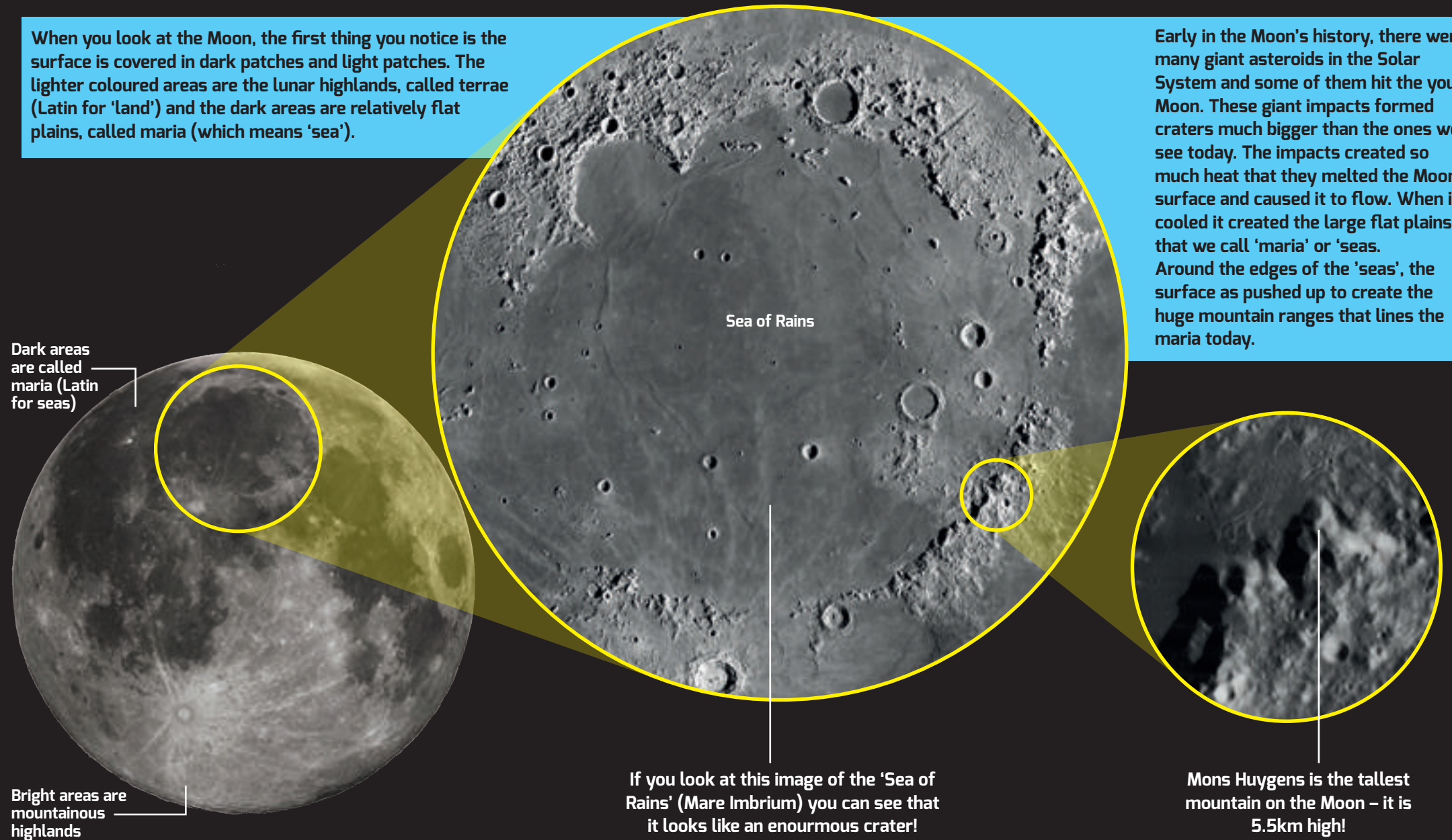
After billions of years of being pummeled by meteorites and asteroids, the lunar surface is covered in a fine-grained layer dust called regolith, which can be up to 20 metres thick.

1.3 DISCOVER THE LUNAR SURFACE

SEAS AND MOUNTAINS

When you look at the Moon, the first thing you notice is the surface is covered in dark patches and light patches. The lighter coloured areas are the lunar highlands, called terrae (Latin for 'land') and the dark areas are relatively flat plains, called maria (which means 'sea').

Early in the Moon's history, there were many giant asteroids in the Solar System and some of them hit the young Moon. These giant impacts formed craters much bigger than the ones we see today. The impacts created so much heat that they melted the Moon's surface and caused it to flow. When it cooled it created the large flat plains that we call 'maria' or 'seas.
Around the edges of the 'seas', the surface as pushed up to create the huge mountain ranges that lines the maria today.



If you look at this image of the 'Sea of Rains' (Mare Imbrium) you can see that it looks like an enourmous crater!

Mons Huygens is the tallest mountain on the Moon – it is 5.5km high!

1.4 ACTIVITY MAKE YOUR OWN CRATERS

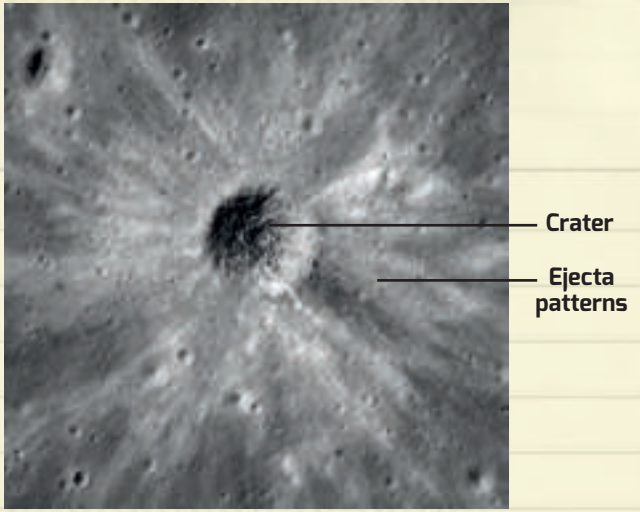
ACTIVITY 1A MAKE AN IMPACT CRATER

The Moon's craters were formed when space rocks, such as astreroids and meteroites, smashed into the Lunar surface. You can make your own craters with some flour, cocoa power and a ball bearing.
The flour will represent Lunar soil (regolith) and the cocoa represents the surface layer of regolith that has been darkened by exposure to the Sun.

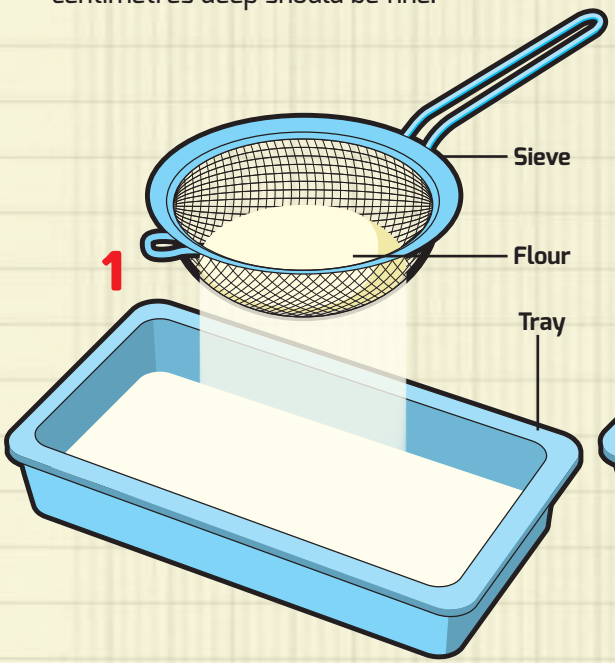
PREDICTIONS

Before you make any craters, try to predict what will happen to the crater when:

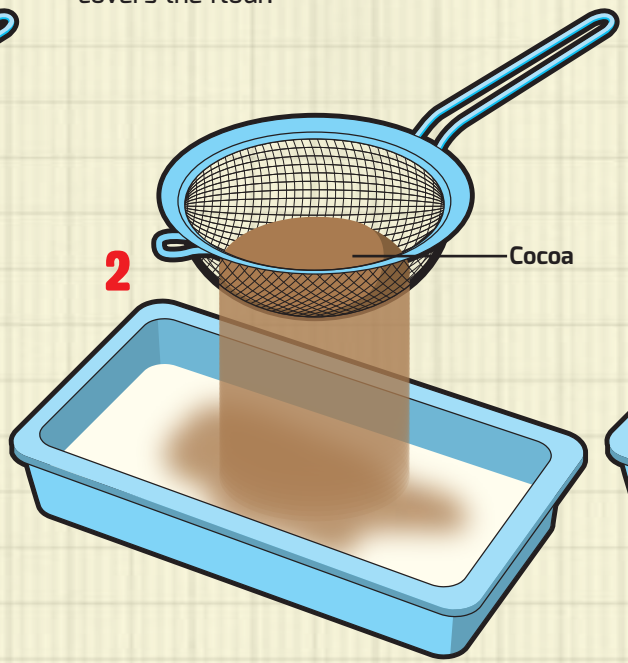
- You drop the ball from a low height.
- You drop the ball from higher up.
- You drop it from an angle.
- If you have two different size ball bearings (one heavy and one light), but you drop them from the same height, will their craters be the same or different?



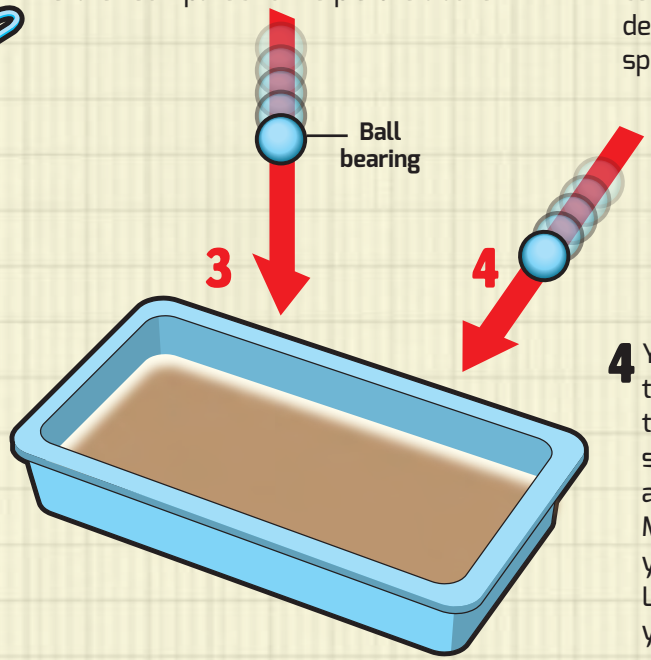
1 Carefully sift some flour into a large plastic tray – about three centimetres deep should be fine.



2 Sift some cocoa into the tray so that it creates a thin layer that covers the flour.



3 Drop a marble, or ball bearing from a height(at least 30cm) and then see how your crater compares to the picture above.



Now try dropping your ball from different heights and see how that affects the depth of the crater and the spread of ejecta.

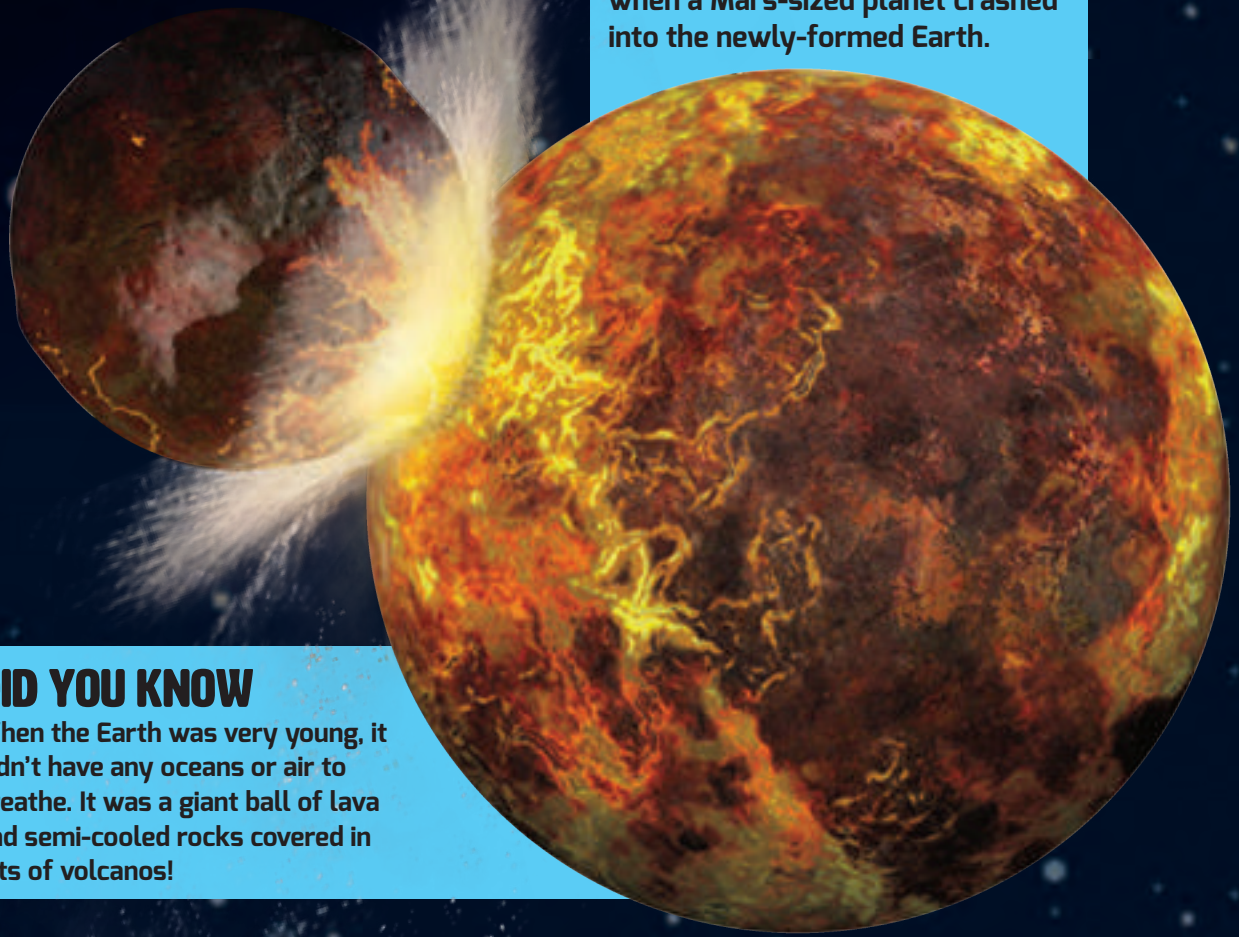
4 You could also try (gently) throwing the ball into the tray from an angle and seeing what happens. Not all meteorites hit the Moon straight on – see if you can find a picture of a Lunar crater than matches your results.

