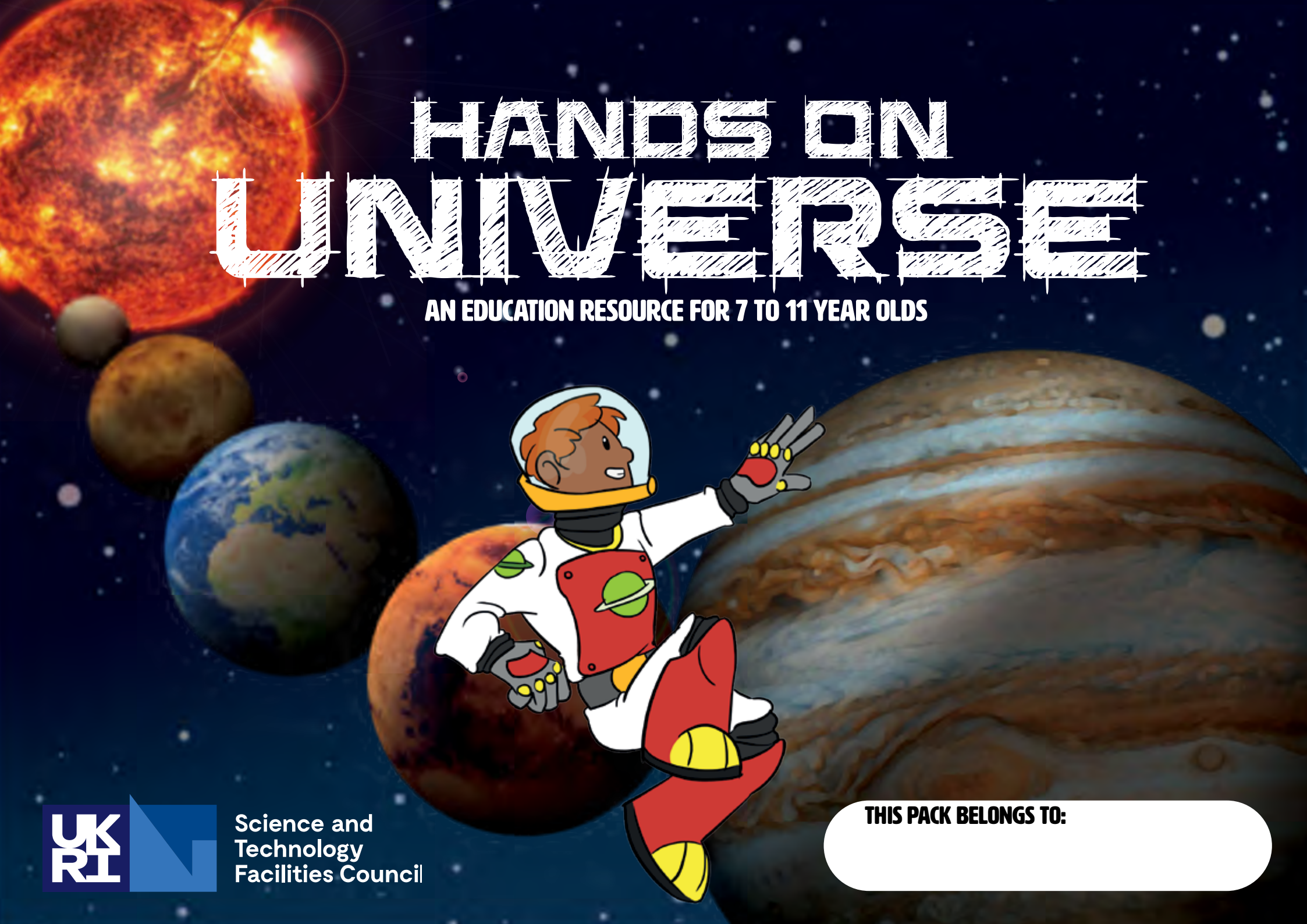
HANDS ON UNIVERSE

AN EDUCATION RESOURCE FOR 7 TO 11 YEAR OLDS



UKRI Science and Technology Facilities Council

THIS PACK BELONGS TO:

HANDS ON UNIVERSE

Science and Technology Facilities Council

HELLO AND WELCOME TO HANDS ON UNIVERSE, 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 'Explore' section. The 'Discover' sections consist of background knowledge and the 'Explore' sections contain activities for students to try out in the classroom.

The six sections are:

1. **The Night Sky**
2. **The Sun**
3. **The Moon**
4. **The Solar System**
5. **Telescopes**
6. **Space**

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 ON ASTRONOMY?

The Royal Observatory Greenwich astronomers release a monthly podcast called 'Look Up' where you can find out about the latest news in astronomy and space exploration and also if there is anything special coming up in the next month. There is also a 'Spacebook' blog where particular things of interest will be covered in more detail. If you are looking for more direct support then why not join the teacher forum at the Royal Observatory Greenwich. Here the astronomy team can help you develop your knowledge and support you to translate that back into your classroom teaching.

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 Royal Observatory Schools 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?

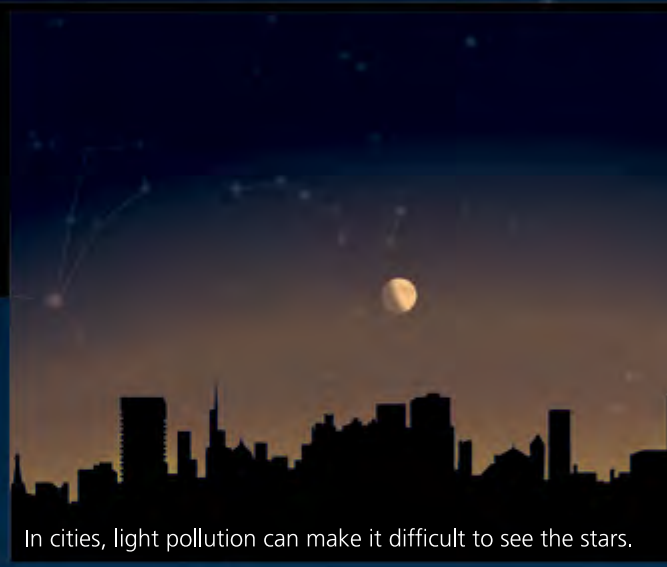
Yes please do, we would love to see it. You can do this by using the social media tag #STFC_HOU or emailing us on STFCPublicEngagementTeam@stfc.ac.uk

1 DISCOVER THE NIGHT SKY

Do you ever look up at the night sky and wonder what is out there?

You may look up and see stars, the Moon and sometimes even planets shining brightly against a dark sky. All of these beautiful objects are roughly spherical although some like the planet Jupiter bulge out a little in the middle because they spin around their axis so quickly.

We cannot always see these objects as clearly as we would like to in the night sky. Clouds or light from towns and cities that can cause light pollution can make it tricky for us stargazers. However, when the weather is good even with bright city lights you can still go out and see the stars just like the astronomers at the Royal Observatory Greenwich do from London.



In cities, light pollution can make it difficult to see the stars.

1.1 DISCOVER THE NIGHT SKY

There is a lot to look at in our night sky. We can see:

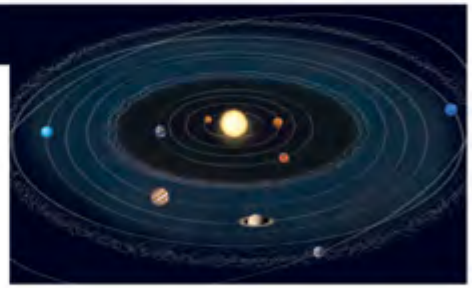
STARS

Stars are big, hot balls of gas. They can be different colours depending on how hot they are. Young very hot stars look blue in colour while older, cooler stars look more red. All the stars we see in the night sky belong to our own galaxy, the Milky Way.

THE MOON

This is the Earth's rocky natural satellite which travels around our planet. It does not make its own light but instead reflects light from the Sun.

PLANETS



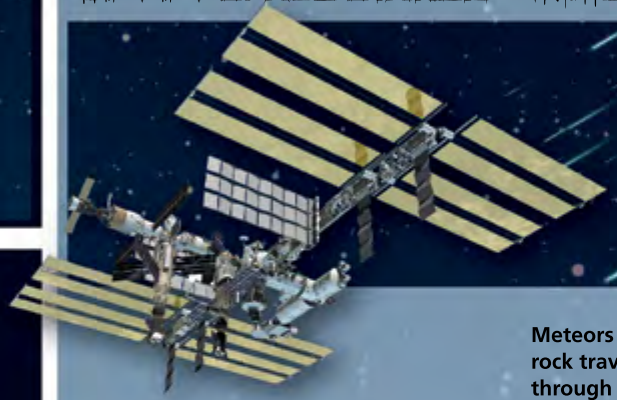
There are eight altogether which orbit our star the Sun and make up our local neighbourhood which we call the Solar System. Like the Moon they do not shine by themselves but instead reflect light from the Sun.

MILKY WAY

If you live away from street lights and large towns you may be able to see a pale fuzzy white band of light running across the sky. This is the Milky Way and what we actually see is the faint light of many millions of distant stars in our own galaxy.

There are also some special extras that we can only see at certain times like:

ISS INTERNATIONAL SPACE STATION



The ISS is a man-made or artificial satellite. At first it can look just like a star but you will see it move across the sky in only a few minutes. The International Space Station takes 90 minutes to orbit the Earth once – pretty speedy!

METEORS

Meteors are pieces of space rock travelling very quickly through our atmosphere. They are often called shooting stars because they form bright streaks as they burn up on their way through the atmosphere. If the space rocks make it through the atmosphere and land on the Earth we call them meteorites.

COMETS

Comets are occasional visitors to our part of the Solar System. They are made of ice and dust and start to burp and splutter as they get closer to the Sun and warm up. The Rosetta Mission team at the European Space Agency recently managed to track the Comet 67P Churyumov-Gerasimenko, they released a lander called Philae onto the comet to take a closer look – impressive stuff.

DID YOU KNOW?

Pluto was considered to be a planet for a very long time, however, in 2006 the definition of a planet changed. To be a planet Pluto had to follow these three rules:

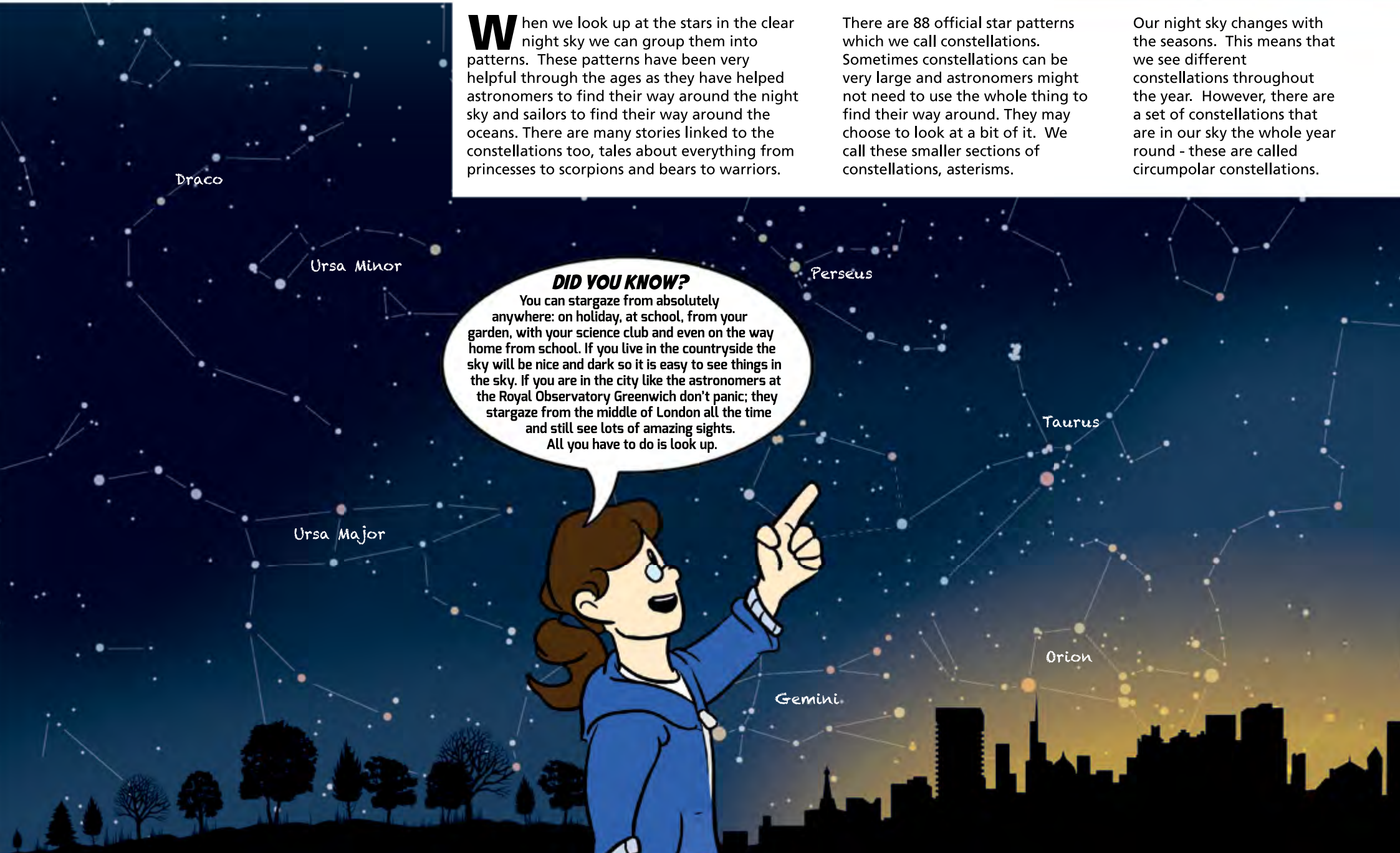
1	**Be spherical** ✓	Pluto is indeed roughly spherical.
2	**Orbit the Sun** ✓	Pluto does orbit the Sun.
3	**Clear its own orbit** ✗ (either join up with other similarly sized space rocks in its path or bump them out of the way).	Pluto is a similar size to some of the other space rocks in its part of the Solar System and shares its orbit with other objects so it was reclassified as a **DWARF PLANET**

1.2 DISCOVER THE NIGHT SKY

When we look up at the stars in the clear night sky we can group them into patterns. These patterns have been very helpful through the ages as they have helped astronomers to find their way around the night sky and sailors to find their way around the oceans. There are many stories linked to the constellations too, tales about everything from princesses to scorpions and bears to warriors.

