Earth in space

Introduction

Ideas about Earth’s place in space have interested people since ancient times. Children love to learn about space, so motivating students should not be a problem for the teacher. However, while there is plenty of scope for children to engage in library research and Internet activities, this should not be overdone. This topic provides a range of hands-on activities that focus on key concepts to do with Earth in space.

Key concepts of Earth in space

The activities in this topic are designed to explore the following key concepts:

Early years

- Earth is the shape of a ball.
- ‘Down’ refers to the centre of Earth (in relation to gravity).
- Earth spins, or rotates, to cause day and night.
- The Moon changes shape over a month.
- Planets go around the Sun.
- Stars have different brightness and colour.
- Humans group stars into constellations.
- The planets in the solar system differ in size.

Middle years

- The universe is extremely large.
- Instruments such as telescopes and binoculars can be used to view objects in the universe.
- There are many different types of objects in the universe.
- The Moon appears in the sky due to reflected light from the Sun.
- The position of the Sun with respect to Earth gives us night and day.
- Stars are still there during daylight.
- The Moon’s gravity is much less than gravity on Earth.
- Earth rotates, which makes the Moon, Sun and stars appear to move.
- Earth’s tilt in orbit causes seasons.
- The Sun is higher in the sky in summer at midday, than at the same time in winter.

- The Sun rises and sets at different places and at different times in summer compared to winter.
- The solar system is a big place.
- Space travel is very difficult.

Students' alternative conceptions of Earth in space

Research into students' ideas about this topic has identified the following non-scientific conceptions:

- The Earth we live on is flat, not round like a ball.
- The Sun moves to cause day and night.
- The Moon emits its own light.
- The phases of the Moon are caused by Earth's shadow.
- There is no connection between mass and gravity.
- Stars and constellations appear in the same place in the sky all the time.
- The Sun rises exactly in the east and sets exactly in the west everyday.
- The Sun is directly overhead at 12 midday (even taking into account daylight saving!).
- We experience seasons because of Earth's changing distance from the Sun: closer in summer, farther in winter.
- Earth is the centre of our solar system.
- The Moon is only visible at night.
- The Moon does not rotate on its axis as it revolves around Earth.
- The phases of the Moon are caused by other things in the solar system either getting in the way or casting a shadow on it.
- The phases of the Moon are caused by Earth's shadow.
- Earth is the largest object in the solar system.
- The solar system is crowded.
- Meteors are falling stars.
- All the stars in a constellation are near each other.
- Stars are evenly distributed throughout the universe.

Activities

Exploring Earth in space

ACTIVITY: 'OUR PLACE IN SPACE' PROBE

Key ideas: The solar system is a big place. There are many different types of objects in the universe.

You will need:

- **storybook: *My place in space* (R Hirst & S Hirst 1988, Five Mile Press, Fitzroy, Vic.).**

Read the storybook *My place in space*. After reading the storybook, discuss some of the objects found in space and what people know about them. For example, people

know that stars produce their own light but planets and satellites are seen because they reflect starlight.

ACTIVITY: CONCEPT MAPPING

Key idea: Interrelationships between concepts of Earth in space. For example, our own galaxy, which is a collection of many stars near each other, is called ‘the Milky Way’.

Create a concept map using the following words:

- **sun**
- **planets**
- **star**
- **earth**
- **solar system**
- **moon**
- **galaxy**
- **satellite**
- **atmosphere**
- **gravity**
- **comets**
- **constellations**
- **Milky Way.**