2 DISCOVER HOW THE MOON WAS FORMED

Many of the planets in our Solar System have their own moons – the gas giant Jupiter has 69! Some of these moons started off as asteroids or other giant space rocks that passed too close and were captured by the planet's gravity. Others were formed from lots of small rocks and dust that orbited the planet and, over time, clumped together to form one large rocky, or sometimes icy, moon.

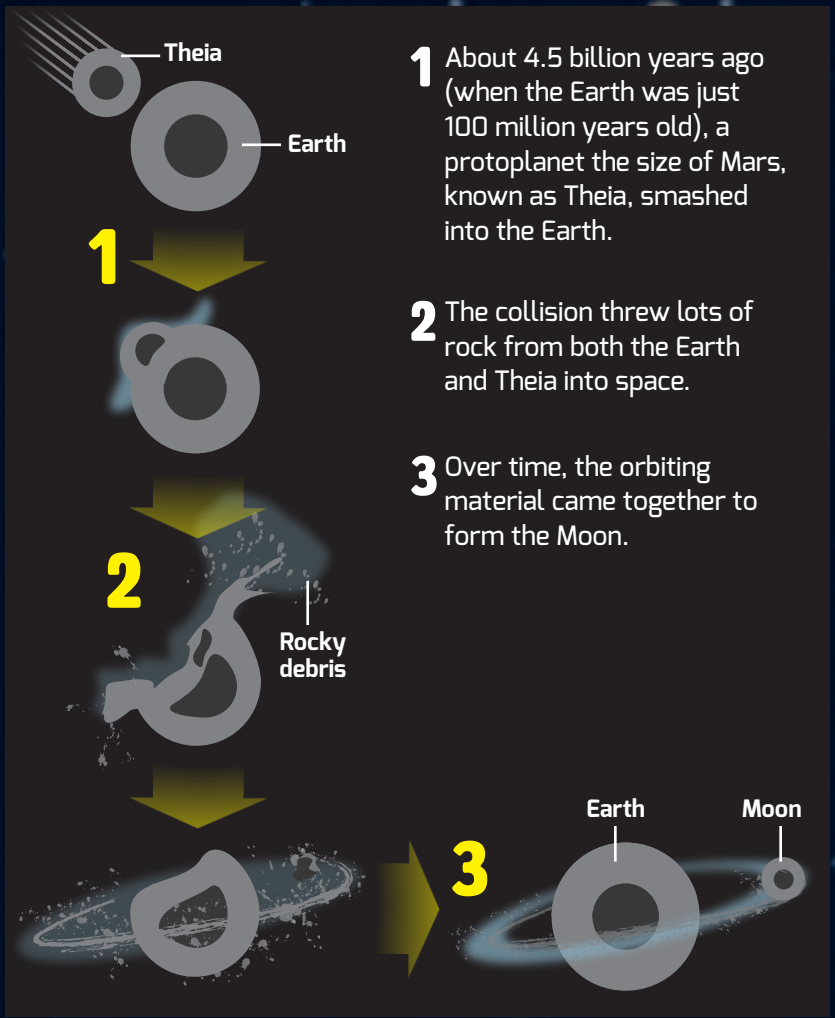
Scientists think that the Earth got its moon in a much more violent way than most planets – in a sort of giant cosmic car crash!

Scientists think that the Moon was created about 4.5 billion years ago when a Mars-sized planet crashed into the newly-formed Earth.



DID YOU KNOW

When the Earth was very young, it didn't have any oceans or air to breathe. It was a giant ball of lava and semi-cooled rocks covered in lots of volcanos!



1 About 4.5 billion years ago (when the Earth was just 100 million years old), a protoplanet the size of Mars, known as Theia, smashed into the Earth.

2 The collision threw lots of rock from both the Earth and Theia into space.

3 Over time, the orbiting material came together to form the Moon.

2.1 DISCOVER WHAT THE MOON IS MADE OF

The Moon is much more than just a big ball of rock – like the Earth, it has a crust, a mantle and core. It even has an atmosphere, but you wouldn't want to try to breathe it!

CRUST

The crust is about 50 km thick (in some places it is much thinner, or thicker) and is made up of a mixture of oxygen, silicon, magnesium, iron, and other minerals.

MANTLE

The mantle is made of solid rock and is about 1,400 km thick.

OUTER CORE

The outer core is liquid and made of mostly iron. It is about 650 km in diameter.

LOWER MANTLE

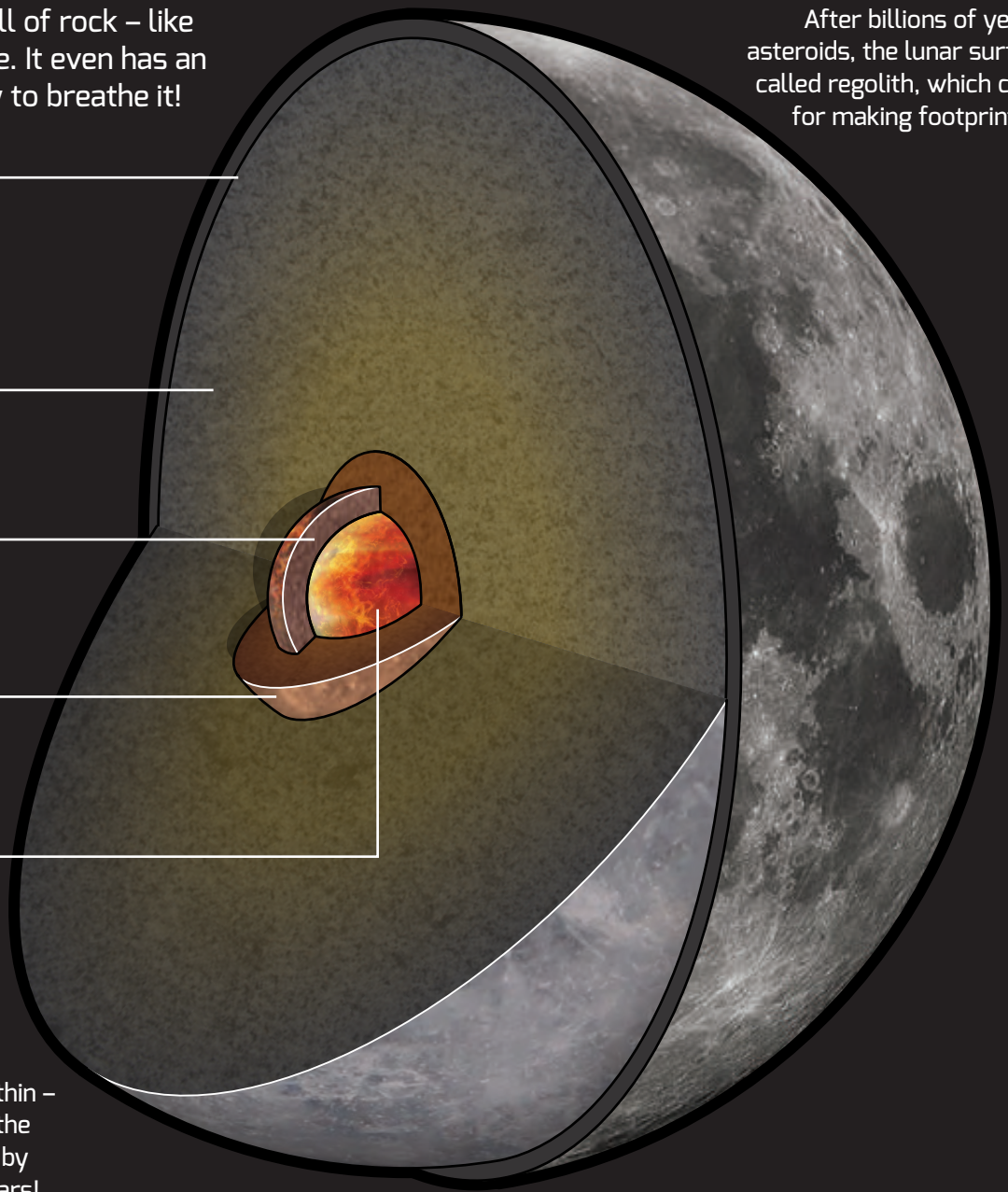
The lower mantle is made of partly melted rock and is about 150 km thick.

INNER CORE

The inner core is solid ball of iron about 480 km wide. It's temperature is about 1400°C.

ATMOSPHERE

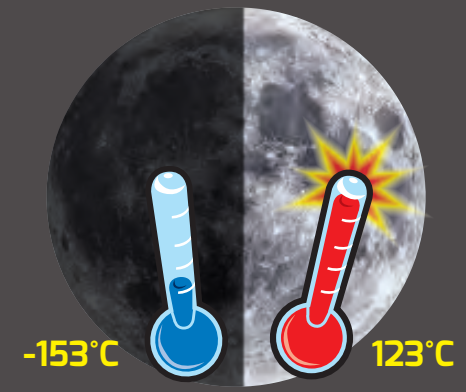
The Moon does have an atmosphere but it is very thin – more than a million million times less dense than the Earth's. This means that the footprints left behind by the Apollo astronauts could last for millions of years!



After billions of years of being pummeled by meteorites and asteroids, the lunar surface is covered in a fine-grained layer dust called regolith, which can be up to 20 metres thick. It is excellent for making footprints in – as the Apollo astronauts found out!

EXTREME TEMPERATURES

The Moon takes 27 days to rotate once on its axis. So most places on the surface experience about 13 days of sunlight, 13 days of darkness and one day of twilight.



Its thin atmosphere means that temperatures vary wildly between the dark and light sides.

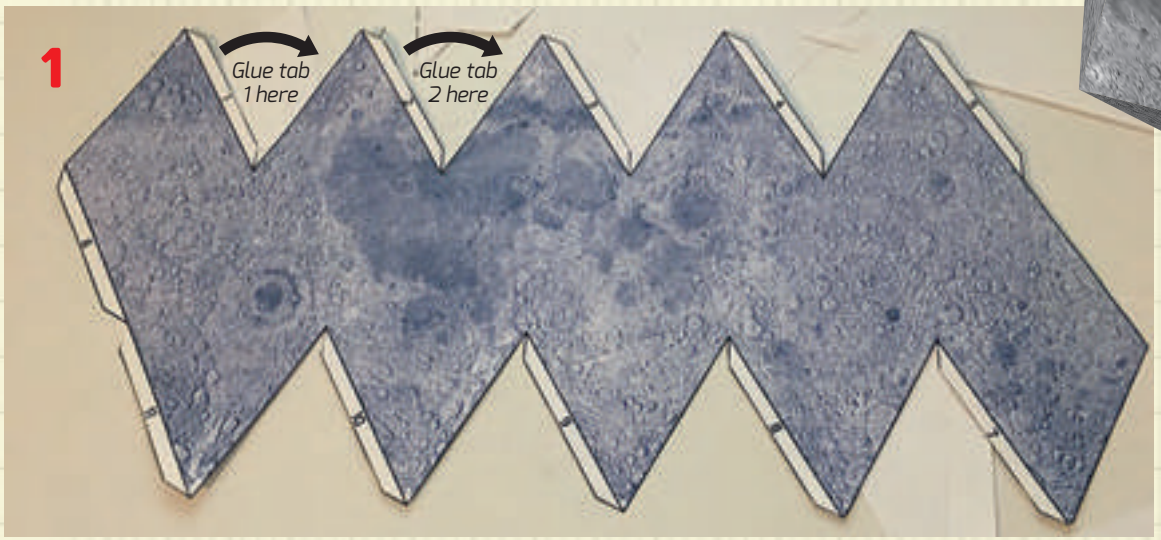
2.2 ACTIVITY MAKE YOUR OWN MOON

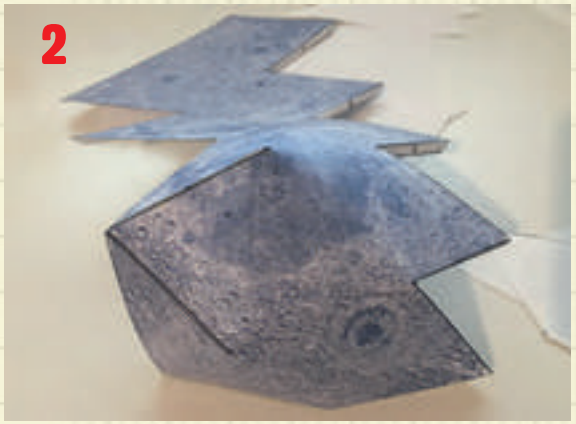
ACTIVITY 2A MAKE YOUR OWN MOON

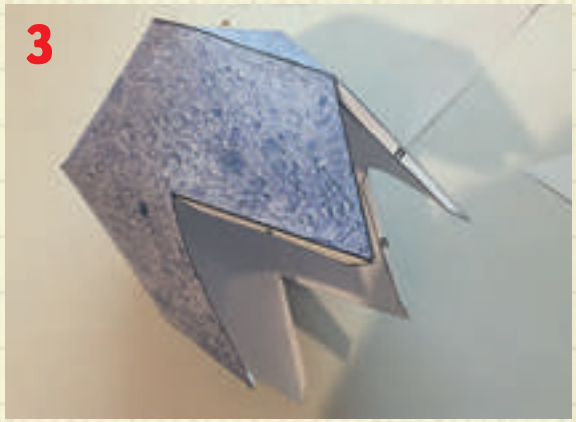
Print out, or photocopy,the template on the next page and carefully cut it out.

Apply a little glue to tab number one and gently fold it around to attach to the tabless side opposite. Do the same for tab number two.

Your finished model will be an 'icosahedron'. An icosahedron is a 20-sided shape with each side made up of an equilateral triangle.