There are 88 official star patterns which we call constellations. Sometimes constellations can be very large and astronomers might not need to use the whole thing to find their way around. They may choose to look at a bit of it. We call these smaller sections of constellations, asterisms.

Our night sky changes with the seasons. This means that we see different constellations throughout the year. However, there are a set of constellations that are in our sky the whole year round - these are called circumpolar constellations.



1.3 EXPLORE THE NIGHT SKY

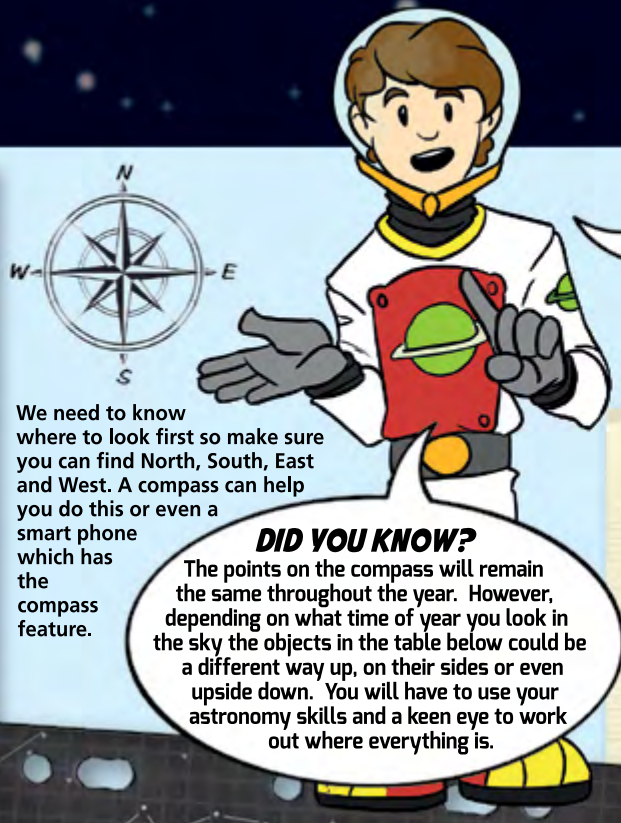
ACTIVITY 1A LET'S GO STARGAZING!

For this activity you will be planning your very own observing trip. Below are three very important things to keep in mind before you start:

1. **Never look directly at the Sun.**
2. **Never go out observing alone.** It doesn't matter if you live in the middle of the countryside or a city centre, being out alone is not safe so be sure to take a parent or guardian with you.
3. **Wear suitable clothing.** Winter is a great time for us to see lots of fantastic things in the night sky. The only thing is it can get very cold, particularly if you are out for a long time. Make sure you wear the right clothing to keep you nice and toasty so you don't have to cut your observing session short.

The table below shows some things to look out for on your trip. There is a mix of stars, asterisms and constellations. Fill in the gaps, ticking things off your list as and when you find them.

Name	Help	Found it	Star, constellation or asterism?
The Plough	Look for seven stars in the night sky that look a little bit like a saucepan (use the diagram to help you)		
Polaris (The North Star)	Using the Plough, find the two stars marked on the diagram called the pointer stars. Using the distance between the stars as a guide, make five jumps of that distance in the direction they point and you should get to Polaris.		
Ursa Major	Ursa Major is also known as the great Bear. The handle of the saucepan is the bear's tail, the pan is the body and there are extra sections to add on for the legs and head.		



ACTIVITY 1B ASTRONOMY STORYTELLER

This activity will need you to work like a scientific researcher. Using the three objects in the table that you observed in the night sky, research the stories behind them. The stories depend on the culture they come from. The names mostly come from ancient Greek legends but if you research carefully you will also find other stories about people and animals in the sky in Scandinavian, American, Indian, Chinese and Arabic myths.

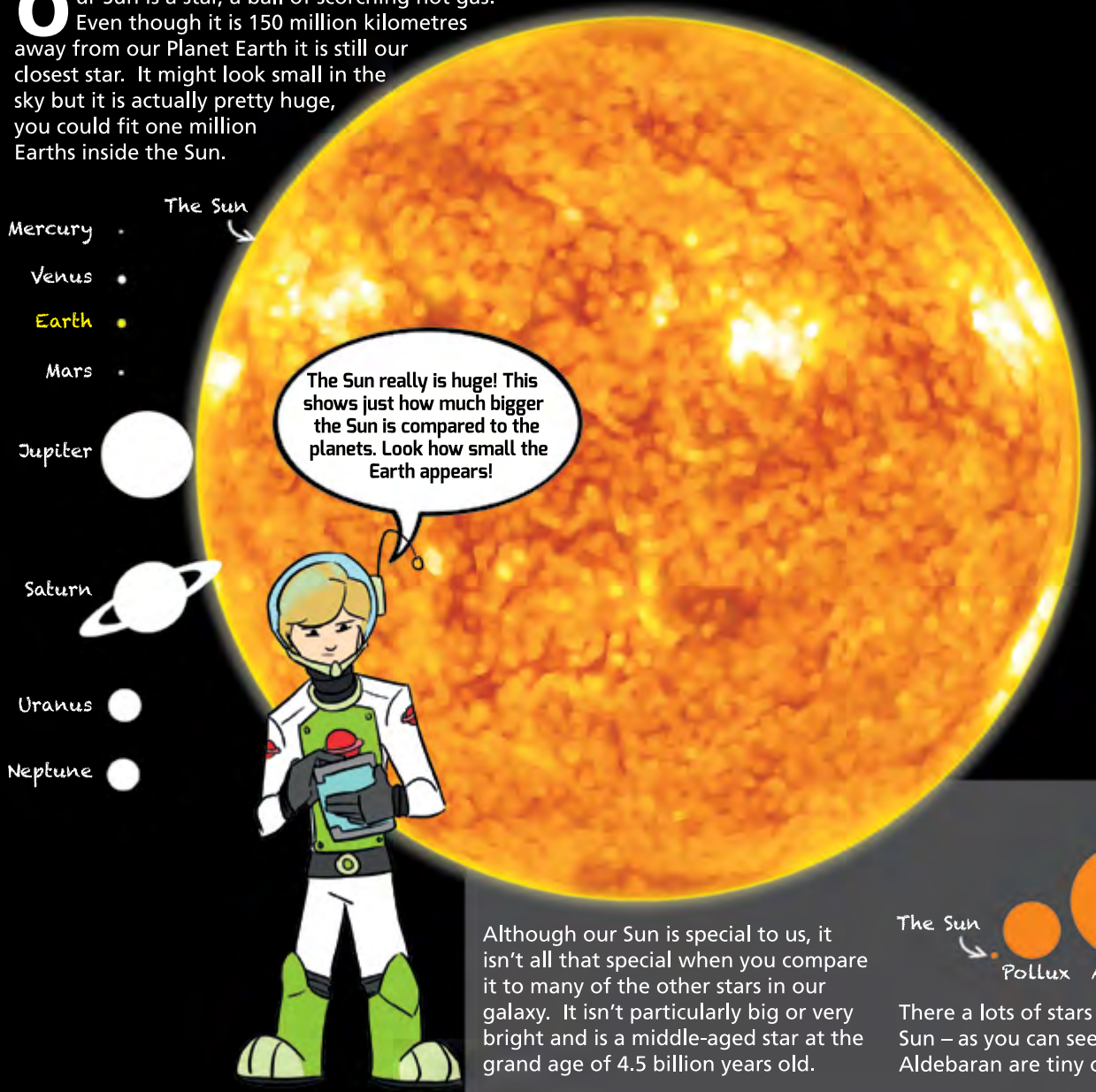
ACTIVITY 1C LOOKING FOR JUPITER

Seeing as you are pretty much an expert now, with all your newfound astronomy knowledge, how about an extension activity to really give your brain a workout? Using the Royal Observatory Greenwich online resource 'Looking for Jupiter' plan another observing trip where you can look for planets in the night sky. Good luck astronomers!

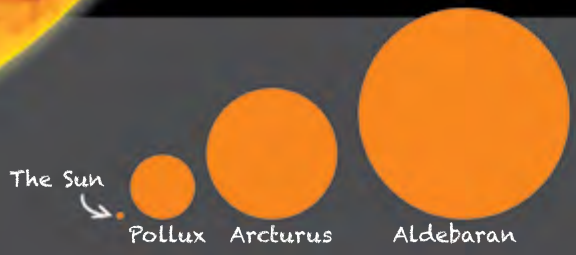
www.rmg.co.uk/discover/teacher-resources/looking-jupiter

2 DISCOVER THE SUN

Our Sun is a star, a ball of scorching hot gas. Even though it is 150 million kilometres away from our Planet Earth it is still our closest star. It might look small in the sky but it is actually pretty huge, you could fit one million Earths inside the Sun.



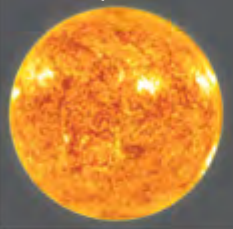
Although our Sun is special to us, it isn't all that special when you compare it to many of the other stars in our galaxy. It isn't particularly big or very bright and is a middle-aged star at the grand age of 4.5 billion years old.



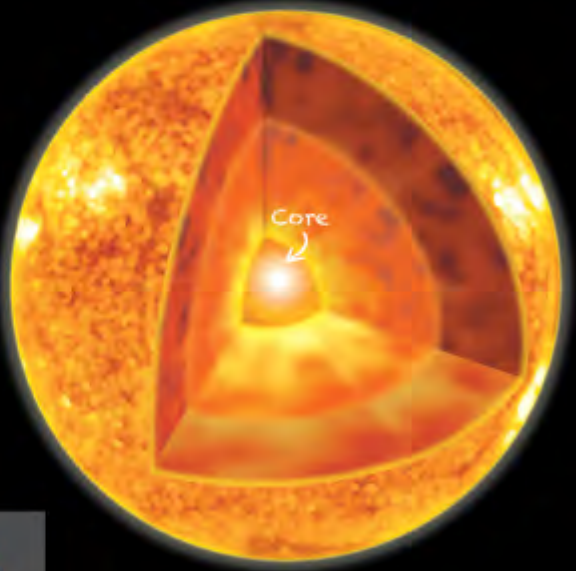
There a lots of stars that are much bigger than our Sun – as you can see here. But even giants like Aldebaran are tiny compared to lots of other stars!

DID YOU KNOW?

The Sun is a very important star to us, our very existence depends on it. It is a source of light. However, there are times when we can't see that light here on Earth. The first is when we turn away from the Sun at night and the second is called a solar eclipse which is when the Moon gets in the way and blocks some of the light from the Sun.



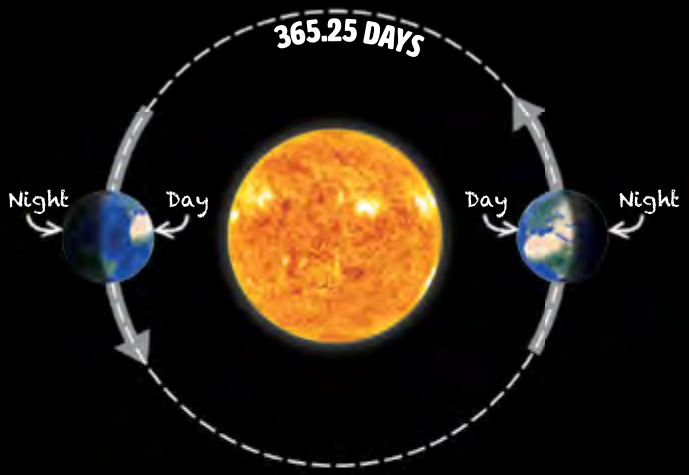
The Sun needs fuel to keep going, just like us humans need food and water to keep us going. This all happens in the core, which is in the centre of the Sun where the temperature reaches a whopping 15,000,000°C.