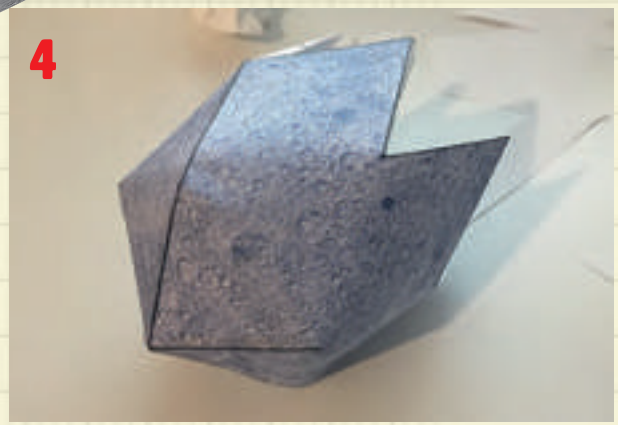


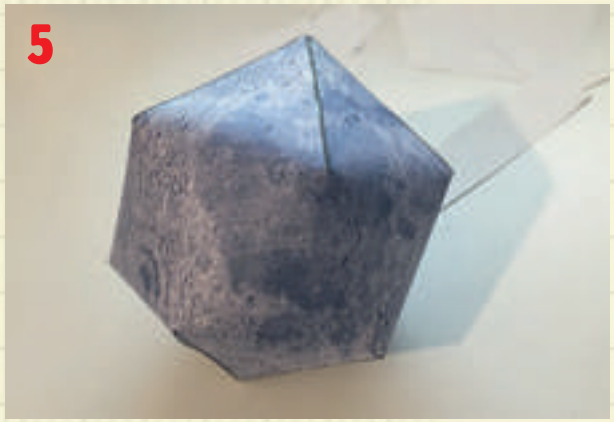


Work your way around until tab number five has been glued to the tabless side near tab number one – and tab six has been glued to the opposite side *(this sounds complicated but, as you glue each tab down, it becomes obvious where the next tab glues to).*

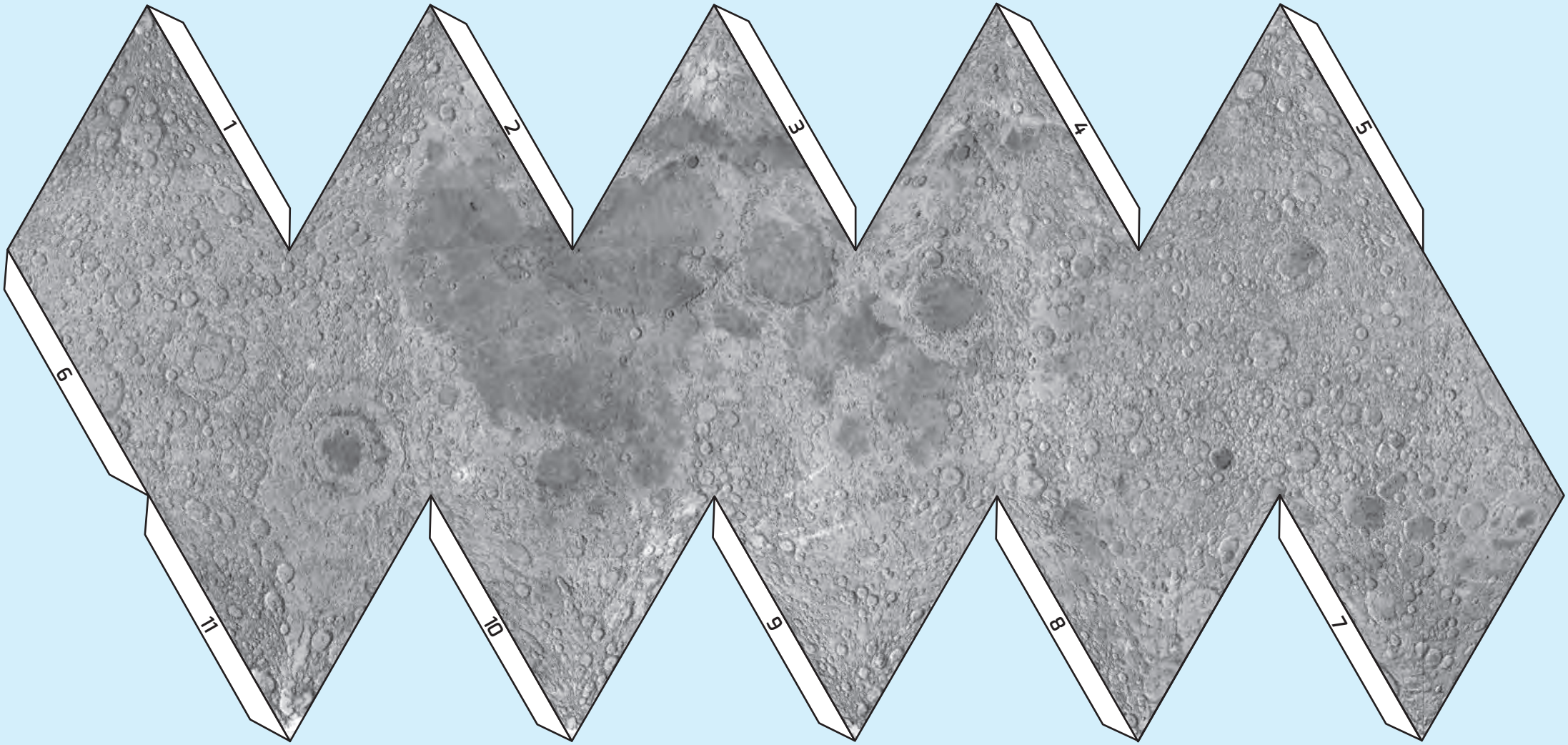
Your Moon model should now look like diagram 3.

Work your way through the remaining numbers to complete your model.





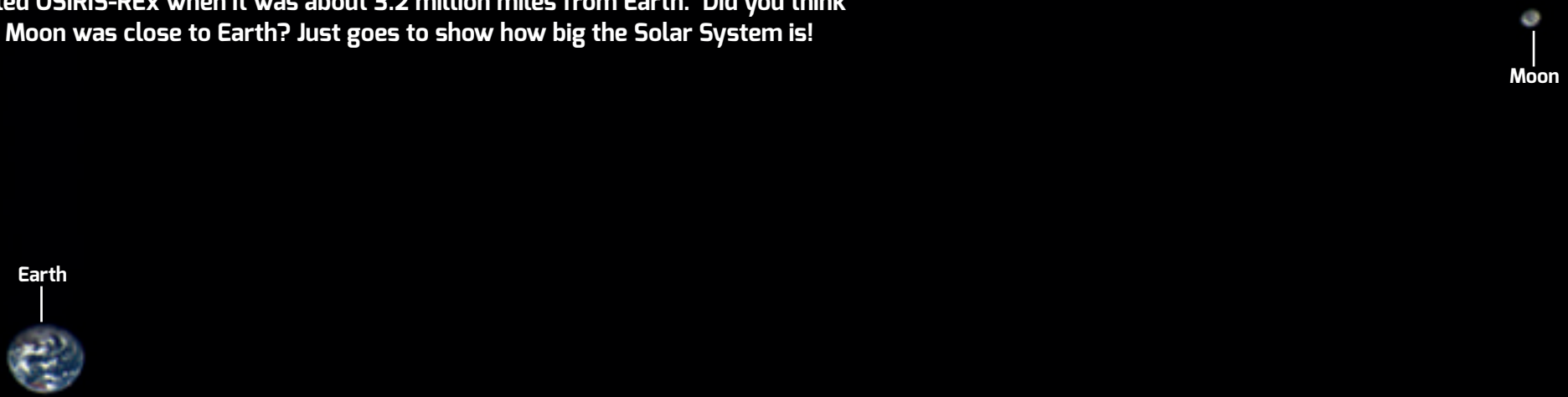
MAKE YOUR OWN MOON TEMPLATE



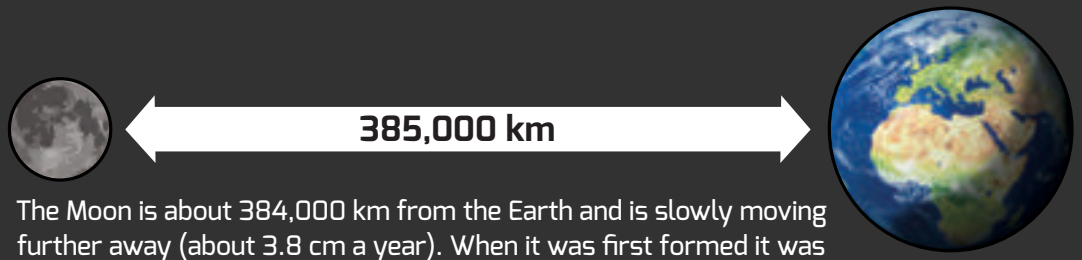
3 DISCOVER THE MOON AND EARTH

The Moon is the Earth's only permanent natural satellite. Although it looks quite close when you look at it in the night sky, it actually orbits at a distance of about 385,000 kilometres (238,856 miles). The Moon is about one quarter the diameter of the Earth, which makes it one of the biggest moons in the Solar System and the biggest compared to its home planet. So, although it is a long way off, because the Moon is so big, it really makes its presence felt here on Earth!

This amazing image of the Earth and the Moon was taken by a NASA spacecraft called OSIRIS-REx when it was about 3.2 million miles from Earth. Did you think the Moon was close to Earth? Just goes to show how big the Solar System is!



The Moon is about one quarter the diameter of the Earth. This makes it one of the biggest moons in the Solar System and the biggest compared to its host planet.



The Moon is about 384,000 km from the Earth and is slowly moving further away (about 3.8 cm a year). When it was first formed it was only 23,000 km away.

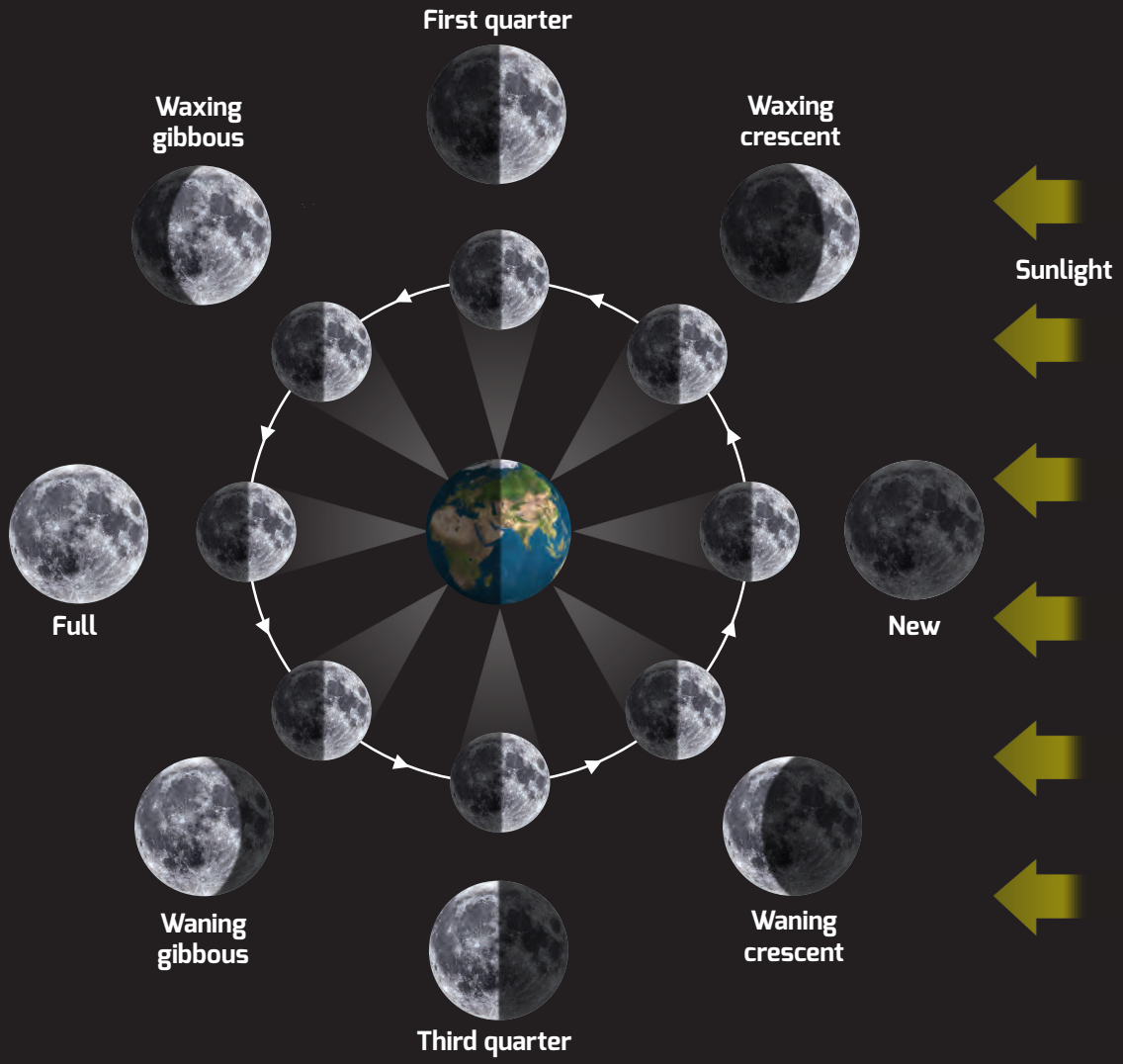
3.1 DISCOVER THE MOON AND EARTH

PHASES OF THE MOON

As the Moon orbits the Earth we see different amounts of its sunlit side. Sometimes we see a bright circle, we call this a full Moon. Sometimes we can't see any of the sunlit side and we call this a new Moon. As it moves from new to full Moon we say it is waxing and after a full Moon is starts to wane until it becomes a new Moon again.