Eventually the Sun will run out of fuel and won't be able to produce any more energy. There is no need to panic though, that won't happen for around 4.5 billion years – phew.

2.1 DISCOVER THE SUN

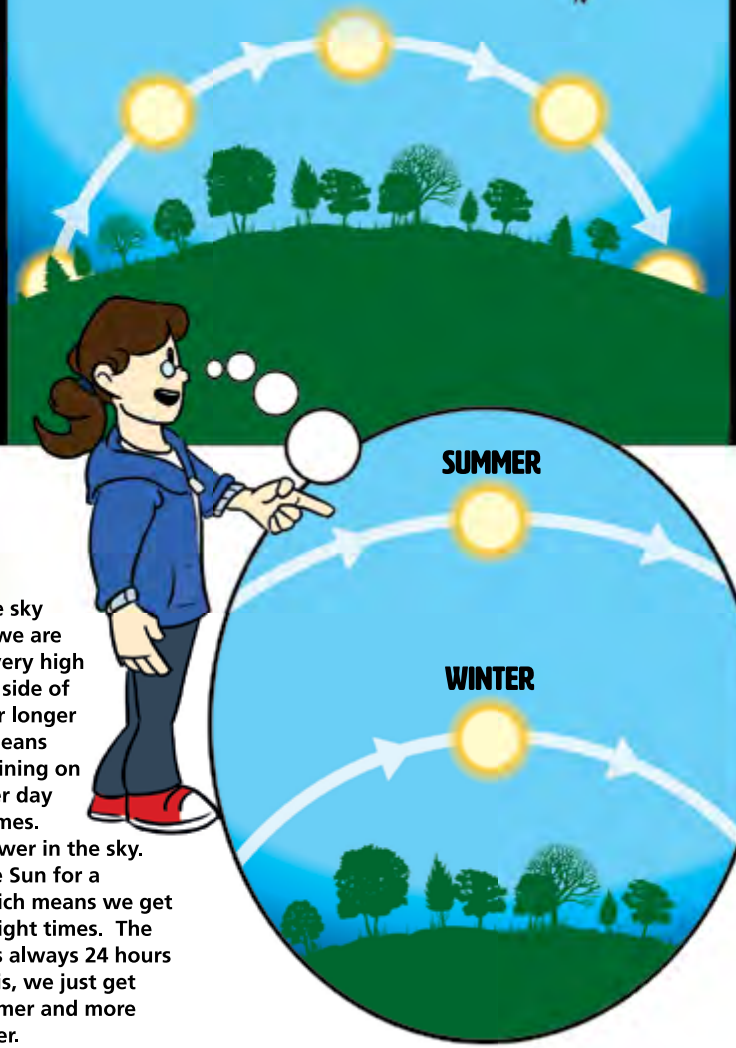
The Earth travels round the Sun in 365.25 days - we call this one Earth year. The quarter of a day is very important because every four years it adds up to a whole extra day on 29th February. That one extra day means there will be 366 days in these special years, which we call leap years.



As our planet Earth moves around the Sun it is also spinning, tilted on its axis. One full spin takes 24 hours and gives us one Earth day.

So how exactly do we get day and night as part of each Earth day? Well, it all depends on where our side of the planet is facing. If we are facing towards the Sun we receive lots of sunlight and it is daytime, if we are facing away from the Sun we do not receive any, it is dark and so it is night-time. Easy-peasy really isn't it?

If we were to safely track the Sun through the sky during the daytime we would see it rise in the East and set in the West. Although it seems like the Sun is moving through the sky it actually isn't - the thing that is moving is our planet!



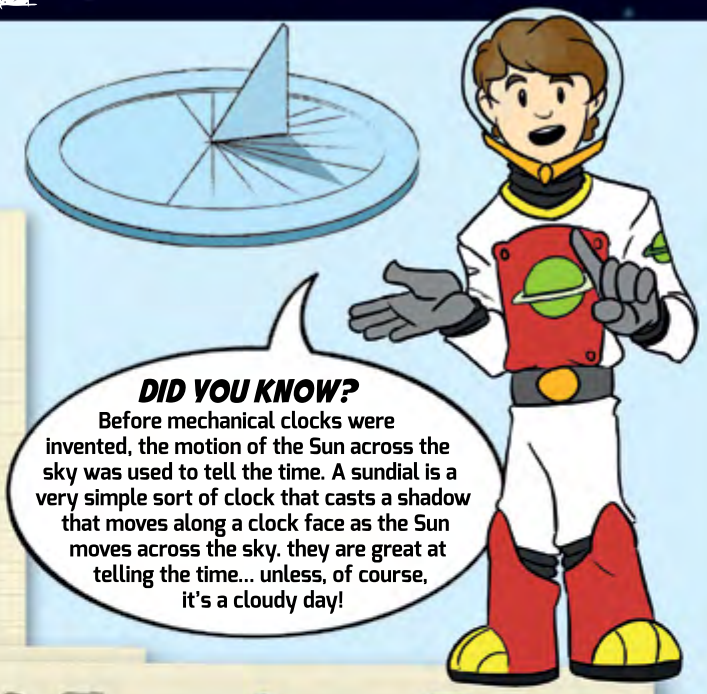
The Earth's tilt also gives us our seasons. For us in the Northern Hemisphere when we point towards the Sun we get summer. At the same time, people living in the Southern Hemisphere would be pointing away from the Sun so they have their winter. As the Earth moves around the Sun during a year we see that the Northern Hemisphere points away and the Southern Hemisphere points towards the Sun giving us winter in the North and summer in the South.

DID YOU KNOW?

How high the Sun is in the sky depends on what season we are in. In summer the Sun is very high in the sky. In summer our side of the Earth faces the Sun for longer than in the winter. This means we have more daylight shining on our planet giving us longer day times and shorter night times.
In the winter the Sun is lower in the sky. We are facing towards the Sun for a shorter length of time which means we get less daylight and longer night times. The length of a day on Earth is always 24 hours no matter what season it is, we just get more sunshine in the summer and more snoozing time in the winter.

2.2 EXPLORE THE SUN

The Sun is a truly fascinating star that we are still finding more and more out about all the time. It is very dangerous to look directly at the Sun, even with sunglasses on. It is so bright it can do some serious damage to your eyes. There are safe ways to look at the Sun, take a look at the activities below to find out how.



ACTIVITY 2A THE HUMAN SUNDIAL

For this activity not only will you be taking the role of an astronomer and running an experiment but you will also be acting as a human sundial. Sounds a little strange? Let the astronomers at the Royal Observatory Greenwich explain. They have made an activity that will talk you through how being able to measure the changing length of your shadow through the day can help you tell the time.

www.rmg.co.uk/discover/teacher-resources/human-sundial

ACTIVITY 2B SOLAR OBSERVING

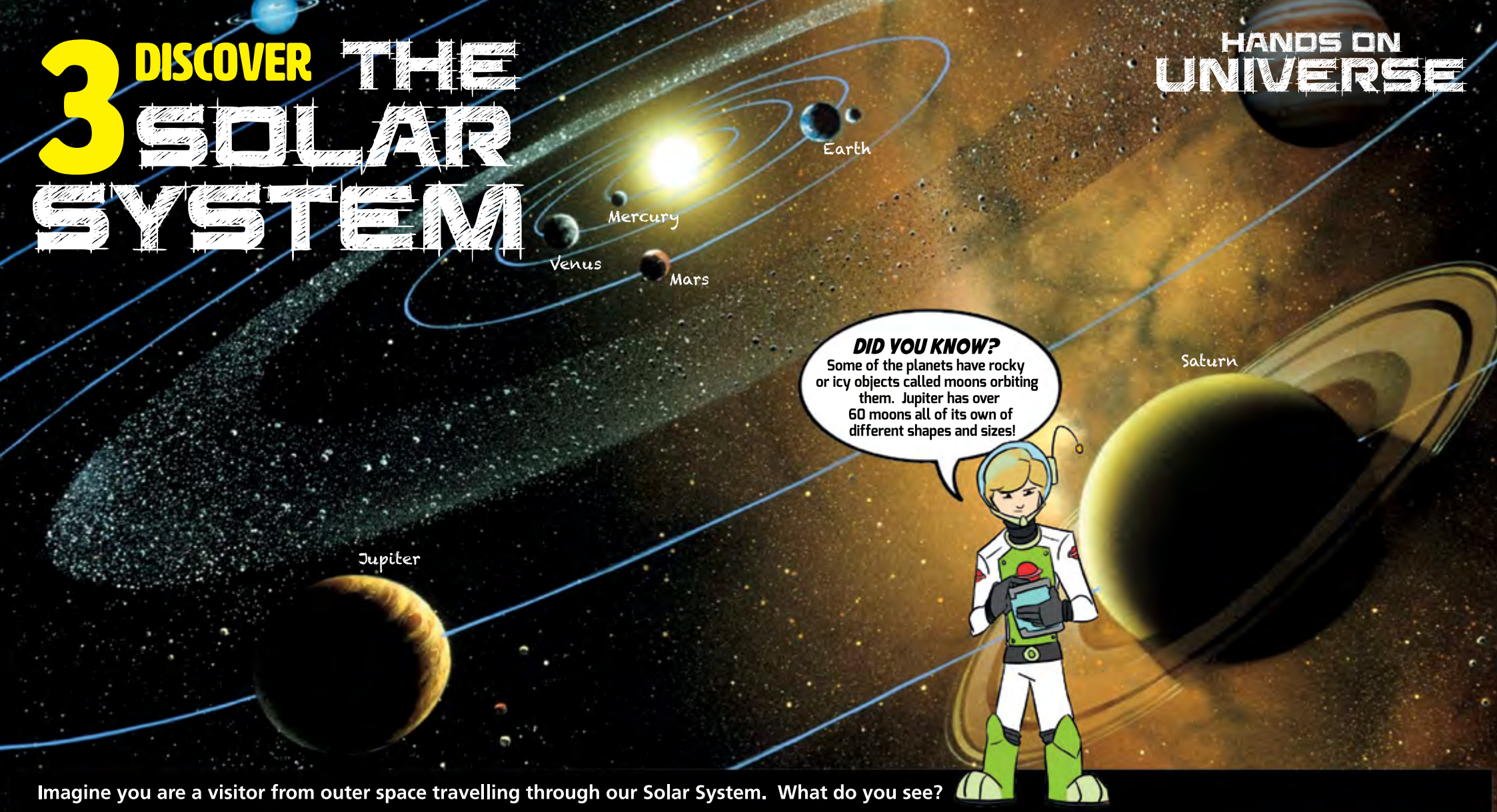
The surface of the Sun is a very active place with hot gases swirling, looping and occasionally even erupting. The Zooniverse project is what is called a citizen science project which means that scientists look for help from the public with their scientific research. If you would like to get involved and classify distant galaxies, sorting Sun spots or even hunting for new planets then this is the activity for you! Take a look at the website and get cracking!

www.zooniverse.org

ACTIVITY 2C SOLAR PODCAST

Our brains are amazing organs but they can't remember every little detail of things we read, experiments to do or observing trips we go on. It is much safer to keep a record of what we find out instead. This doesn't just have to be writing everything down, there are lots of other ways of keeping a record. At the Royal Observatory Greenwich the astronomers record monthly 'Look Up' podcasts to talk about what is in the sky and any new discoveries so why not have a go yourself? Work in pairs and use your newfound solar knowledge to help you record your very own podcast. You might want to think about some questions to ask each other and some fantastic facts you would like to include so writing a list of things to talk about before you start recording can be very handy.

3 DISCOVER THE SOLAR SYSTEM



Imagine you are a visitor from outer space travelling through our Solar System. What do you see?

For starters you would see our Sun burning brightly. You would also see eight planets orbiting it and some added rocky extras along the way too. Our Solar System is a large and interesting place so there would be plenty to look at for sure.

There are four planets close to our star. They are all small, rocky and quite warm as they are near the Sun. There are four larger planets a little further away. They are giants compared to the rocky planets and are made of hydrogen and helium gas and frozen gases or liquids such as water, ammonia and methane. Jupiter is the largest planet and could fit 1300 Earths inside it – that is a lot of planet Earths.

Between Mars and Jupiter we find the asteroid belt and the closest dwarf planet to us, Ceres. Beyond Neptune is a doughnut of icy rocks called the Kuiper belt. Here you can find Pluto and other dwarf planets as well as icy space snowballs called comets.

All the planets are different to each other and some have very unusual features. In the past we learned about them using telescopes. Now we send spacecraft with measuring equipment and cameras on board to the planets so that we can study them in detail. None of the planets has been visited by humans – yet. Maybe you could train as an astronaut and be the first person to land on Mars.

From the Earth the other planets look like stars in the sky. The planets aren't stars though and the difference is that planets move around among the stars in the night sky from night to night or year to year. This explains their name – in Greek 'planet' means 'wanderer'. They are bright because they reflect sunlight rather than make their own like our Sun.