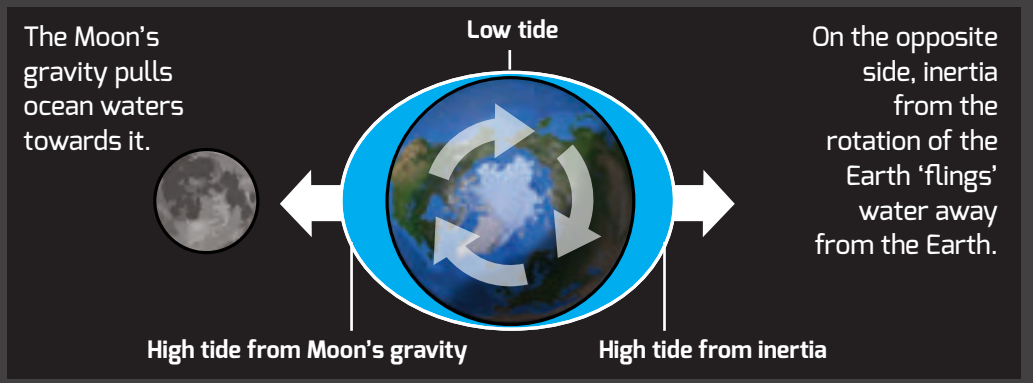
The Moon takes 27.3 days to orbit the Earth. The Moon does not shine by itself – it reflects light from the Sun towards the Earth.
As the Moon orbits the Earth we see different amounts of its surface and so the Moon appears to change shape during a month. These are called lunar phases.

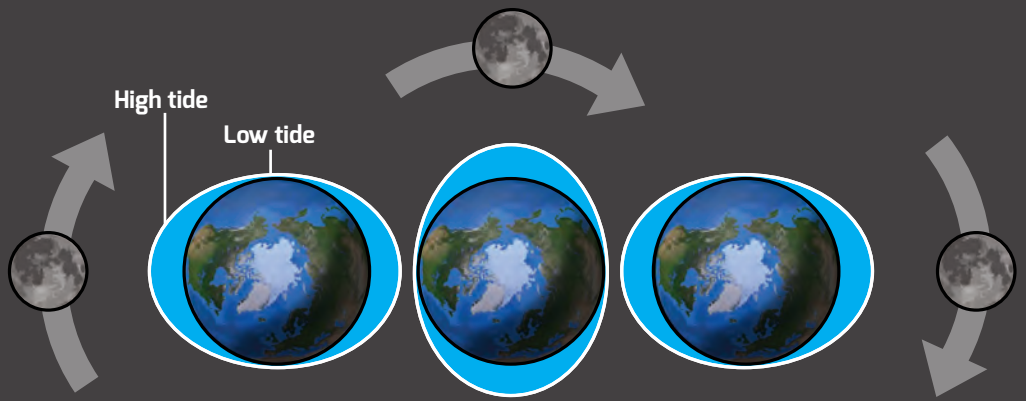
We have to wait 29.5 days to see the same phase of the Moon again, this is a few days longer than the time it takes the Moon to orbit the Earth. The Earth is also orbiting the Sun during that time and we must wait for the Moon to be in the right place so we see the same phase again.



THE TIDES

As well as providing a shape-shifting light show, as the Moon orbits the Earth it also creates the tides that make the sea rise and fall twice a day.





As the Moon orbits the Earth, its gravity pulls the ocean along with it – giving us two high tides a day.

3.2 DISCOVER THE MOON AND EARTH

ECLIPSES

The orbit of the Moon is not flat, it rises and dips as it makes its way around the Earth. Sometimes the new and full moons are a little above the line between the Earth and the Sun and sometimes a little below it.

Sometimes the Moon can be found in between the Sun and the Earth and it casts a shadow on the Earth – this is a solar eclipse. When the Moon moves into the shadow of the Earth we call this a lunar eclipse.

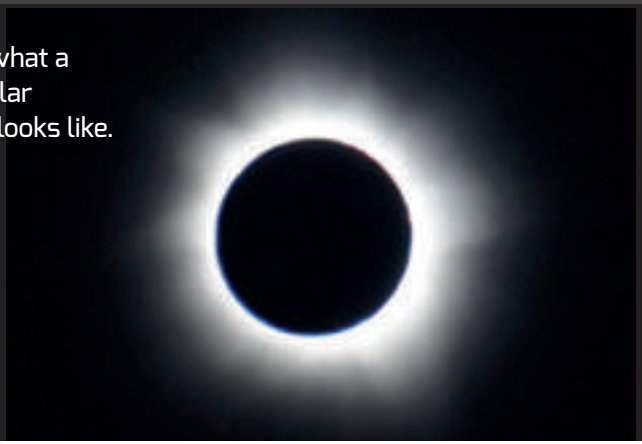
SOLAR ECLIPSE

A solar eclipse only occurs when the Sun, Moon and Earth are all in a line and the Moon passes in front of the Sun.

TOTAL COSMIC COINCIDENCE

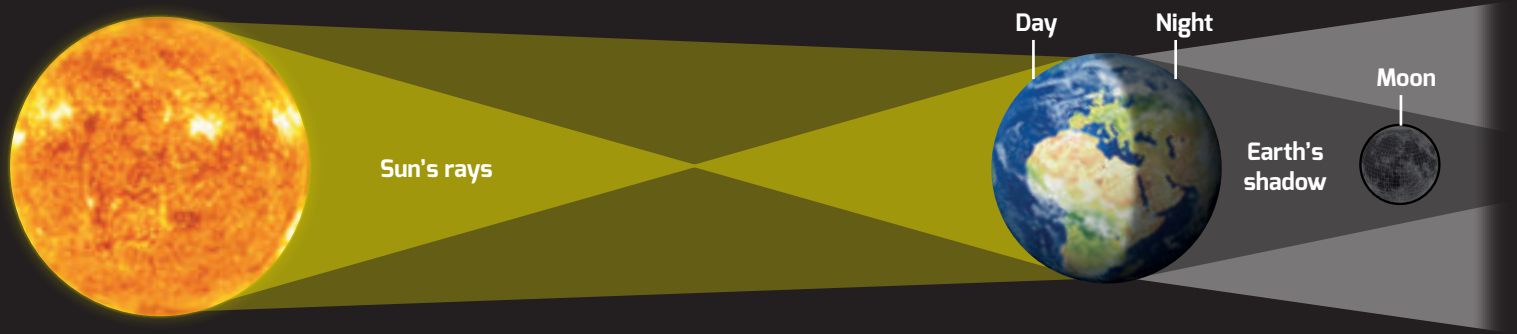
The Sun's diameter is about 400 times larger than that of the Moon but, by coincidence, the Sun is also about 400 times further away. This makes the Sun and Moon appear to be same size as seen from Earth. If the Moon was a little bit further away from the Earth (as it will be in the future), the Moon wouldn't be big enough to cover the Sun and total solar eclipses wouldn't happen at all!

This is what a total solar eclipse looks like.



LUNAR ECLIPSE

A lunar eclipse happens when the Moon moves behind the Earth and passes into the Earth's shadow.

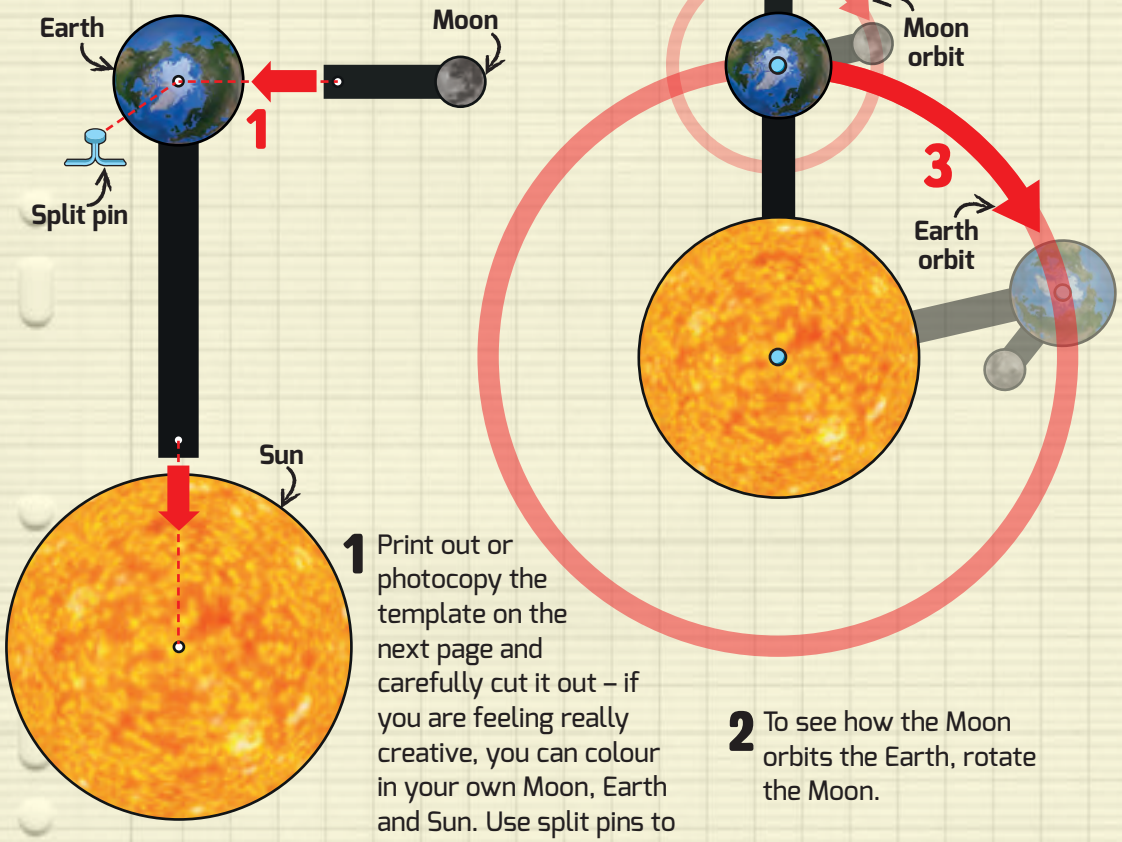


During a lunar eclipse, the Moon turns a rusty red colour because the sunlight passing through the Earth's atmosphere gets filtered and bent towards the Moon.

3.3 ACTIVITY ORBIT INVESTIGATION

ACTIVITY 3A MAKE AN ORBIT MODEL

You can get a good idea of how the Moon orbits the Earth and the Earth orbits the Sun by building this model. When you've built it, have a play and see if you can figure out where in their orbits a Solar eclipse and Lunar eclipse will take place.



1 Print out or photocopy the template on the next page and carefully cut it out – if you are feeling really creative, you can colour in your own Moon, Earth and Sun. Use split pins to attach the Moon to the Earth and then the Earth to the Sun.

2 To see how the Moon orbits the Earth, rotate the Moon.

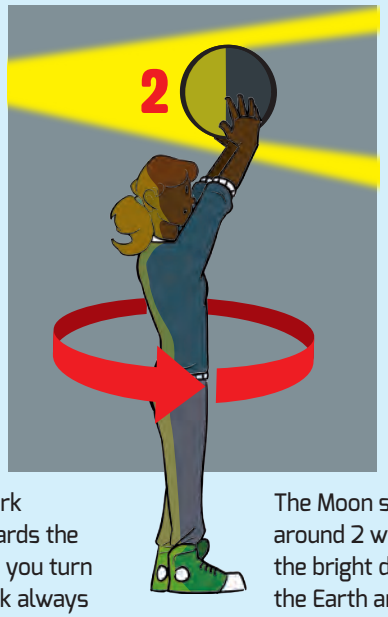
3 To see how the Earth orbits the Sun, rotate the Earth.

ACTIVITY 3B PHASES OF THE MOON

In this activity you are going to pretend that you are the Earth.

1 Stand in the light of a projector (the Sun), holding a ball (your Moon) at arm's length, just above your head. Mark a 'face' on the ball. Turn slowly on the spot. This represents one lunar orbit – about one month.

2 As you turn look at the brightness of the Moon. What do you see? Is it the same all the time or does the pattern of light and dark change as you turn?



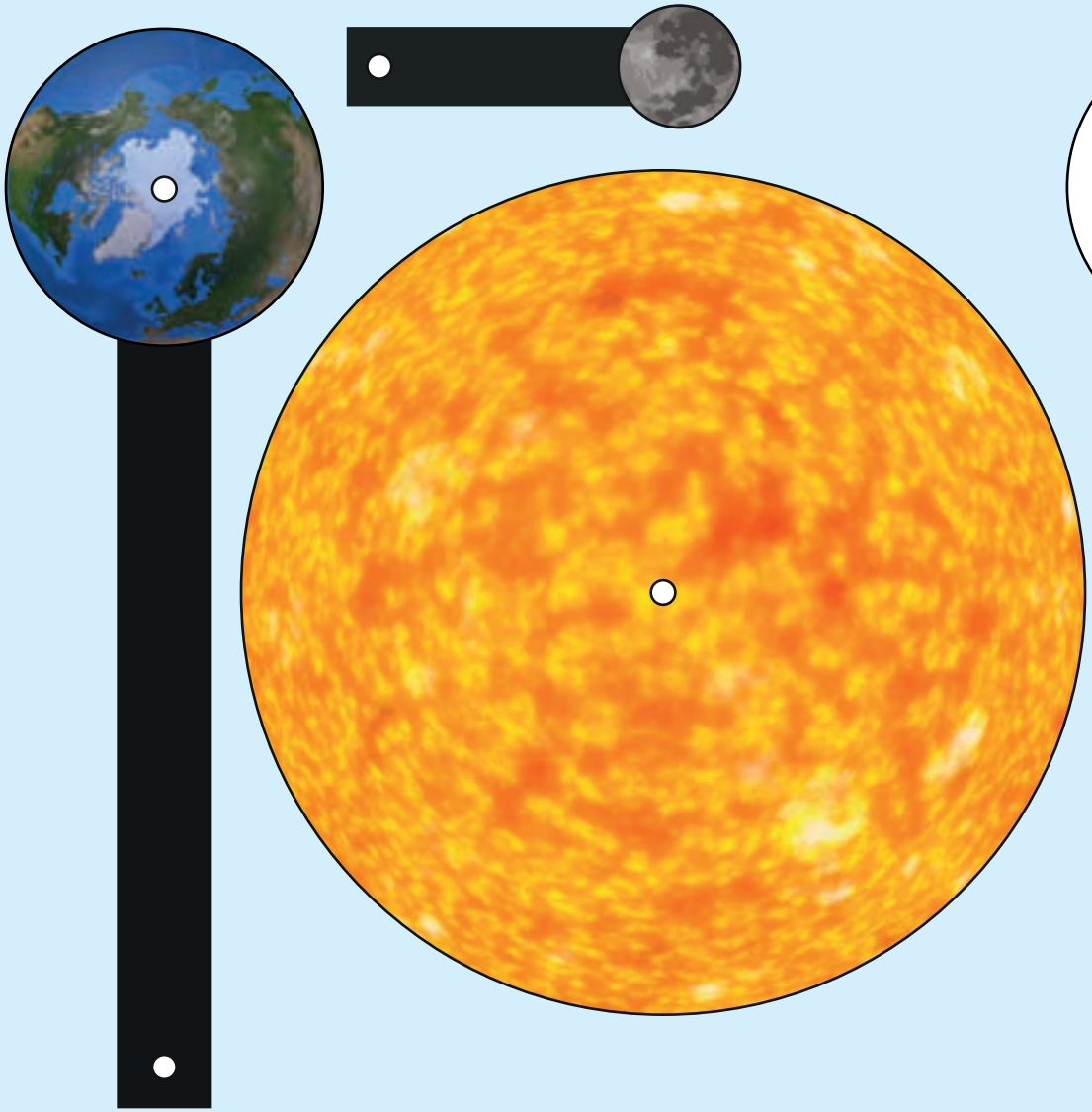
As you go round, the 'face' on the Moon will always be pointing towards us. It turns on its axis once in the same time it takes to orbit the Earth once (27.3 days). This is why we only ever see one side of the Moon. If you are not convinced that the Moon must turn, make a mark on the opposite side of the ball from the 'face' you drew.