3.1 DISCOVER THE SOLAR SYSTEM

Astronomers used to study the Solar System with telescopes but it was difficult to see very much detail. For a long time scientists thought they could see canals full of water on Mars but that wasn't what was there at all; because they couldn't see clearly they had to make some guesses based on what they could see. Now we send space probes and satellites to planets to find out more about their atmospheres, surfaces and moons to get a much clearer picture.

In 2012 the NASA Mars Curiosity rover landed in Gale Crater and showed that there used to be a lake or sea there many years ago.
In 2014 the ESA Rosetta spacecraft reached Comet 67P and a small lander called Philae (about the size of a washing machine) landed on the comet and studied its unusual surface. The furthest spacecraft is Voyager 1. Launched in 1977 it has left the Solar System and it is still sending data back to Earth.

When scientists think about how the Sun and Solar System were made their ideas have to explain all these facts. Most scientists think the Sun and all the planets were made at the same time 4.5 billion years ago, from a huge spinning cloud of hydrogen gas and dust.

3.2 EXPLORE THE SOLAR SYSTEM

ACTIVITY 3A MOON DISCOVERIES

Astronomers discover new moons around the big gas planets all the time. For this task you will need to use your skills as a scientist to do some research.

Use the internet to find out the current number of moons for each planet and fill in the details in your own copy of this chart

Image of Jupiter and three of its moons - Europa, Io and Callisto.

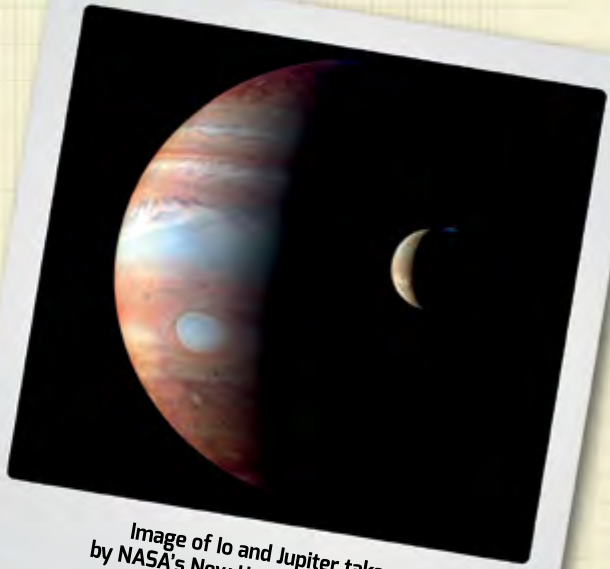


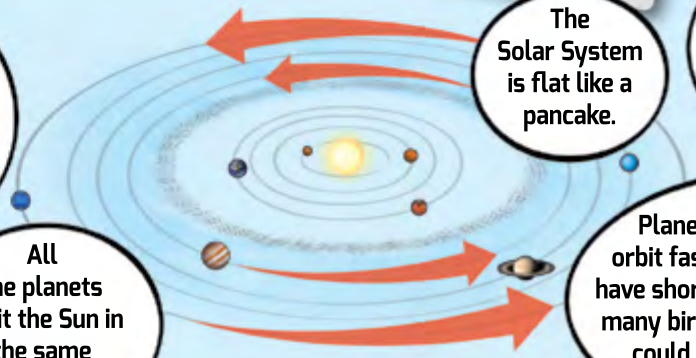
Image of Io and Jupiter taken by NASA's New Horizons spacecraft.

HOW MANY MOONS?

Planet	Distance from Sun (millions of km)	Time to orbit the Sun	Average surface temperature	Number of moons
Mercury	57	88 days	167 °C	
Venus	108	225 days	462 °C	
Earth	150	365.25 days	15 °C	
Mars	228	687 days	-63 °C	
Jupiter	778	12 years	-108 °C	
Saturn	1429	30 years	-139 °C	
Uranus	2875	84 years	-197 °C	
Neptune	4504	165 years	-201 °C	

ACTIVITY 3B THE FACTS

The planets in our Solar System are pretty amazing you know. Here are some of our favourite facts:



All the planets orbit the Sun in the same direction.

The Solar System is flat like a pancake.

Planets closer to the Sun orbit faster which means they have short years – just think how many birthdays (and cakes) you could have on a planet like Mercury.

All the planets spin about their axes at different speeds so they have different lengths of day.

The gas giants have more moons than the small rocky planets.

There are lots more amazing facts to discover so why not go on a fact finding mission? You could then collect all your facts together to make your very own guide to the Solar System mini-book to share with your classmates. You can use websites like the ones below to help you.

Celestia: www.shatters.net/celestia

Royal Observatory Greenwich: www.rmg.co.uk/discover/teacher-resources

3.3 EXPLORE THE SOLAR SYSTEM

ACTIVITY 3C A MODEL OF THE SOLAR SYSTEM

You can make your very own model of the Solar System; a small or a large version depending on how much room you have.

IN YOUR CLASSROOM

You can make a solar system in a box to see how everything fits together. The astronomers at the Royal Observatory Greenwich have made a video to show you how so check it out here: www.vimeo.com/64635558

THINK BIG

You and your classmates can represent the planets in the Solar System in your school field. Use a football for the Sun and seeds or small balls for the planets. Someone must carry the Sun and stand in the middle of the field. Eight more people must carry each of the planets. The Solar System is so large and the planets so small that you will not have to carry very much. Using the scale below see how many planets will fit on to your school field.

TOP TIP

Bring a stopwatch and try orbiting the Sun in the times listed in the 4th column of the table. Only do this for the first four planets, as you can see your classmates carrying the gas giants would have to take between 50 minutes and 11 and a half hours to walk around the Sun once!

Planet	Size (mm)	Distance from Sun (metres)	Time to orbit the Sun
Mercury	1	12	1 min
Venus	2.5	22	2.5 min
Earth	3	30	4.1 min
Mars	1.5	46	7.8 min
Jupiter	30	158	50 min
Saturn	26	286	2 hr 5 min
Uranus	10	574	5 hr 50 min
Neptune	10	900	11 hr 28 min

ACTIVITY 3D TRIP TO ANOTHER WORLD

Write an entry for a holiday brochure of the future, encouraging tourists to travel to another planet. Remember you need to show visitors all the very best bits of the planet so they really want to go.

Here are some questions you might want to think about:

- What are the special features of the planet?
- Has it got rings?
- Does it have lots of exciting moons?
- How about huge volcanoes?
- Are there high mountains?
- Is there a colourful atmosphere?
- What could you visit in your spacecraft?
- Is the planet hot or cold?
- What will the weather be like?
- Will your spacecraft have to pass near the Sun or the asteroids in its journey from Earth?
- How long will the journey take?

You can use your imagination to describe what your space hotel will be like in the year 2200.

4 DISCOVER THE MOON

The Moon is a rocky ball which orbits the Earth. It is about one sixth of the size of the Earth. This is unusually large because most moons of other planets are far smaller than the planet they orbit.

THE FULL MOON

The Moon is covered in bright craters – most of which were formed over 3 billion years ago. The large dark areas are called seas – but there is no water there, just very old solid lava.

Mare Imbrium (Sea of Showers)

Mare Serenitatis (Sea of Serenity)

Mare Crisium (Sea of Crises)

Kepler crater

Copernicus crater

Mare Vaporum (Sea of Vapours)

Mare Tranquillitatis (Sea of Tranquility)

Oceanus Procellarum (Ocean of Storms)

Mare Nubium (Sea of Clouds)

Mare Humorum (Sea of Moisture)

Tycho crater

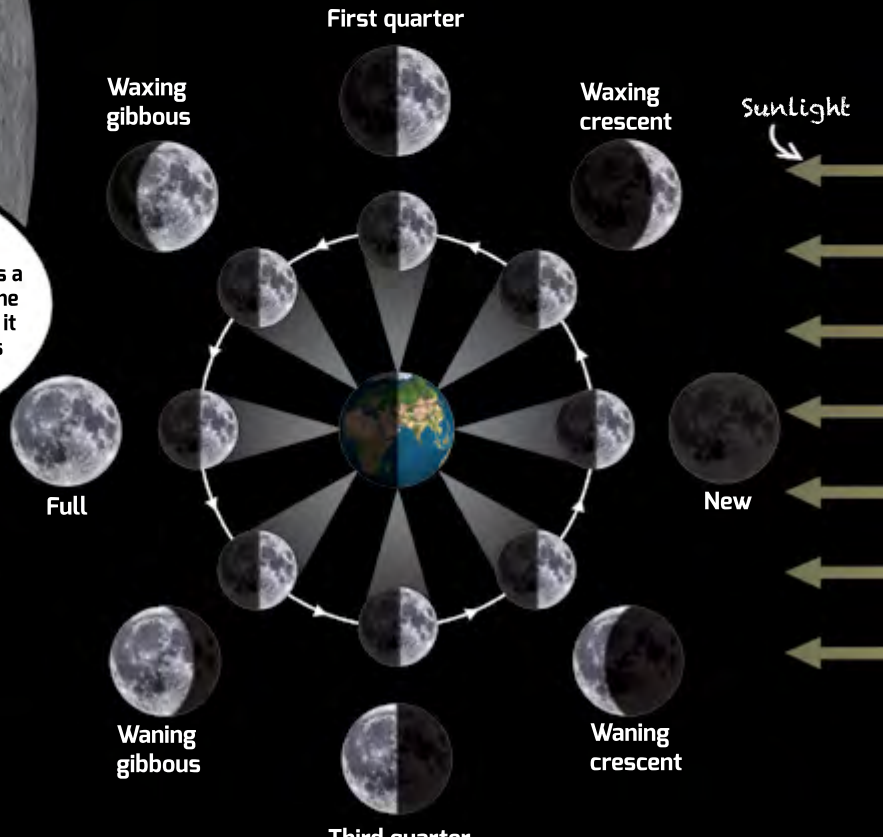
DID YOU KNOW?

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.

LUNAR PHASES

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.



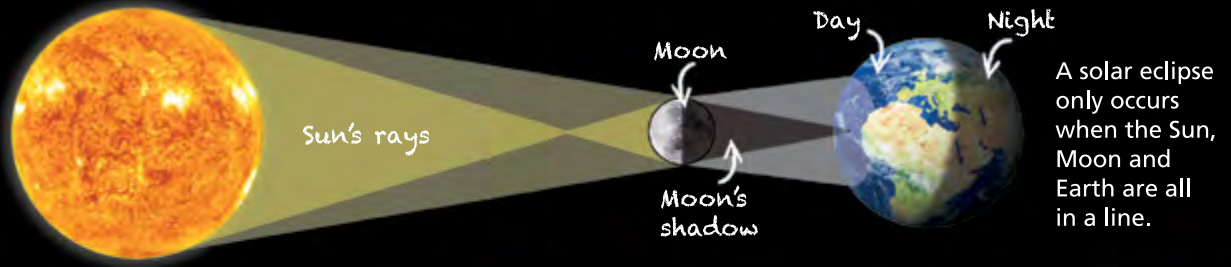
4.1 DISCOVER THE MOON

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. This means we see a bright full Moon when it is on the other side of the Earth to the Sun.

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



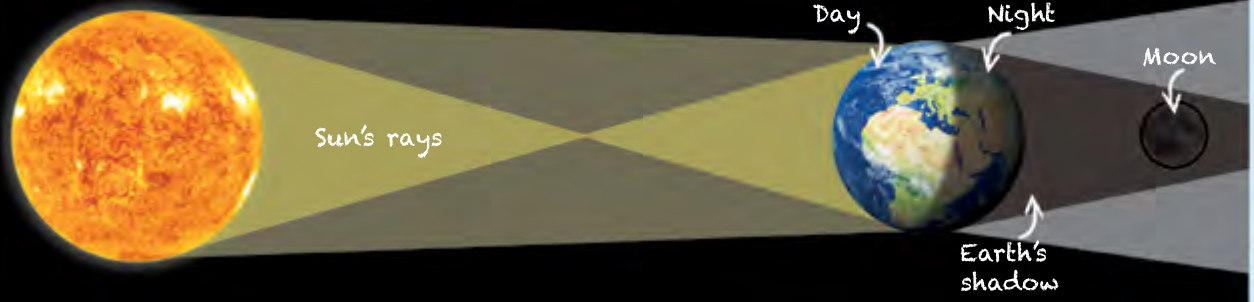
A solar eclipse only occurs when the Sun, Moon and Earth are all in a line.

DID YOU KNOW?

When the Moon is in the Earth's shadow we see a lunar eclipse. It turns a rusty red colour because the sunlight passing through the Earth's atmosphere gets filtered and bent towards the Moon.

This is what a solar eclipse looks like.

LUNAR ECLIPSE



VISITING THE MOON

The Moon has been visited by astronauts from Earth. The first were Americans, Neil Armstrong, Buzz Aldrin and their team mate Michael Collins in 1969. Neil and Buzz landed on the Moon while Michael stayed in orbit keeping an eye on things instead. Altogether, 12 astronauts have stood on the Moon. They have carried out many scientific experiments and even tried to play golf!

The Saturn V rocket that took men to the Moon was 111 metres tall – that's 15 metres taller than Big Ben!