Have this mark pointing towards the projector. As you turn with the mark always facing the projector, you eventually get to see all of the ball. If the Moon did not slowly turn on its axis as it orbited the Earth we would eventually see all of the Moon. But we don't, we only ever see one side of the Moon – to see the other side requires a spacecraft.

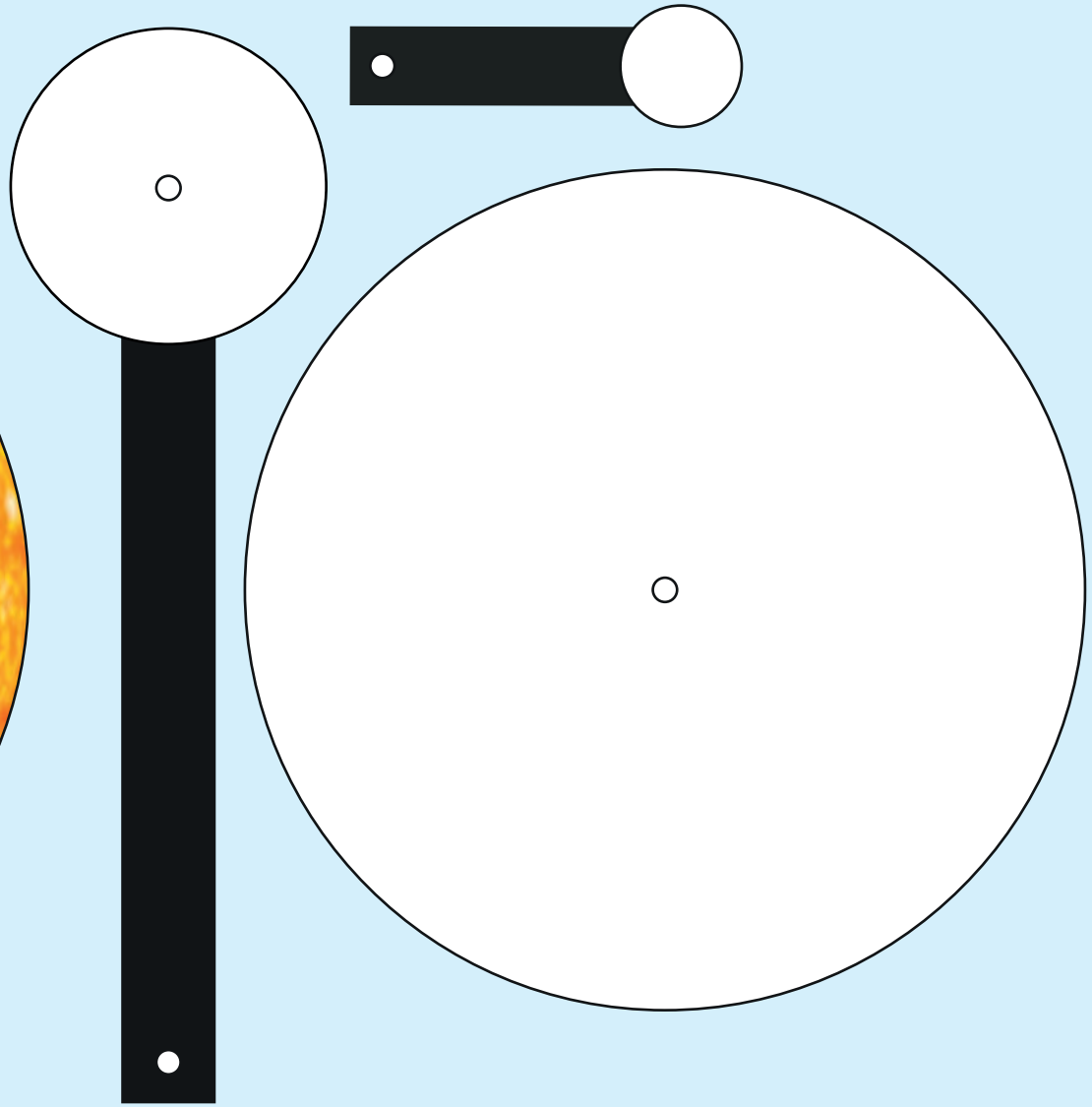
The Moon spends around 2 weeks in the bright day-side of the Earth and then the last 2 weeks in the dark night-side of the Earth as it goes around, this means we sometimes see it during the day and sometimes during the night.

EARTH & MOON ORBIT TEMPLATE

CUT THIS ONE OUT...



OR COLOUR IT IN

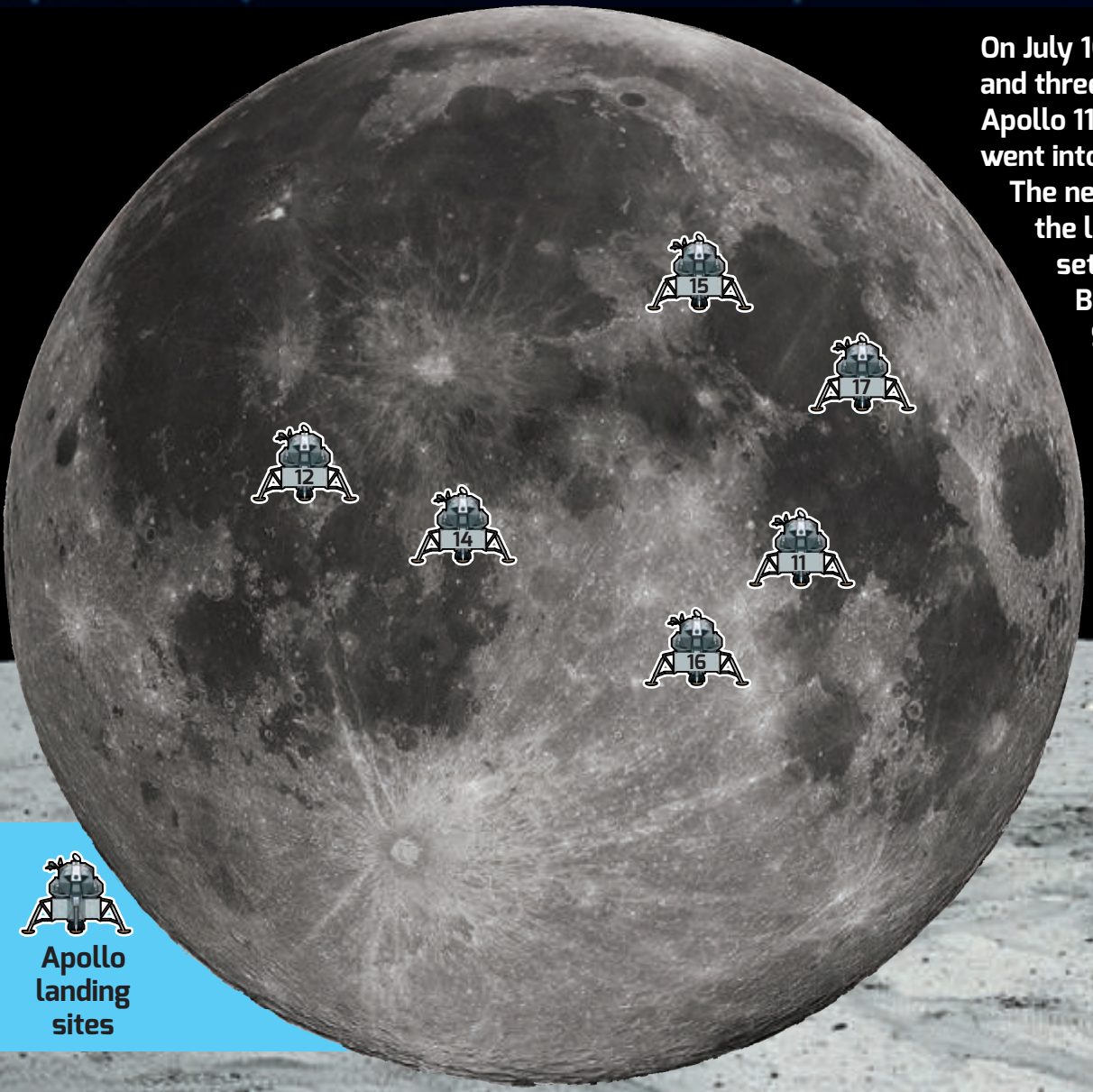


4 DISCOVER HOW WE WENT TO THE MOON

On July 16, 1969 a giant Saturn V rocket blasted off – carrying Apollo 11 and three astronauts on their journey to the Moon. Three days later, the Apollo 11 Service Module, Command Module and Lunar Module (lander) went into orbit 65 miles above the surface of the Moon.

The next day, astronaut Neil Armstrong piloted the Lunar Module onto the lunar surface. He and Edwin "Buzz" Aldrin became the first men to set foot on another world.

Between 1968 and 1972, nine Apollo missions visited the Moon. Six of those missions landed on the Lunar surface and the astronauts performed experiments and collected samples of Lunar material, which they brought back to Earth.



Apollo landing sites

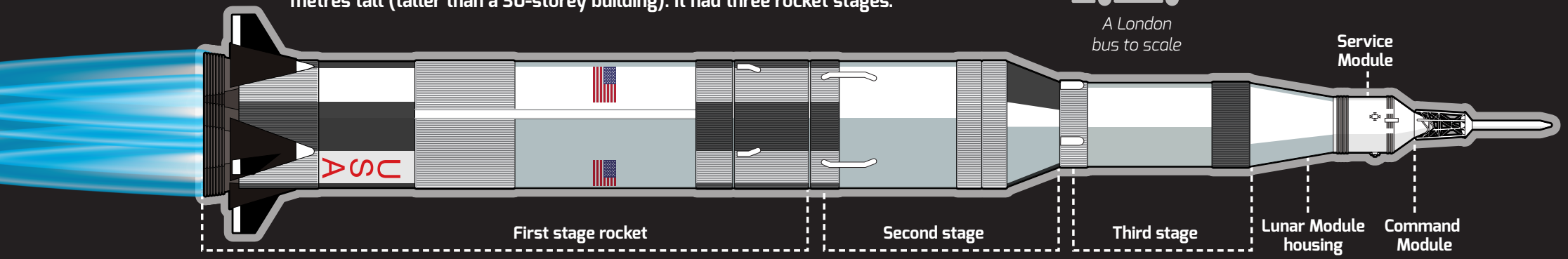
This image shows the Apollo 16 landing site.

4.1 DISCOVER HOW WE WENT TO THE MOON

SATURN V

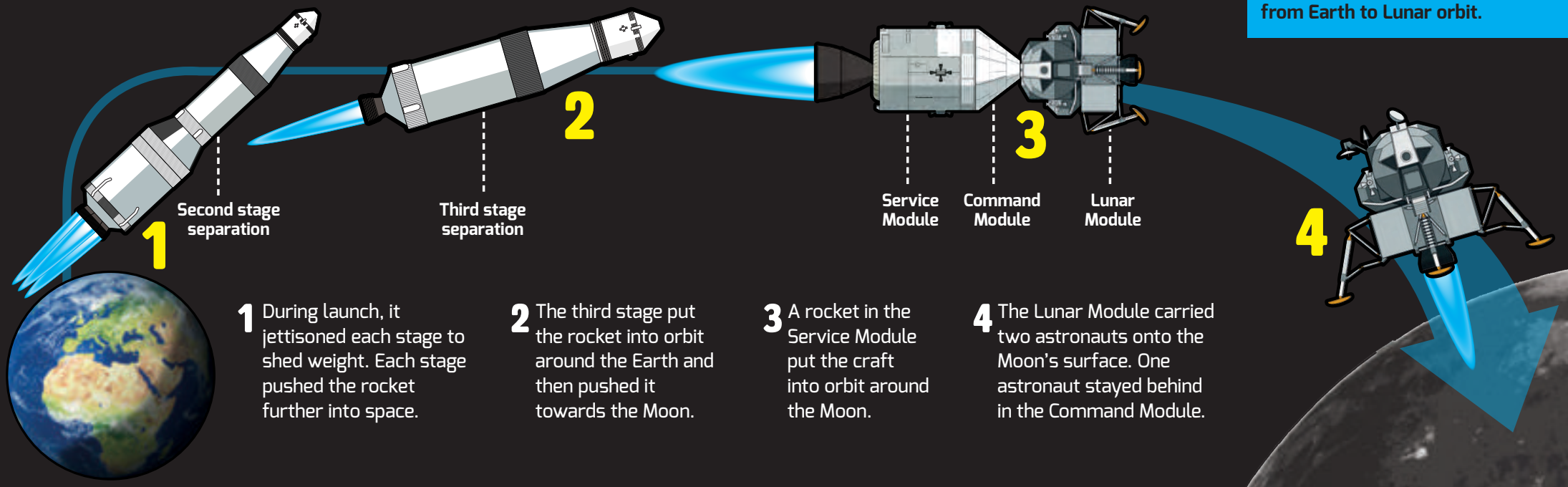
The giant Saturn V rocket was developed especially to carry humans to the Moon. It is still the biggest and most powerful rocket ever built. It was 111 metres tall (taller than a 30-storey building). It had three rocket stages.