Astronauts from Apollo 17 with their Lunar Rover in 1972. In it, they travelled 35 km across the Moon's surface.

QUICK MOON FACTS

- The Moon is rocky.
- The gravity on the Moon is only one sixth of the strength of the Earth's gravity.
- There is no atmosphere on the Moon.
- It is a similar age to the Earth (4,500,000,000 or 4.5 billion years old!).
- There are sometimes 'moonquakes'.
- Most of the craters on the Moon's surface were created after large rocky objects such as asteroids crashed into the Moon billions of years ago.

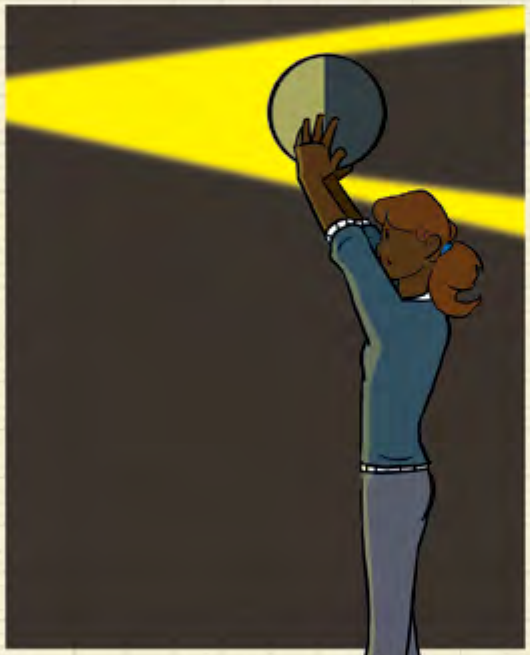
4.2 EXPLORE THE MOON

ACTIVITY 4A THE PHASES OF THE MOON

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

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.

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.

ACTIVITY 4B OBSERVING THE MOON

You can also observe the Moon for yourself. Your observation sheet will look something like the one below. Sometimes you will need to look for the Moon in the evening, sometimes in the morning. Draw as accurate a picture as you can. Does the Moon show a pattern of light and dark like the model in activity 4.1?

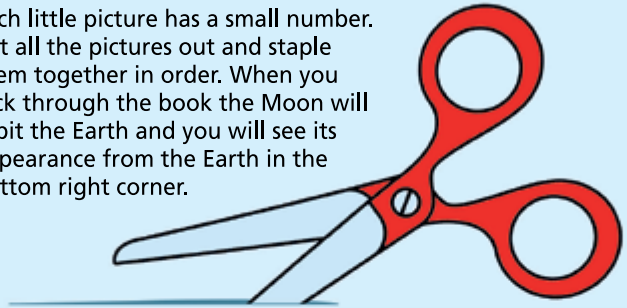
You can find information about Moonrise and Moonset times here: www.timeanddate.com/moon

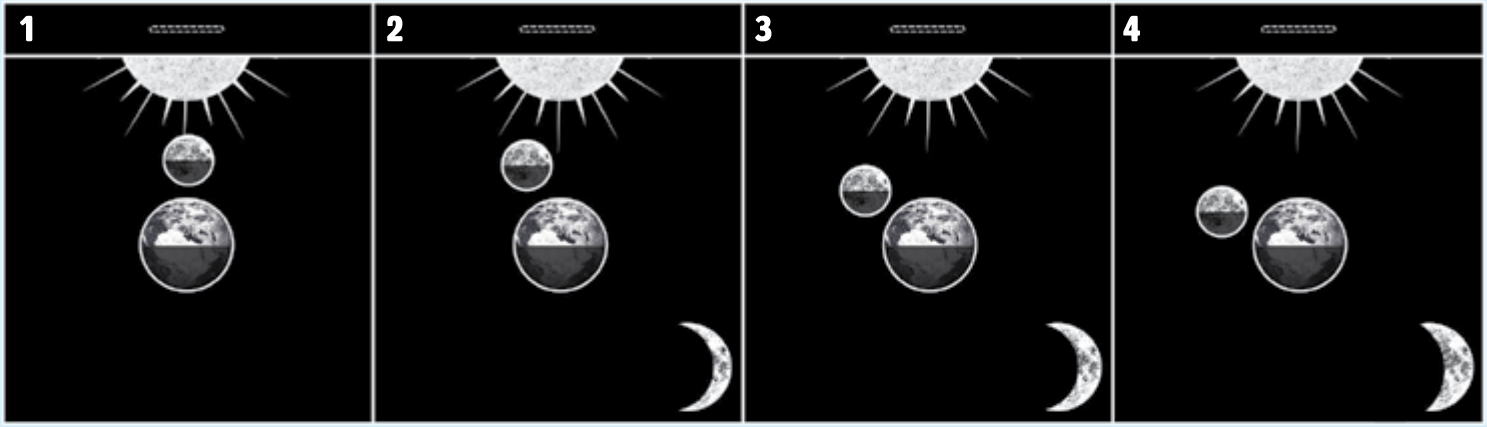
4.3 EXPLORE THE MOON

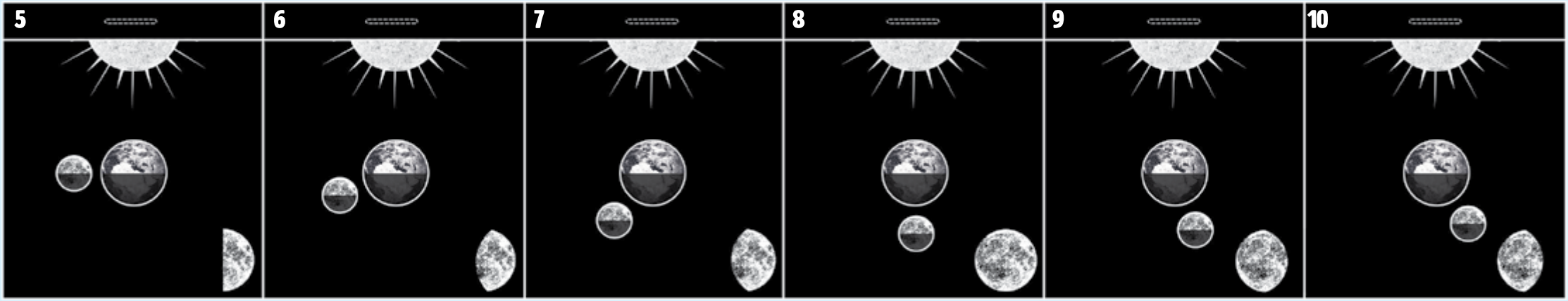
ACTIVITY
4c MAKING A MOON FLICKBOOK

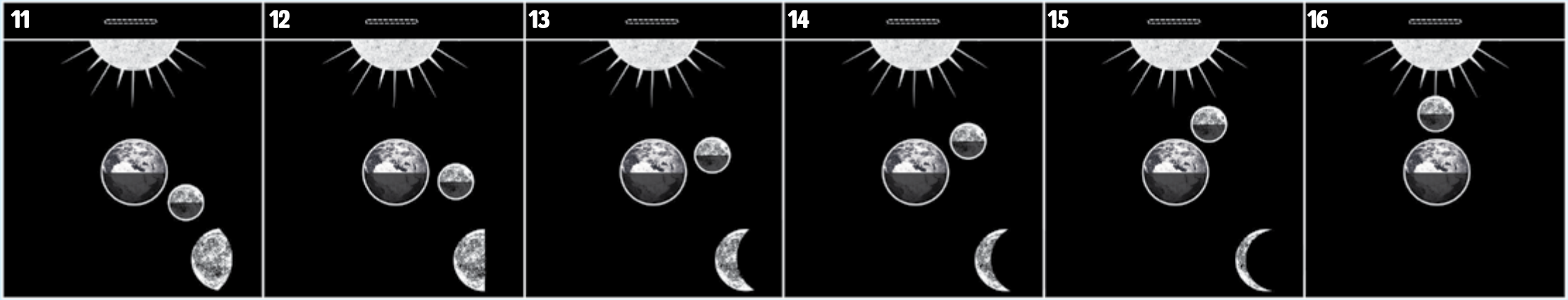
You will need a photocopy of the whole of this page.

Each little picture has a small number. Cut all the pictures out and staple them together in order. When you flick through the book the Moon will orbit the Earth and you will see its appearance from the Earth in the bottom right corner.









5 DISCOVER TELESCOPES

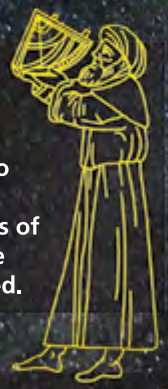
Throughout the ages people have looked at the night sky using just their own eyes - we call this 'naked eye' observation. We can learn to spot the bright planets moving among the constellations and to follow the motion of the Sun and Moon without any fancy equipment other than our eyes.
If we want to look at things in more detail, we need something like a pair of binoculars or telescopes to give us a helping hand.

Binoculars and lots of telescopes work a little bit like the human eye, well more like a superhero version really. They collect light which travels in straight lines using a large lens or mirror and focus it into a picture that we see. Telescopes are so good at collecting light from things like very far away stars and faint and distant nebulae that they allow us to sneak a peek into the rest of the Universe. Sometimes we even discover things we didn't know were there like comets, moons and planets around other stars.

HISTORY OF THE TELESCOPE

1 Patterns were noticed in the stars.

2 Ancient civilisations began to keep records of the events in the sky.



3 Simple instruments to make measurements of the stars were made and used.

4 The Italian astronomer Galileo used his telescope to discover the moons of Jupiter.

5 The British Astronomer Isaac Newton invented and used a telescope like this one.

6 By the 18th century astronomers could build large telescopes to look at stars in detail.

7 In the 19th century people like Astronomer Royal, William Christie used telescopes like the Great Equatorial Telescope at the Royal Observatory Greenwich to do their research.

8 The William Herschel Telescope is a general purpose large telescope with a main mirror 4.2m across.

9 Astronomers are now using telescopes like the VLT (Very Large Telescope Array) to be able to see more than ever before.

5.1 DISCOVER TELESCOPES

Telescopes are not just being used to study visible light in our Universe as scientists have discovered that there is more to space than meets the eye. They have developed telescopes that are able to see things our human eyes can't but can help us understand how our Universe works.

Scientists have developed lots of different ways of being able to see the invisible on Earth which can be very useful indeed.

X-RAYS

X-rays can be used to look at the human skeleton to check for broken bones.

ULTRAVIOLET

Ultraviolet light and pens with special ink can be used to send super-secret messages.

INFRARED

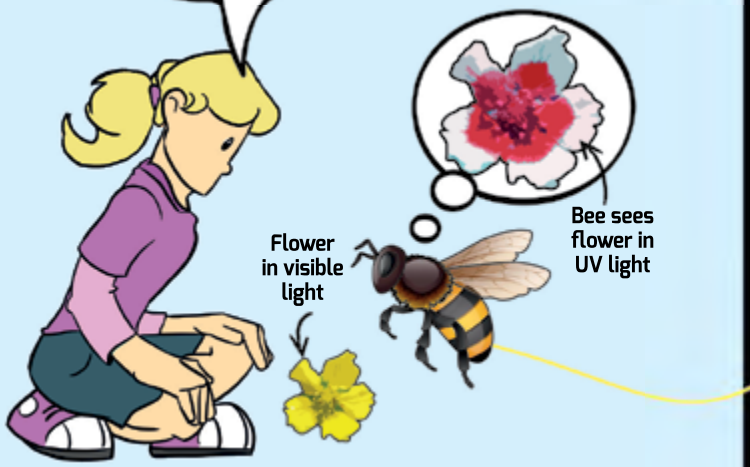
Infrared cameras are very useful for mountain rescue crews. They can even use them at night (when there is no sunlight to help them see) because all they have to do is look for the lost person's body heat!

RADIO

Radio waves are used by walkie talkies to help people in the emergency services talk to each other.

DID YOU KNOW?

There are creatures on Earth that can see things our eyes can't too. It is not just special machines that can see the invisible. Bumblebees can see ultraviolet light. This means that when they look at a flower they see it differently to us. Being able to see UV helps them see where is best to land and find the sweet nectar.



There are some telescopes that are able to see the invisible too. Take a look below to find out what they can see that our eyes can't!

XMM-NEWTON X-RAY MULTI-MIRROR MISSION

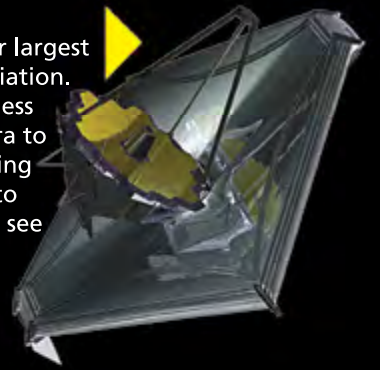
This telescope is named after the physicist and astronomer Sir Isaac Newton. Rather than collecting visible light like binoculars do, this telescope collects x-rays in space.