A London bus to scale



THE JOURNEY TO THE MOON

It took 2 days, 3 hours and 51 minutes for Apollo 11 to travel from Earth to Lunar orbit.



1 During launch, it jettisoned each stage to shed weight. Each stage pushed the rocket further into space.

2 The third stage put the rocket into orbit around the Earth and then pushed it towards the Moon.

3 A rocket in the Service Module put the craft into orbit around the Moon.

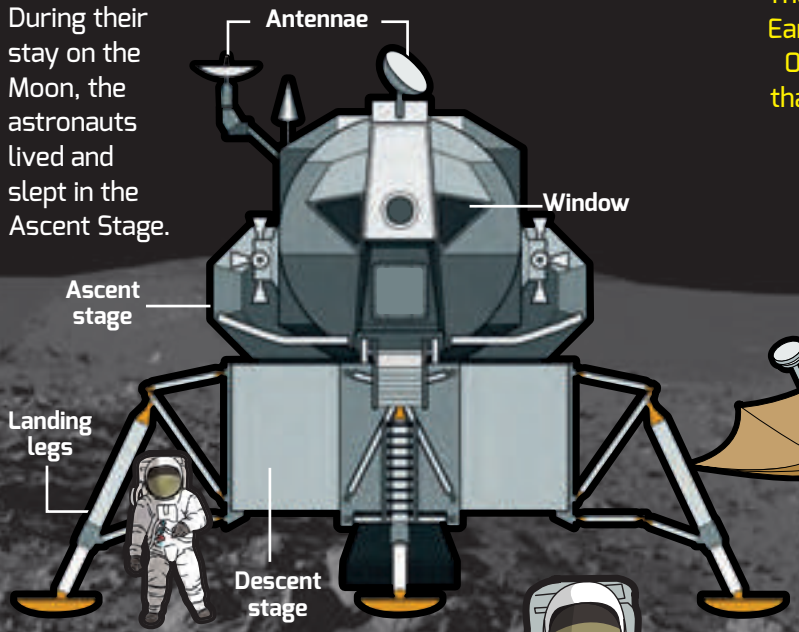
4 The Lunar Module carried two astronauts onto the Moon's surface. One astronaut stayed behind in the Command Module.

4.2 DISCOVER HOW WE EXPLORED THE MOON

The Moon's lack of atmosphere and low gravity make it a very difficult place to explore. The Lunar Module was nice and safe and even had windows, but to explore the surface, astronauts needed the protection of their spacesuits, which were slow to walk in. From Apollo 15, astronauts were able to drive around the lunar surface in their very own Moon Buggy!

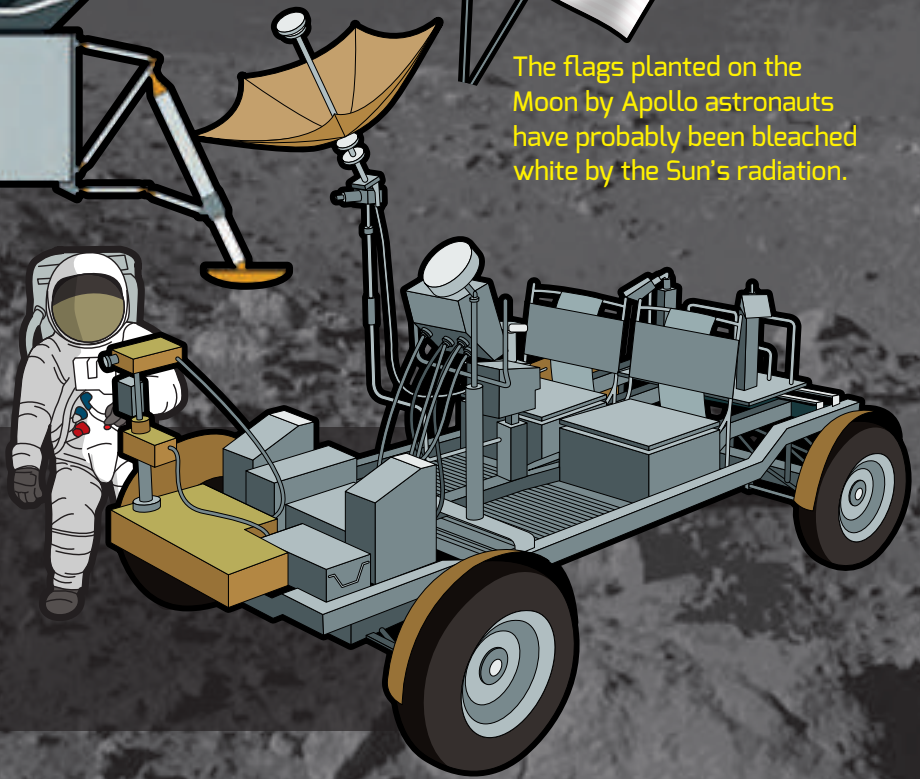
LUNAR MODULE

During their stay on the Moon, the astronauts lived and slept in the Ascent Stage.



The Moon only has about 1% of the Earth's mass and its gravity is only 0.17G (Earth's is 1G). This means that astronauts weigh a lot less on the Moon than they do on Earth.

The flags planted on the Moon by Apollo astronauts have probably been bleached white by the Sun's radiation.



LUNAR ROVER

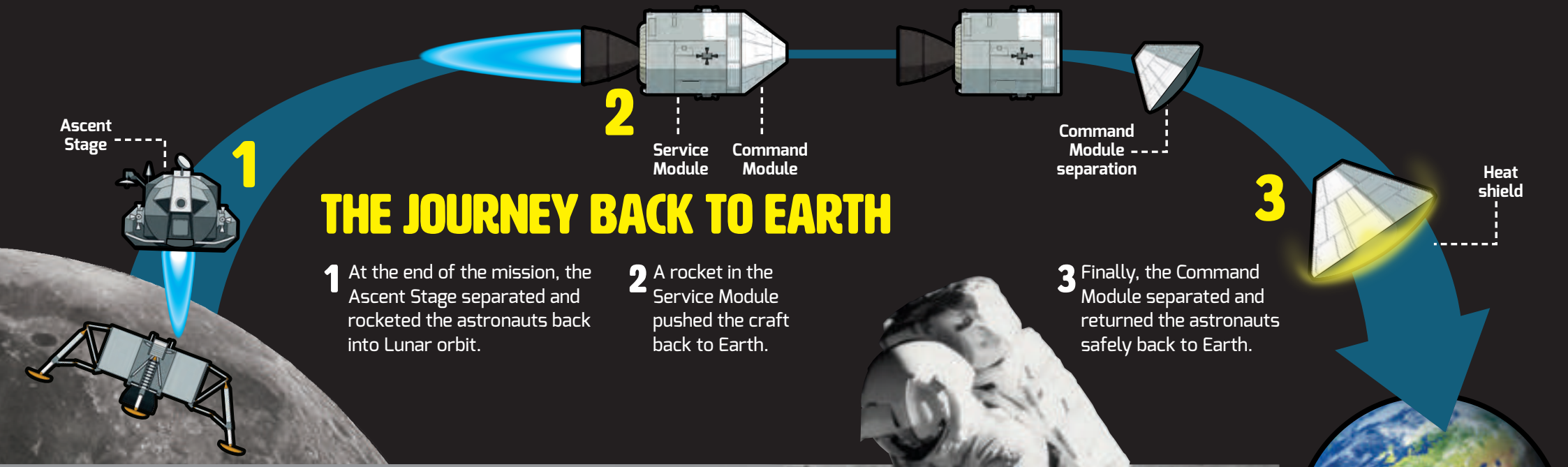
Apollo 15, 16, and 17 astronauts used a battery-powered rover to explore the surface. It could carry two astronauts, their equipment and samples.
In total, the rovers travelled 90 km across the lunar surface.

LUNAR SPACESUIT

This picture of "Buzz" Aldrin was taken by Neil Armstrong (if you look carefully, you can see Neil's reflection in Buzz's visor)

4.3 DISCOVER HOW WE WENT BACK TO EARTH

When it came time to return to Earth, the astronauts fired up the rockets in the Ascent Stage of the Lunar Lander – they didn't need the Landing Stage any more, so this was left behind on the Lunar surface. Once they had docked with the Service Module in Lunar orbit, the Ascent Stage was also left behind in space.



THE JOURNEY BACK TO EARTH

1 At the end of the mission, the Ascent Stage separated and rocketed the astronauts back into Lunar orbit.

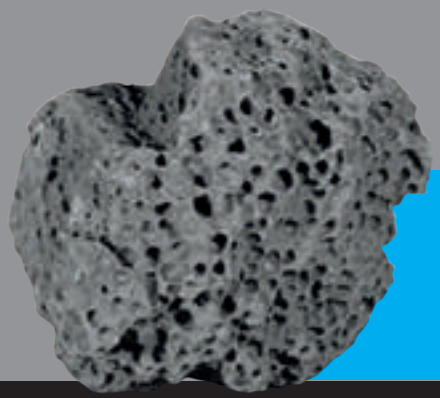
2 A rocket in the Service Module pushed the craft back to Earth.

3 Finally, the Command Module separated and returned the astronauts safely back to Earth.

ASTRONAUT SOUVENIRS

The Apollo missions brought back 382 kilograms of lunar rocks, core samples, pebbles, sand and dust from the lunar surface.

The samples have been used to study the early history of the Moon, the Earth, and the inner Solar System.



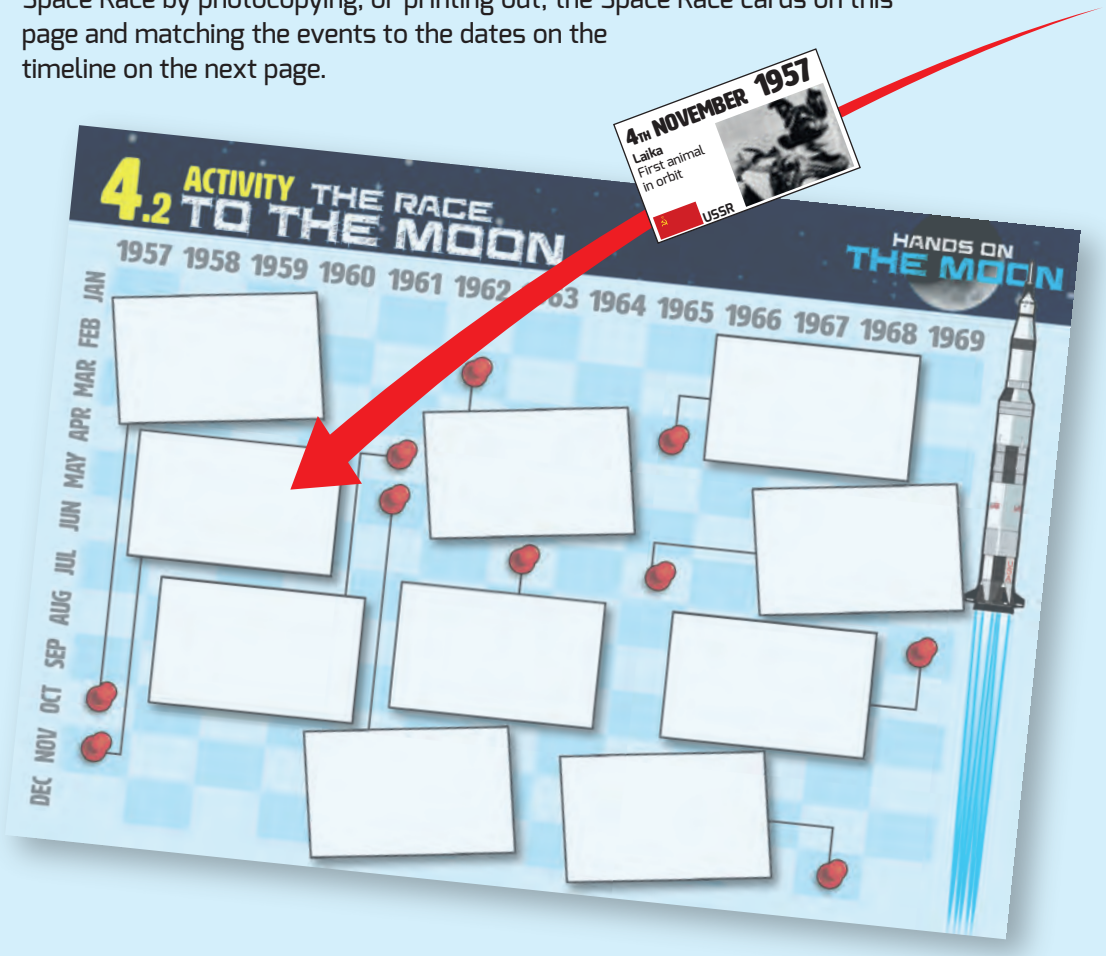
The STFC runs the UK's only 'Lunar Loans' scheme, which allows schools and scientific organisations to borrow samples of the Lunar material brought back by the Apollo astronauts.

In this image, Apollo 15 astronaut James B Irwin collects rock samples from the Moon.

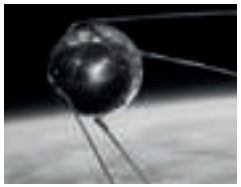
Only 12 men walked on the Moon between 1969 and 1972 – we haven't been back since.

ACTIVITY 4A SPACE RACE TIMELINE

The Space Race was a competition between the US and the Soviet Union to be the first country to go into space and to the Moon. The Soviet Union was the first country to put an artificial satellite into space and the first to put a man into space, but eventually the US won the race by being the first country to put a man on the Moon. Get to know the many milestones the Space Race by photocopying, or printing out, the Space Race cards on this page and matching the events to the dates on the timeline on the next page.