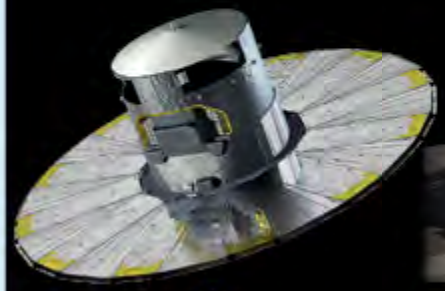
ALMA ATACAMA LARGE MILLIMETRE ARRAY

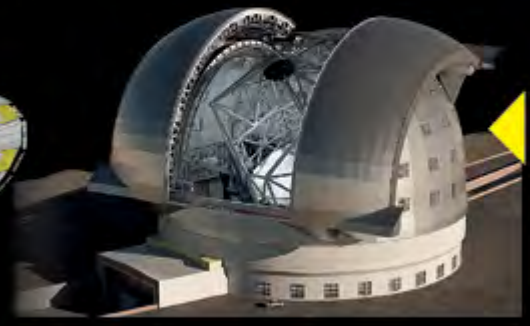
ALMA doesn't collect the light our eyes would see (visible light). This collection of 66 antennas works together to study radio waves instead. Scientists are hoping that ALMA might be able to tell us more about how stars as well as our own Universe formed.

JWST JAMES WEBB SPACE TELESCOPE

When this telescope launches it will be our largest space telescope. It uses infrared (heat) radiation. Our eyes cannot see infrared radiation unless we use an infrared or heat-sensitive camera to give us a helping hand. Scientists are hoping that this telescope will be able to help us to peer through huge dust clouds in space to see what hides inside.







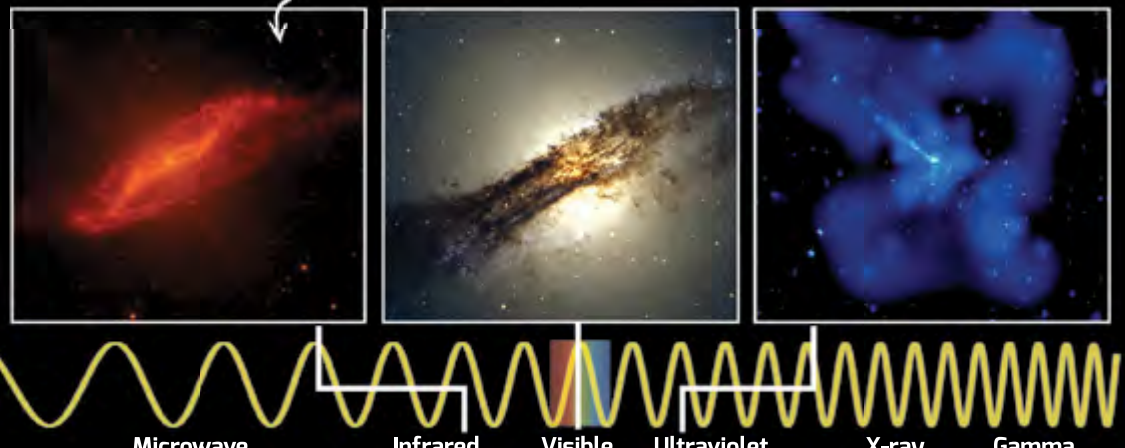
E-ELT EUROPEAN EXTREMELY LARGE TELESCOPE

This telescope really is huge – 39.3 metres across in fact! It uses visible light, but it also uses infrared too. Scientists are hoping it will help us to search for life on planets around other stars. It won't be in use until 2024 though so we have a little while to wait yet.

GAIA

This is a pretty special one because it is more than a telescope, it is its own observatory in space. Gaia's mission is to create a 3D map of 1 billion stars. Gaia's camera is the largest camera ever flown into space and has its very own shield to protect it from the Sun which is the size of half a tennis court!

The same galaxy seen in different wavelengths. Each reveals different features.



5.2 EXPLORE TELESCOPES

After finding out all that amazing information about telescopes would you like to get your hands on a real robotic telescope and see the invisible too? Well, now you can.

The fantastic teams working on the Bradford Robotic Telescope, the Faulkes Telescope Project and the National Schools' Observatory Project can help you to take your very own robotic telescope images. All of these organisations have access to telescopes around the world that you can book time on – pretty special stuff.

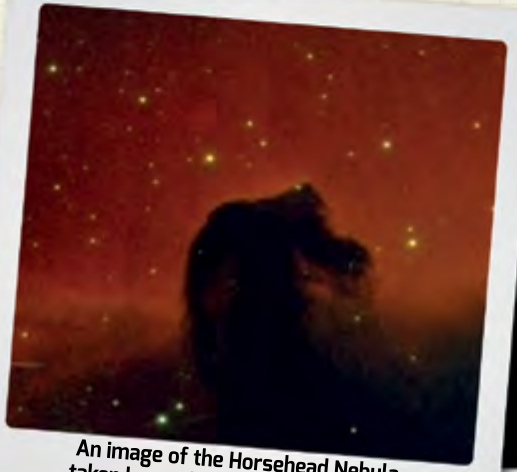
ACTIVITY 5A A TRIP TO DEEP SPACE

PLANNING YOUR TRIP

First thing's first - you need to plan what you are going to photograph. It could be a distant star, nebula or even galaxy.

TAKING PHOTOGRAPHS

Next up you need to book some time on a telescope. They get quite busy as there are a lot of people wanting to use them all over the world, so get in there fast. Take a look at the groups on the right to find out how to book your slot.



An image of the Horsehead Nebula taken by students using the Faulkes Telescope Project.

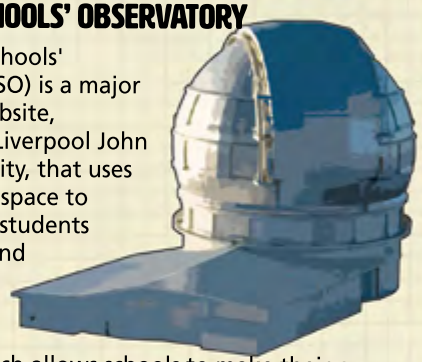
A picture of a spiral galaxy taken by students using the National Schools' Observatory.

FAULKES TELESCOPE PROJECT

The Faulkes Telescope Project provides free, web-based access to observing time on two 2-metre telescopes (located in Hawaii and Australia), and a network of 1-metre telescopes (Chile, South Africa, mainland USA). The FT observing time is dedicated to education and public outreach, through the Dill Faulkes Educational Trust. The telescopes are available to educational groups to use as part of classroom or extra-curricular activities, and are fully supported by a range of educational resources.

Check out their website here:
www.faulkes-telescope.com

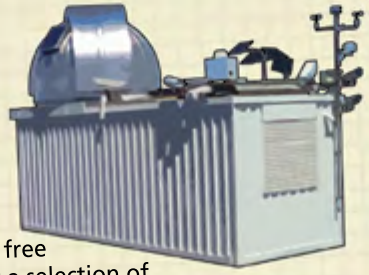
NATIONAL SCHOOLS' OBSERVATORY



The National Schools' Observatory (NSO) is a major educational website, established by Liverpool John Moores University, that uses astronomy and space to enthuse school students about science and technology. At the centre of this is "Go Observing" which allows schools to make their own observations alongside professional astronomers with the world's largest fully-robotic telescope – the Liverpool Telescope, in the Canary Islands – for free.

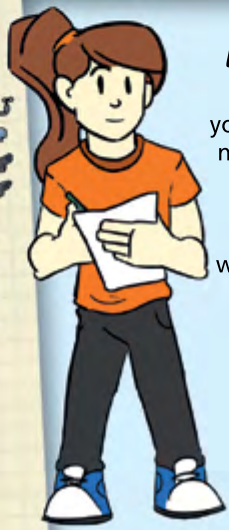
Check out their website here:
www.schoolsobservatory.org.uk

AUTONOMOUS ROBOTIC TELESCOPE



The Autonomous Robotic Telescope is a collection of telescopes and other instruments on Mount Teide, Tenerife. It is available for everyone to use for free and is supported by a selection of schools' resources available through the website.

Check out their website here:
www.telescope.org



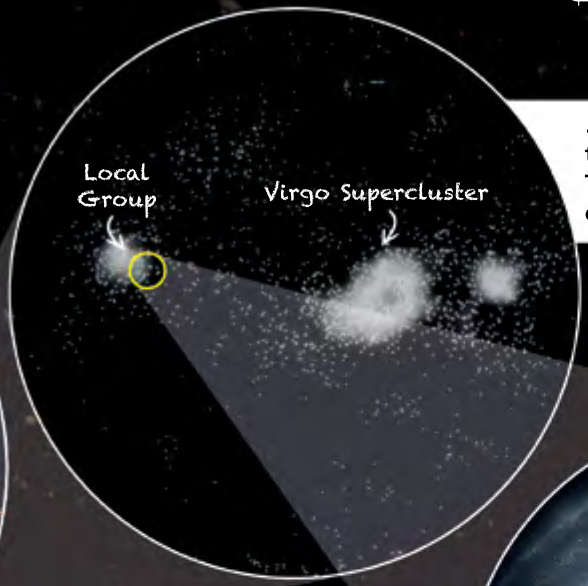
ANALYSIS

After you get your images you need to analyse them, do they look how you thought they would? You can then use this information to decide if you might like to take photographs next – happy snapping!

6 DISCOVER SPACE

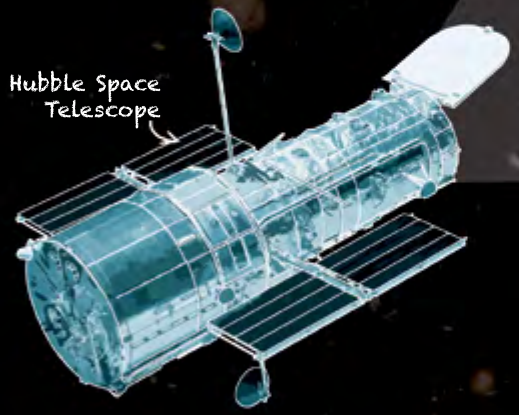
Space is big, huge, enormous, bigger than you can possibly imagine! To get an idea of just how big we can look at this image the Hubble Space Telescope took of one, tiny part of the sky. In this image, there are 10,000 dots of light...

...and each one of those dots is a galaxy...

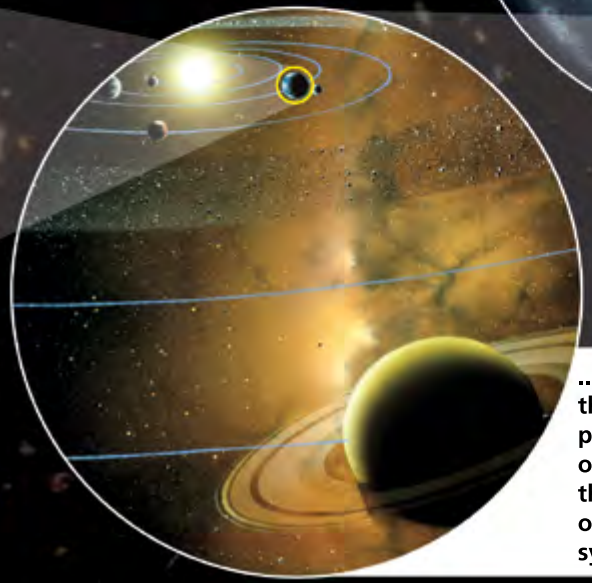


...and those galaxies often group together in space in a galaxy cluster. The Virgo Supercluster contains our own galaxy – the Milky Way...

...and each galaxy contains hundreds of thousands of millions of stars...



...And some of those planets have liquid water, like the planet Earth...



...and many of those stars have planets that orbit them, like the planets in our own solar system.

...which has you!

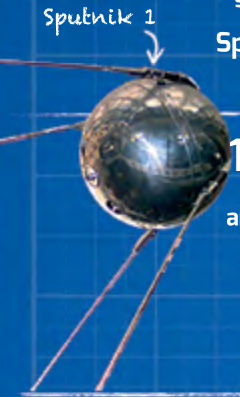
With the James Webb Space Telescope, soon we will be able to see EVEN MORE STARS!

6.1 DISCOVER SPACE

In just 60 years of space exploration we have achieved so much! Since 1957 we have put satellites, rockets, animals, humans, space stations and telescopes into space. We have sent robots to other planets and probes to the outer edge of our Solar System and beyond. Below are some highlights of space explorations. Where do you think we will go next?

1950s

1957 First man-made satellite
Sputnik 1 (Russia)



1957 First animal in orbit
Laika (Russia)

1959 First impact on the Moon
Luna 2 (Russia)

1961 First chimp in space
Ham (USA)

1960s

1961 First human spaceflight
Yuri Gagarin (Russia)

1961 First piloted spaceflight
Alan Shepard (USA)

1963 First woman in space
Valentina Tereshkova (Russia)

1965 First spacewalk
Alexei Leonov (Russia)

1970s

1966 First orbital docking
Gemini 8 (USA)

1969 First human on the Moon
Neil Armstrong (USA)

1971 First space station
salyut 1 (Russia)

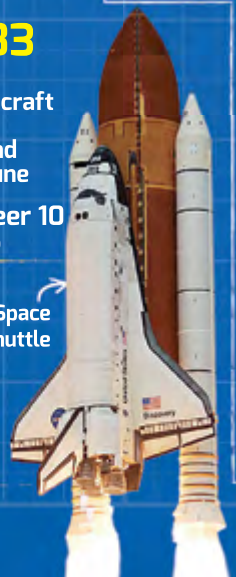
1975 First multi-national space project
Apollo-soyuz (International)

1976 First soil sampling on Mars
Viking 1 (USA)

1977 Voyager 1 and 2 head out into solar system
Voyager 1 & 2 (USA)

1980s

1981 First reusable spacecraft
Space Shuttle (USA)



1983 First spacecraft to go beyond Neptune
Pioneer 10 (USA)

1986 Mir space station built
MIR (RUSSIA)

1986 First probe to make close up observations of a comet
Giotto (ESA)

1990s

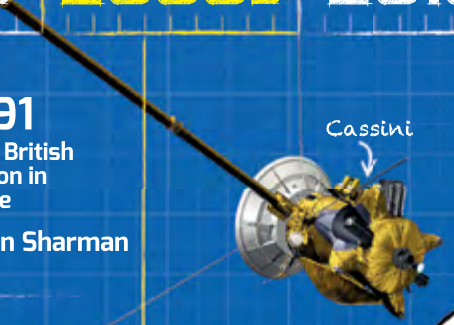
1990 First orbital observatory
Hubble Space Telescope (USA)

1991 First British person in Space
Helen Sharman (UK)

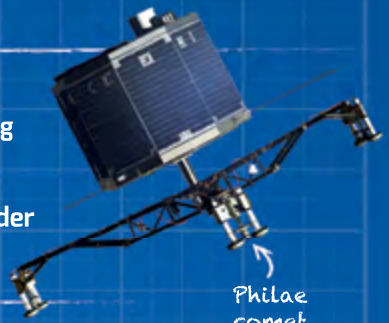
1998 First multi-national Space Station
International Space Station (International)

2000s

2004 First orbit of Saturn
Cassini Huygens (International)



2014 First landing on a comet
Philae lander (Rosetta) (ESA)



2010s

2015 First British ESA astronaut
Tim peake (UK)

FUTURE

Huge infrared space telescope
James Webb Space Telescope (JWST) (International)

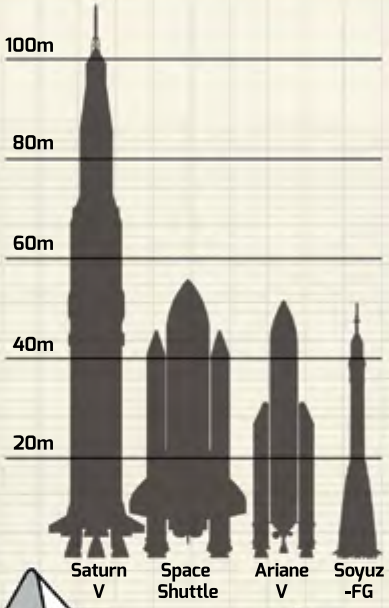
European rover to Mars
ExoMars (ESA)

6.2 EXPLORE SPACE

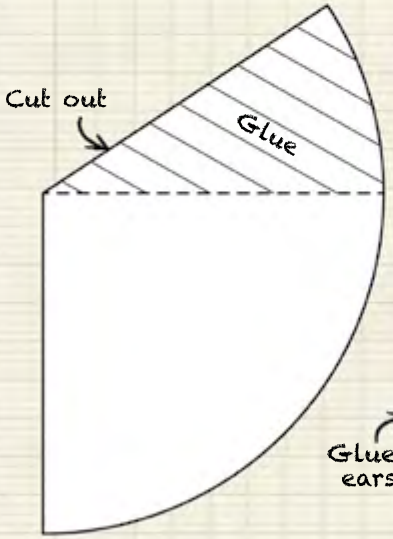
ACTIVITY 6A MOUSE ROCKETS

Rockets come in all shapes and sizes. From Europe's Ariane 5 rocket to Russia's Soyuz-FG that launches astronauts up to the International Space Station.

But you can make your own, simplified rocket from an empty plastic milk bottle and some paper.

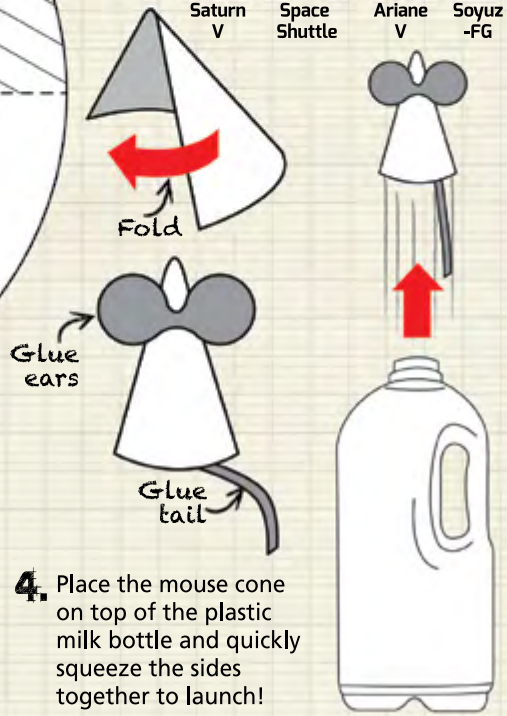


1. Print out the mouse rocket on the next page and cut out all of the parts.



2. Fold this section into a cone by bending the corners around, folding one side over the dotted section and use tape to fix it in place.

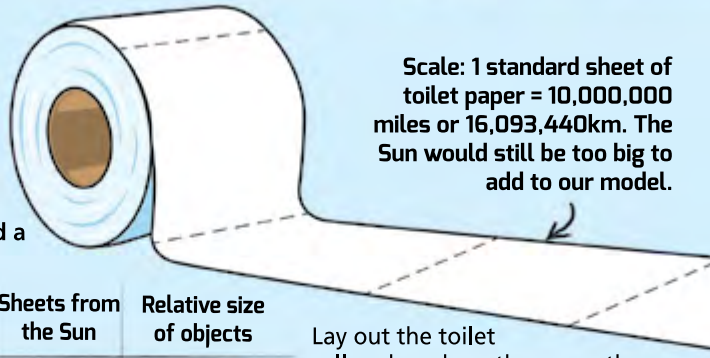
3. Attach the ears and tail to the cone.



4. Place the mouse cone on top of the plastic milk bottle and quickly squeeze the sides together to launch!

ACTIVITY 6B TOILET PAPER SOLAR SYSTEM

Space is huge and the space between celestial objects (like planets and moons) is hard to picture. Using this activity, find out the relative distance and size of objects in our solar system. You will just need a toilet roll and some common foods listed below.



Scale: 1 standard sheet of toilet paper = 10,000,000 miles or 16,093,440km. The Sun would still be too big to add to our model.

Object	Sheets from the Sun	Relative size of objects	Object	Sheets from the Sun	Relative size of objects
Sun	0	-	Asteroid belt	28	Poppy seeds
Mercury	3.6	Pepper corn	Jupiter	48.4	Watermelon
Venus	6.7	Grape	Saturn	88.7	Grapefruit
Earth	9.3	Cherry tomato	Uranus	178.6	Apple
Mars	14.1	Blueberry	Neptune	280	Lime

Lay out the toilet roll and mark on the paper the different objects as they occur. You will need a big indoor space like a school hall to do this. Now add the fruits to illustrate the relative size of the planets and other celestial bodies in our solar system.

ACTIVITY 6C HYDROPONICS – GROWING FOOD IN SPACE

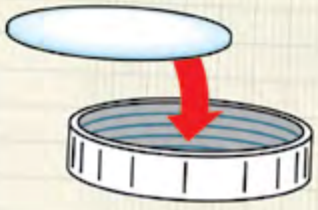
On the International Space Station, plants are being grown without soil (hydroponics) to provide the astronauts with food. Tests need to be done to see if this will work. You are going to investigate how the amount of light affects how well cress can grow in a hydroponic environment.

To make your kits you will need:

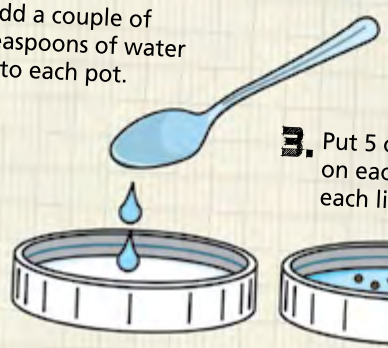
2 coffee pot lids
Cotton wool pads
Cress seeds
Teaspoon
Water

For a fair test, everything must be kept the same, except for one thing. Keep one of your cress growing kits in a well-lit place and the other somewhere there isn't much light, like a cupboard. Watch what happens over a week, and measure how much each grows.

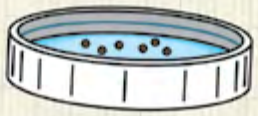
1. Make sure both lids have a cotton wool pad at the bottom.



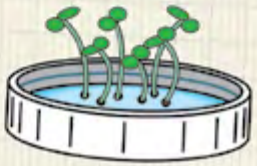
2. Add a couple of teaspoons of water into each pot.



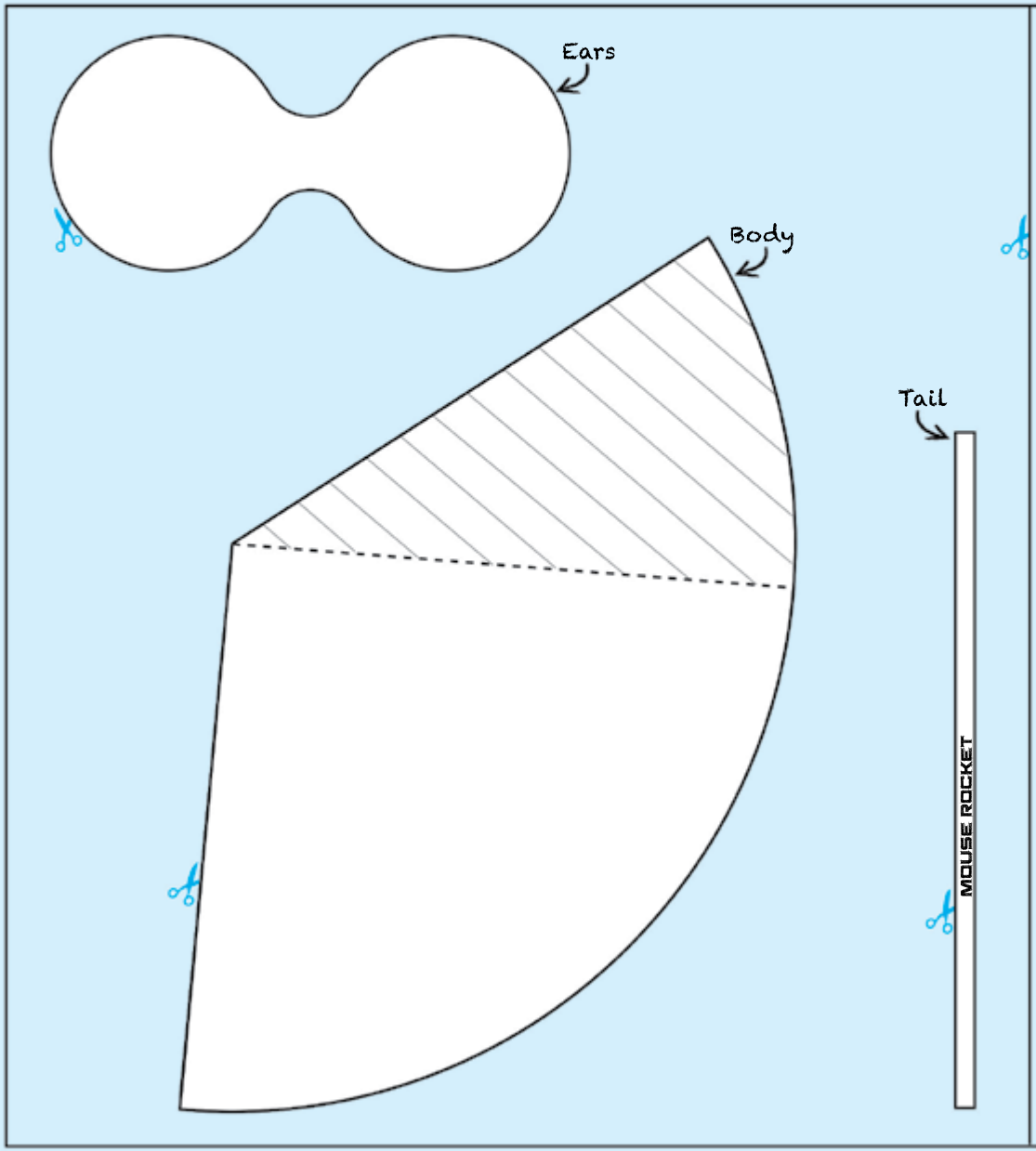
3. Put 5 or 6 seeds on each pad in each lid.