4TH OCTOBER 1957
Sputnik 1
First satellite in space
USSR



4TH NOVEMBER 1957
Laika
First animal in orbit
USSR

12TH APRIL 1961
Yuri Gagarin
First man in space
USSR

5TH MAY 1961
Alan Shephard
First US man in space
USA

20TH FEBRUARY 1962
John Glenn
Orbits Earth 3 times
USA

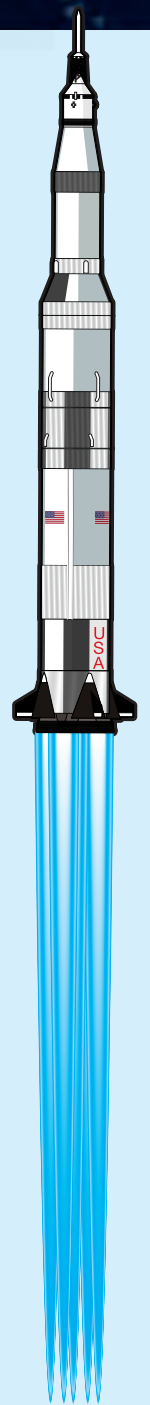
16TH JUNE 1963
Valentina Tereshkova
First woman in space
USSR

16TH MARCH 1965
Alexi Leonov
First space walk
USSR

3RD JUNE 1965
Ed White
First US space walk
USA

24TH DECEMBER 1968
Apollo 8
Orbits the Moon
USA

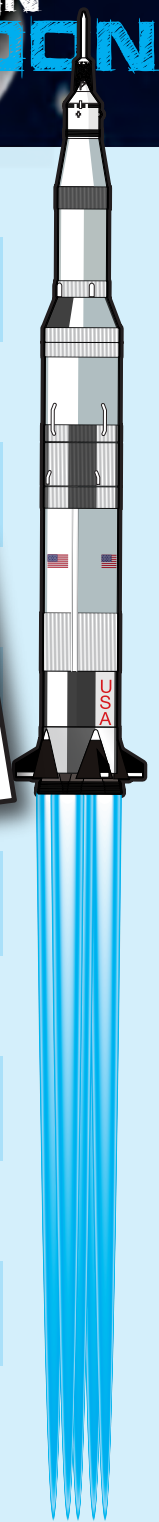
20TH JULY 1969
Apollo 11
First humans on the Moon
USA



4.2 ACTIVITY THE RACE TO THE MOON

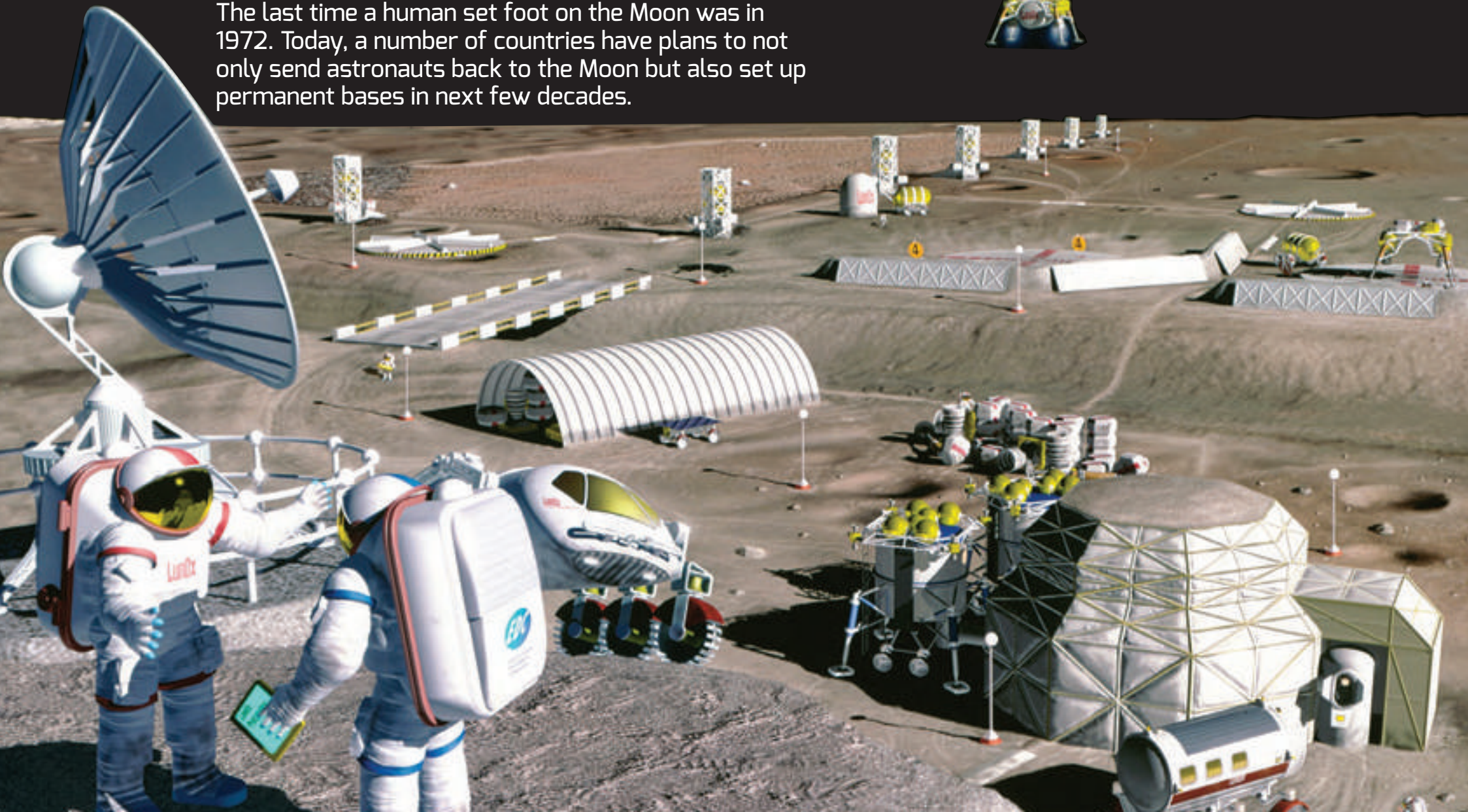
1957 1958 1959 1960 1961 1962 1963 1964 1965 1966 1967 1968 1969

JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC



5 DISCOVER WILL WE LIVE ON THE MOON?

The last time a human set foot on the Moon was in 1972. Today, a number of countries have plans to not only send astronauts back to the Moon but also set up permanent bases in next few decades.



5.1 DISCOVER WILL WE LIVE ON THE MOON?

The Moon is a long way from Earth so, if anyone is going to live there permanently, a Lunar colony will need to be self-sufficient. We know that there are reserves of water (in the form of ice) on the Moon, but where would Lunar colonists get their food and energy from? Here are a few of the things a Moon base would need.

1 Launch vehicle: Lunar colonists won't want to be trapped on the Moon so they will need a launch vehicle that can carry them into space and transport supplies to the lunar surface.

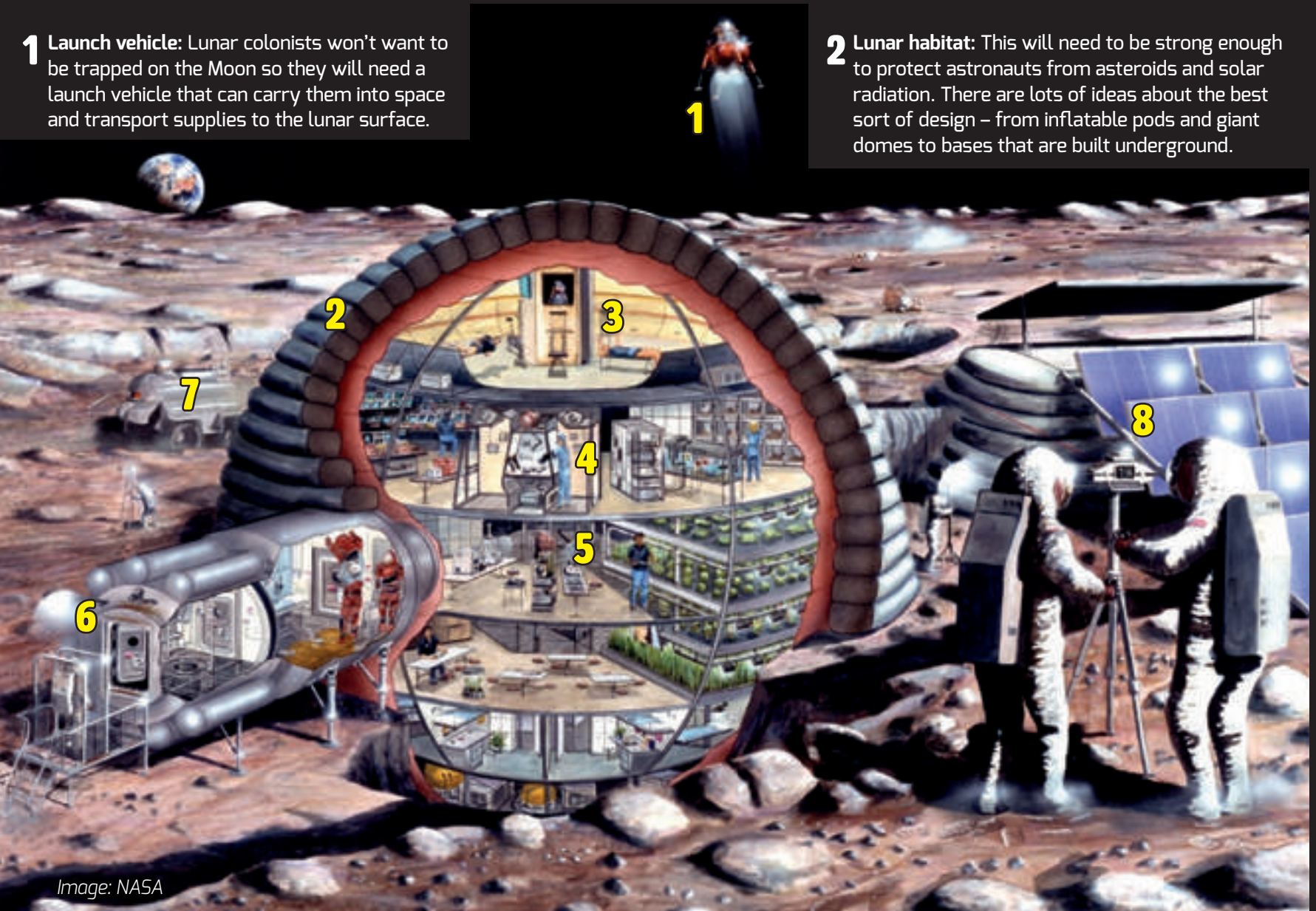


Image: NASA

2 Lunar habitat: This will need to be strong enough to protect astronauts from asteroids and solar radiation. There are lots of ideas about the best sort of design – from inflatable pods and giant domes to bases that are built underground.

3 Exercise: The Moon's gravity is much weaker than the Earth's so, to prevent muscle and bone weakness, colonists will need to do lots of exercise.

4 Science labs: Just like astronauts on the International Space Station, Moon colonists will do lots of science experiments.

5 Food: Colonists won't want to rely on food being sent from Earth so they will grow their own in specially designed hydroponics bays.

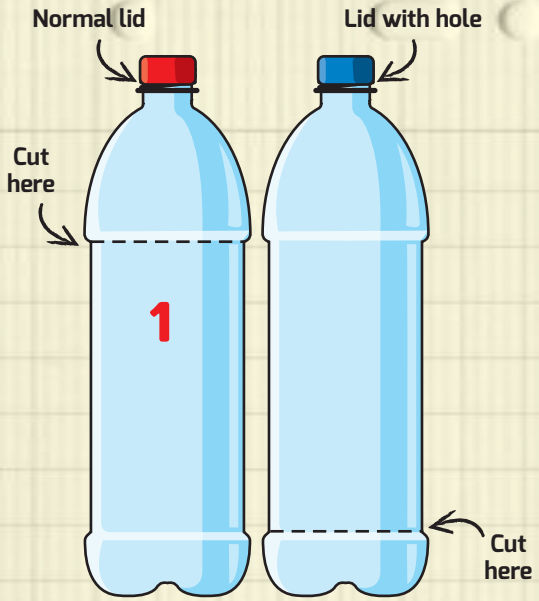
6 Airlock: This is a pressurised doorway that allows colonists to exit the habitat.

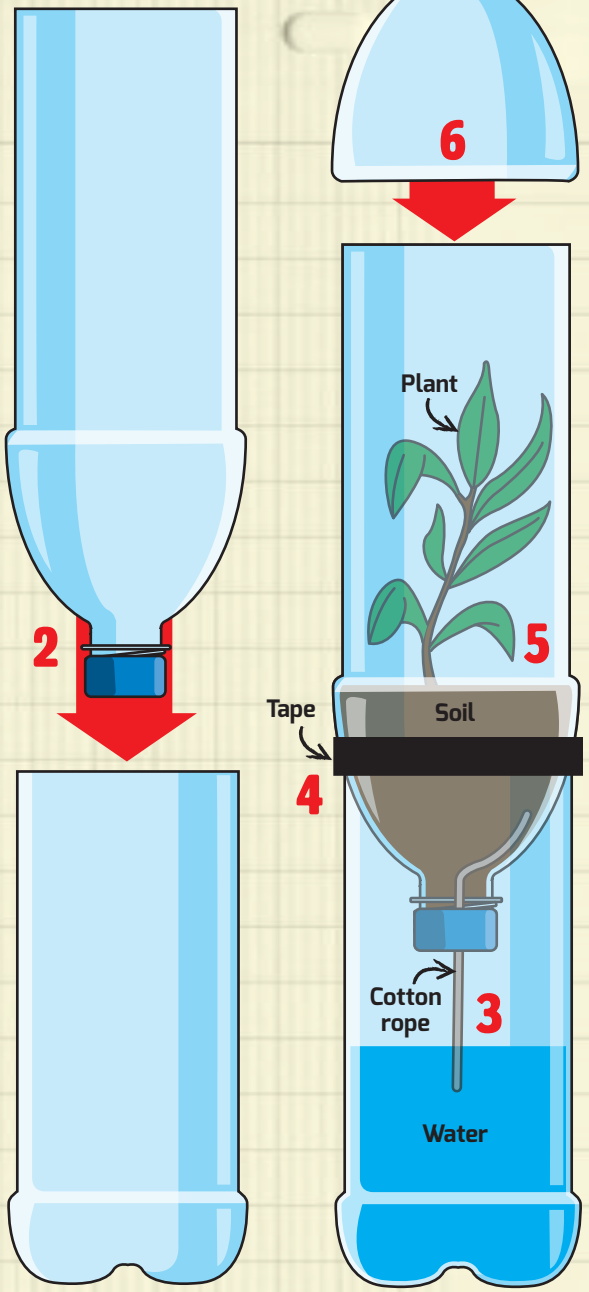
7 Lunar vehicles: Colonists will need vehicles to explore the Lunar surface and to travel between different parts of the Moon base.