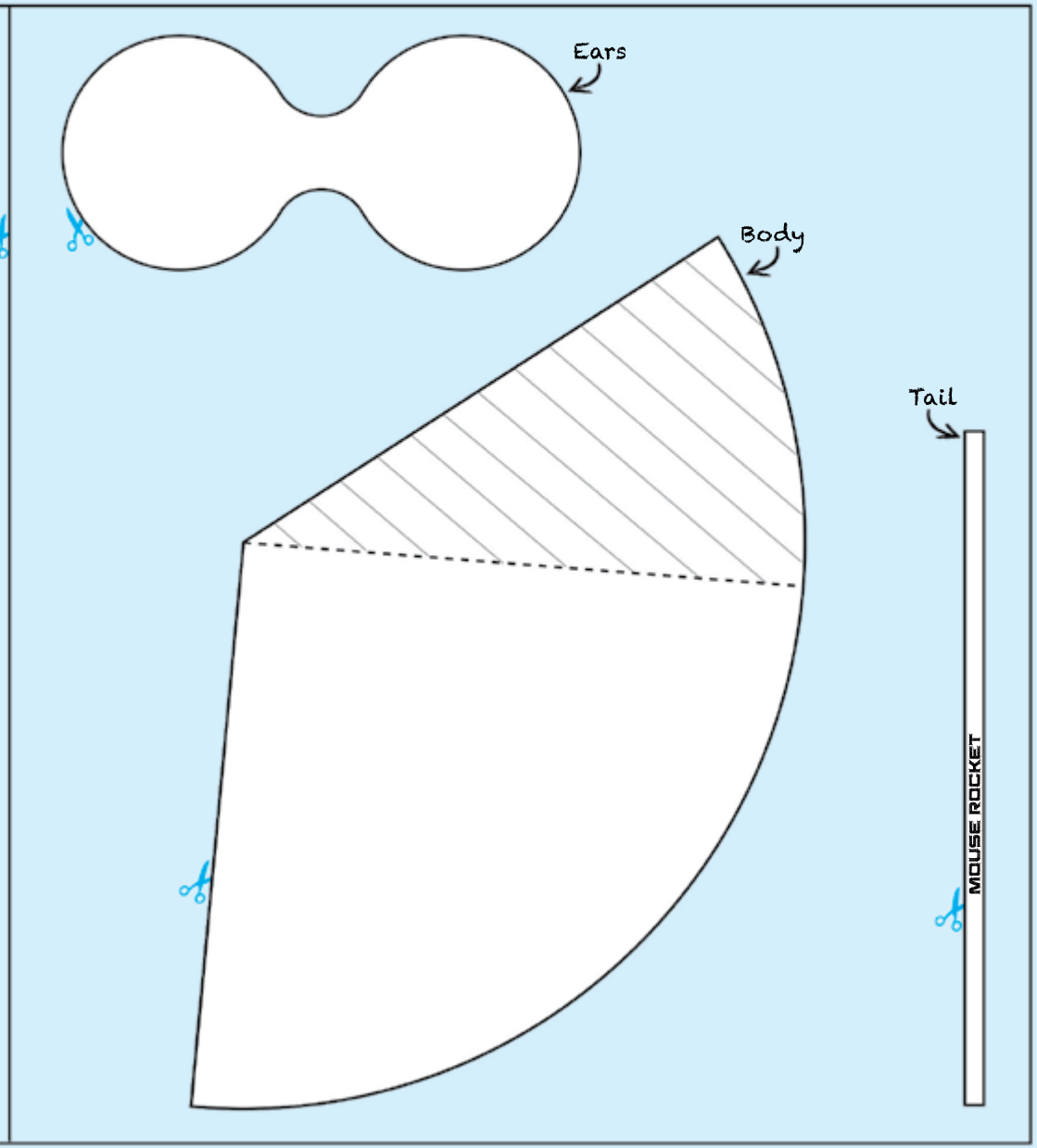


4. Place one set in a light place and one set in a dark place. Leave them to grow and observe what happens!



MOUSE ROCKET TEMPLATE

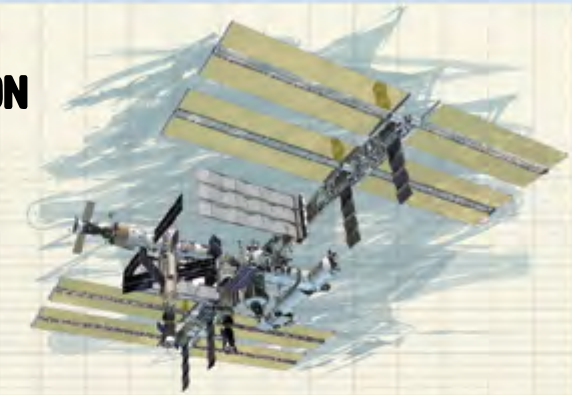




ACTIVITY 6D BUILD A SPACE STATION

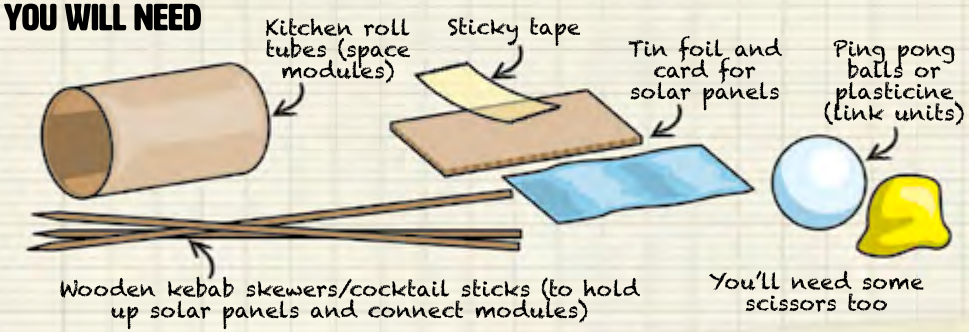
The International Space Station (ISS) supports six astronauts on board for months at a time. Orbiting 400km above the surface of the Earth it is our permanent outpost in space.

Space stations are made of multiple modules in which the astronauts live and work, with solar panels to provide the energy on board. Everything an astronaut needs to survive must be provided.



Can you design your own model space station with everything an astronaut needs?

YOU WILL NEED



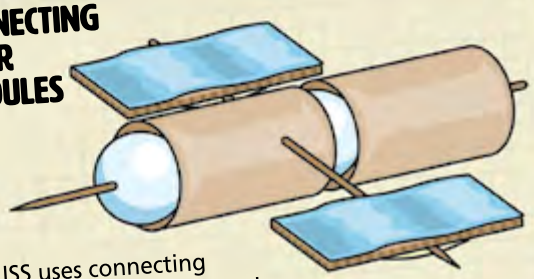
Which modules to include?

Possible modules:

- **Research laboratories**
- **Habitation units**
- **Observation decks**
- **Exercise and food preparation module**
- **Utility module for water sanitation and air recycling**

Do you think your space station provides everything an astronaut would need? Do you have enough solar panels to generate enough electricity?

CONNECTING YOUR MODULES

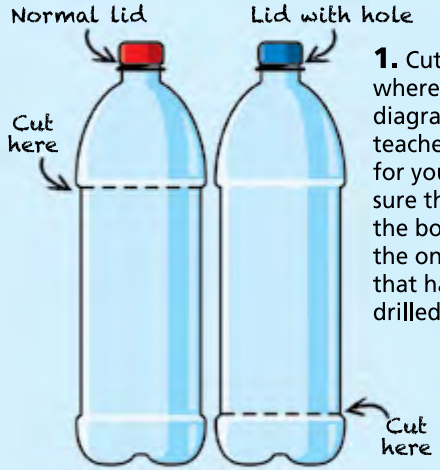


The ISS uses connecting modules to allow all the main modules to be linked together. For this you can either use cubes of plasticine, or ping pong balls with holes poked into them. You can then use cocktail sticks or wooden kebab skewers to attach your modules to them.

ACTIVITY 6E MAKE A BIODOME

If humans are going to live on another planet like Mars, they will need to make a habitat where everything they need is provided.

You can build a mini bio dome yourself from 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.

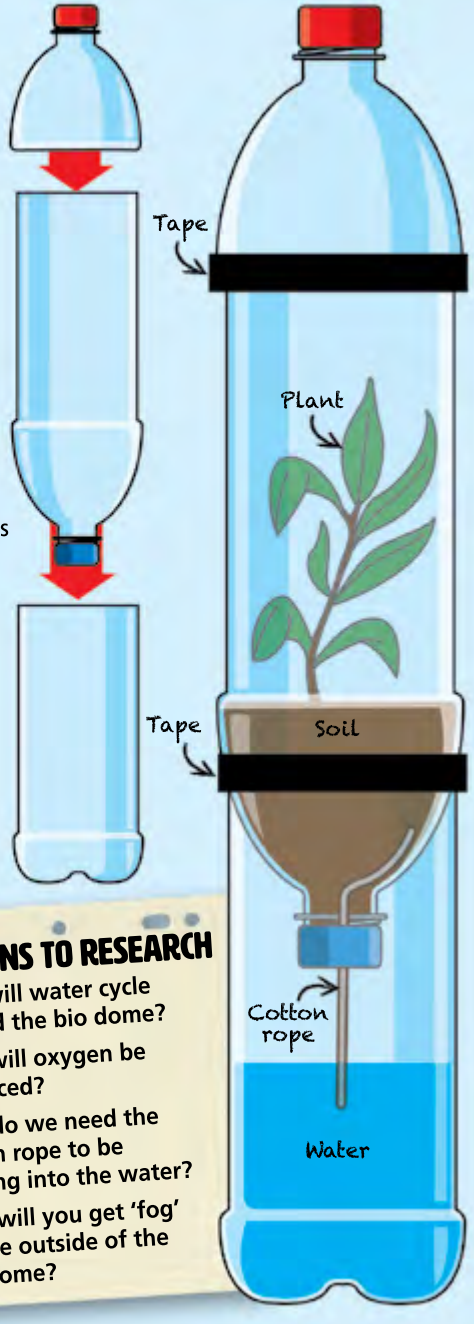
2. Turn the cut bottle with the lid that has a hole upside down and put it in the bottle with the top cut off. Fill the bottom up with water so it comes to just below the lid and feed the cotton rope through the hole so that it dips in the water. Tape the rope into place.

3. Use black tape to tape around the join.

4. Fill the top bottle with soil until it is one third full.

5. 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.

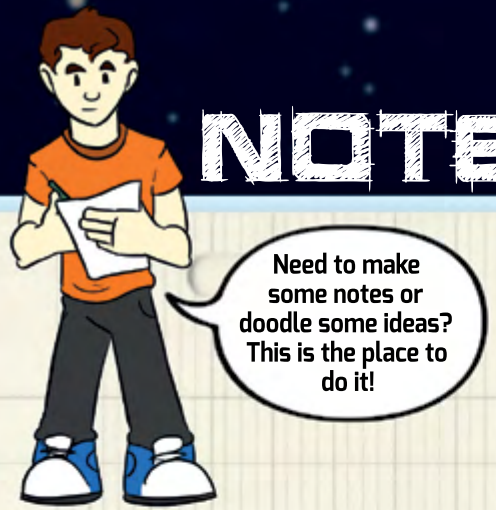
6. Take the cut off top bottle with a full lid and use black tape to attach it to the top. Your bio sphere is complete and now you can monitor your habitat!



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?**

NOTES


Need to make some notes or doodle some ideas? This is the place to do it!

The Science and Technology Facilities Council operates world-class, large-scale research facilities; supports scientists and engineers world-wide; funds researchers in universities and provides strategic scientific advice to government.

The Council's Public Engagement Team offers a wide range of support for teachers, scientists and communicators to facilitate greater engagement with STFC science which includes astronomy, space science, particle physics and nuclear physics:

100-01-03

FOR SCHOOLS

- **Free Publications and resource guides** suitable for teaching ages 10-18.

- **Funding** schemes for projects and school visits.

- **A Moon rock and meteorite loan scheme**.

- **Visits** to STFC's UK laboratories in Cheshire, Oxfordshire and Edinburgh plus CERN in Geneva.

www.ukri/stfc.org

UKRI Science and Technology Facilities Council

HANDS ON UNIVERSE

ACKNOWLEDGEMENTS

Science and Technology Facilities Council

SCIENCE AND TECHNOLOGY FACILITIES COUNCIL FOR DEVELOPING THE RESOURCE.

NATIONAL SPACE CENTRE FOR THE CONTENT DEVELOPED BY SOPHIE ALLAN, ROBERT COPELAND, CHRIS DARBY, CHARLOTTE ISHAM AND KIERANN SHAH

BRADFORD ROBOTIC TELESCOPE, FAULKES TELESCOPE PROJECT, NATIONAL SCHOOLS OBSERVATORY PROJECT AND ZOONIVERSE FOR THEIR INPUT.

THE SCIENCE MUSEUM FOR THE MOUSE ROCKETS.

ROYAL OBSERVATORY GREENWICH FOR THE CONTENT DEVELOPED BY ELIZABETH AVERY AND RADMILA TOPALOVIC.

DESIGN, LAYOUT AND GRAPHICS: BEN GILLILAND.
CHARACTER ILLUSTRATIONS: JAY GILLILAND.