8 Power: Huge banks of solar panels could provide power to the habitats. These might be best placed near the Moon's polar regions where there is more sunlight.

ACTIVITY 5A MAKE A BIODOME

If humans are going to live long-term on the Moon or on Mars, we will need food, water and air to breathe. A biodome is a self-sustaining habitat that provides everything it needs by recyling water, growing food and creating its own oxygen. You can make your own biodome using two 2 litre bottles.





1 Cut the bottles where shown in the diagram (your teacher may do this for you) and make sure the bottle with the bottom cut off is the one with a lid that has a hole drilled through it.

2 Turn the cut bottle with the lid that has a hole upside down and put it in the bottle with the top cut off.

3 Fill the bottom up with water so it comes to just below the lid and feed the cotton rope through the hole so that it dips in the water. Tape the rope into place.

4 Use black tape to tape around the join.

5 Fill the top bottle with soil until it is one third full. Plant a couple of plants and add some moss and twigs to the bottom. If you want to add woodlice at this point you can.

6 Take the cut off top bottle with a full lid and use black tape to attach it to the top. Your biodome is complete and now you can monitor your habitat!

QUESTIONS TO RESEARCH

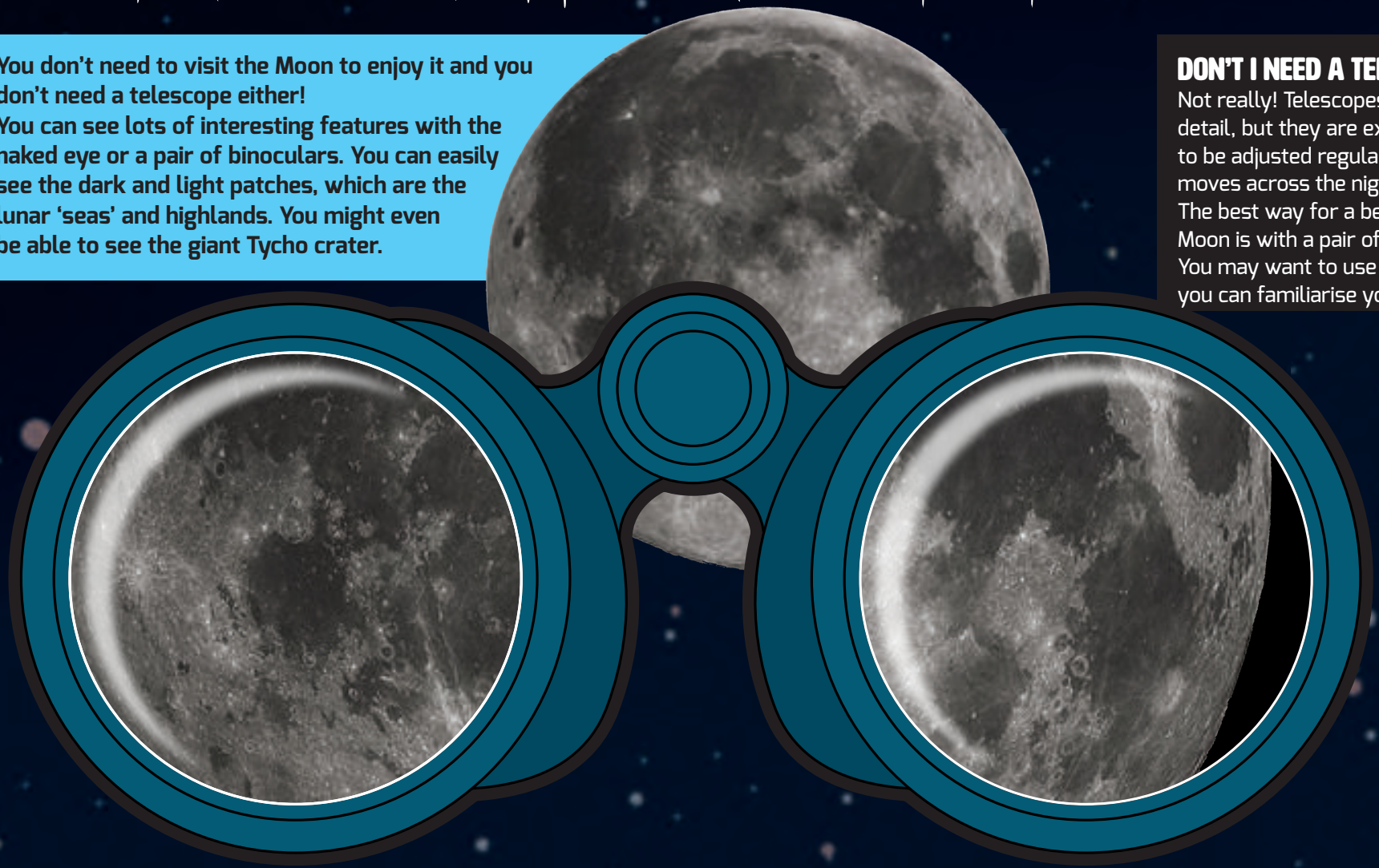
- How will water cycle around the bio dome?
- How will oxygen be produced?
- Why do we need the cotton rope to be dipping into the water?
- Why will you get 'fog' on the outside of the bio dome?

6 DISCOVER HOW TO LOOK AT THE MOON

You don't need to visit the Moon to enjoy it and you don't need a telescope either!
You can see lots of interesting features with the naked eye or a pair of binoculars. You can easily see the dark and light patches, which are the lunar 'seas' and highlands. You might even be able to see the giant Tycho crater.

DON'T I NEED A TELESCOPE?

Not really! Telescopes are great for looking at fine detail, but they are expensive and their position needs to be adjusted regularly to follow the Moon as it moves across the night sky.
The best way for a beginner to get a closer look at the Moon is with a pair of binoculars.
You may want to use a cheap pair when you start so you can familiarise yourself with the process.

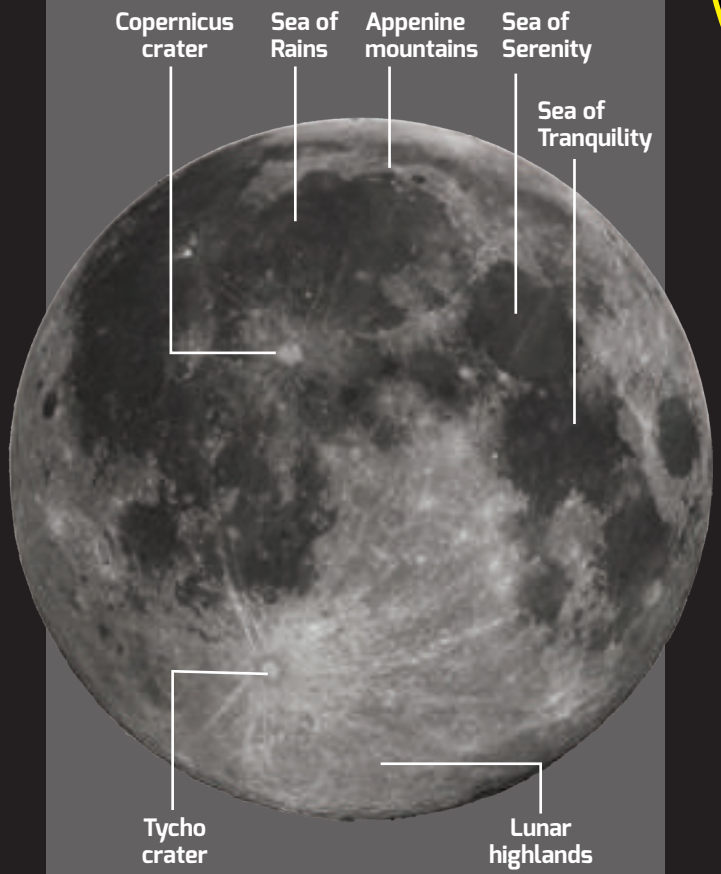


REMEMBER: A magnified image can be a shaky image! This is because every movement of the binoculars is greatly exaggerated – if your hand is just a little bit wobbly, it might look like the Moon is shaking all over the sky! If you can mount your binoculars on a tripod, this will keep the image steady.

6.1 DISCOVER HOW TO LOOK AT THE MOON

The best time to view the Moon is during the first or last quarter when sunlight hits the surface from the side, which casts shadows that highlight the Moon's features. The worst time is during a full Moon when sunlight hits the surface straight on, which bleaches out the features.

SOME FEATURES TO LOOK FOR



The best place to look is along the 'terminator' – the border between the dark and light sides. At this region , deep shadows really highlight the craters.

6.1 ACTIVITY FIND SOME LUNAR FEATURES

ACTIVITY 6A LUNAR FEATURES TICK LIST

The Moon is full of interesting features, but some are easier to spot than others. Using the map on the previous page, see how many of these features you can tick off this list. You will need binoculars to spot some of them (look for the binoculars symbol).

REMEMBER: The Moon is big and bright so it is much easier to see in the night sky than the stars, but you should still try to find a safe viewing location that is not brightly lit... and make sure you turn off your torches. It is important that you allow your eyes to adjust to the dark for about 20 minutes.

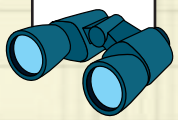
SEA OF TRANQUILLITY (MARE TRANQUILLITATIS)

This 500-mile wide, smooth basin was formed when a giant asteroid hit the Moon almost four billion years ago. It was the site of the Apollo 11 landing in 1969.

SEA OF RAINS (MARE IMBRIUM)

The Imbrium basin the largest basin on the Moon and one of the largest in the Solar System. It was formed from a collision with a proto-planet about four billion years ago.

APPENINE MOUNTAINS (MONTES APENNINUS)

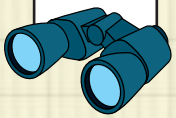


Apennine Mountain were formed when the Imbrium basin was blasted out nearly four billion years ago. Mountain ranges on the Earth take millions of years to form, but these were created in a matter of minutes! The Apennines stretch out over 370 miles and include more than 3,000 peaks. The highest peak in this range is Mons Huygens.

SEA OF SERENITY (MARE SERENITATIS)

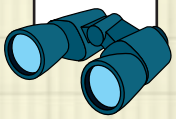
Apollo 17 astronauts landed on the edge of the Sea of Serenity and sampled some of the oldest rocks on Moon from here.

COPERNICUS CRATER



This is one of the most obvious craters on the Moon and is also one of the youngest – having formed less than one billion years ago. Its ejecta rays spread out across 500 miles.

TYCHO CRATER

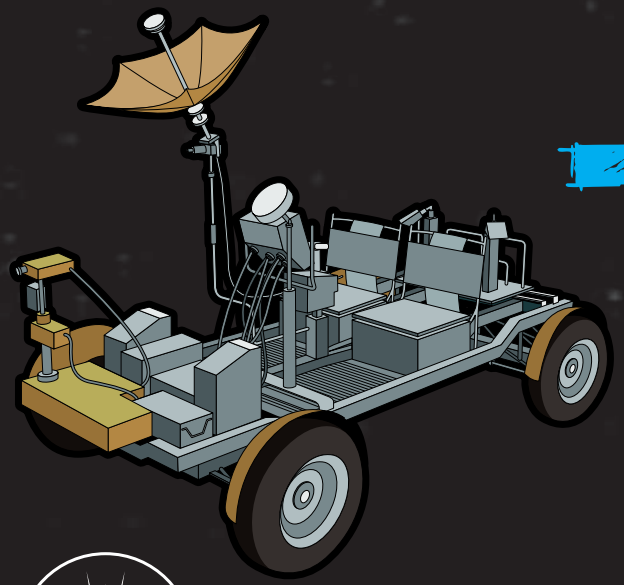


Formed only about 108 million years ago, this crater is even younger than Copernicus. It is also much bigger – the crater is 53 miles wide and its ejecta rays stretch over 1,200 miles! Tycho crater appears so bright because it is so young – over time, the bright ejected material darkens.

LUNAR HIGHLANDS

The lighter areas of the Moon's surface are the Lunar highlands. These are the oldest regions on the Moon – formed when the Moon's surface was still a sea of magma. Because they are so old, they are covered with billions of years of impact craters, which makes them very rough.

Once you've mastered your binoculars, you might want to get a more powerful pair or even a telescope. You can buy or download detailed Moon maps that will allow you identify all sorts of features as you explore the Lunar surface.



HANDS ON THE MOON

ACKNOWLEDGEMENTS

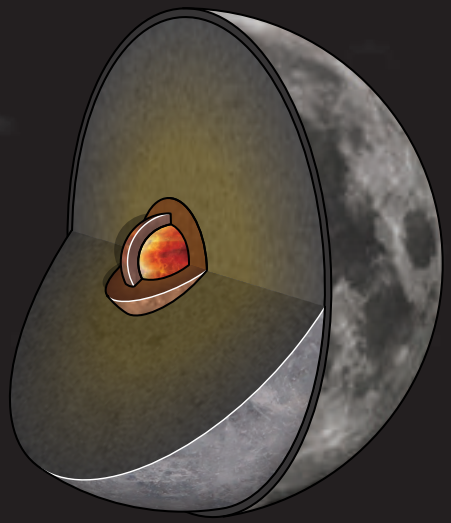
Science & Technology Facilities Council

CONTENT DEVELOPED AND WRITTEN BY

BEN GILLILAND

DESIGN, LAYOUT AND GRAPHICS: **BEN GILLILAND**

OTHER IMAGES: **NASA, ESA**



UK Research and Innovation

NATIONAL SPACE ACADEMY

NATIONAL SPACE ACADEMY FOR ADDITIONAL CONTENT DEVELOPED BY **DR KIERANN SHAH, SOPHIE ALLAN AND CHARLOTTE ISHAM**

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