ACTIVITY: THE CHANGING SHAPES OF THE MOON

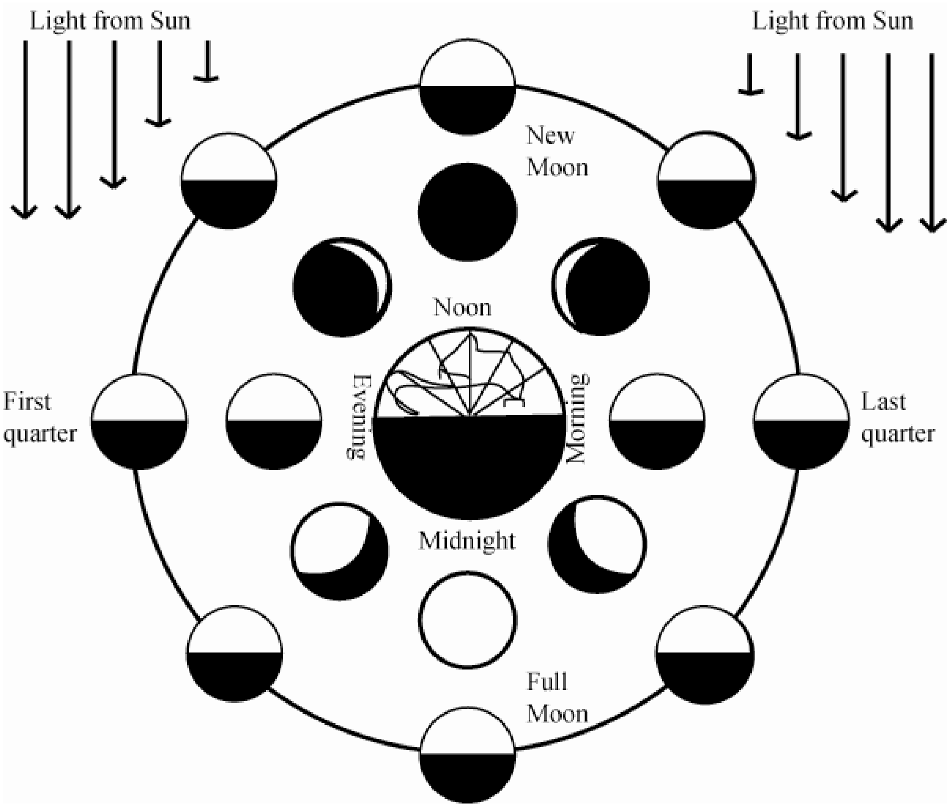
Key ideas: The Moon changes shape over a month. The Moon reflects light from the Sun.

The Moon reflects light from the Sun to Earth. The phases of the Moon are produced by its orbit around Earth. Observe the Moon shapes you see on days 1, 8, 15, 22 and 29 of any month.

Explanatory note: The shape of the Moon depends on the relative positions of Earth, the Moon and the Sun. The changing shapes of the Moon provide a good case for disputing the view that the Moon gives off its own light; if it did it should always appear as a disc.

Looking at the figure *The changing shapes of the moon* below, assume that the Sun is located at the top of the figure. The outside ring of circles represents the different positions of the Moon with respect to Earth (at the centre). Notice that for all positions of the Moon the Sun illuminates exactly half of the Moon. However, when the Moon is observed from Earth we don’t always see the full illuminated side. The inside ring of circles shows what the Moon will look like at the positions indicated by the outer circles.

FIGURE: THE CHANGING SHAPES OF THE MOON

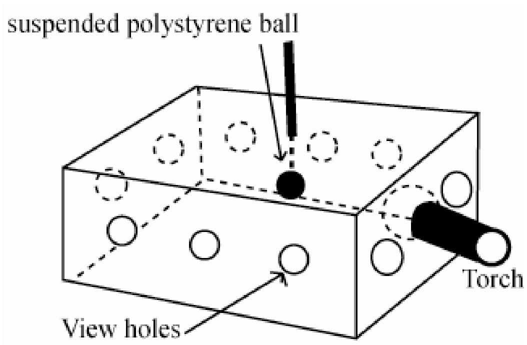


ACTIVITY: PHASES OF THE MOON

Key idea: The Moon changes shape over a month.

You will need:

- **a shoe box**
- **a Stanley knife**
- **a polystyrene ball**
- **wire**
- **black and grey paints**
- **a torch.**



This activity produces a model that demonstrates the phases of the Moon.

Paint a shoe box black inside and out; alternatively, it could be covered with black cardboard. The model of the Moon is to be painted dark grey; this is the colour of the Moon. Suspend the Moon so it is located in the centre of the box using the wire.

On one end of the box cut out a hole large enough for the head of a torch to fit through. Then, cut out small observation holes around each side of the box. Turn on the torch and observe the phase of the Moon inside the box.

ACTIVITY: DAY AND NIGHT

Teaching note: A key idea of modelling day and night is to use a sphere for Earth. Why do we believe Earth is spherical? Wherever and whenever possible, students should be encouraged to make and interpret the following observations:

- the way ships disappear over the horizon
- circumnavigation of Earth; it is possible to fly around Earth
- the curved edge of the shadow of Earth, for example, during eclipses
- photos of Earth—we now have photos of Earth taken from the Moon and from Earth satellites in space.

Key idea: Earth spins, or rotates, with respect to the Sun, to cause day and night.

You will need:

- **a globe of Earth**
- **a torch**
- **a darkened room.**

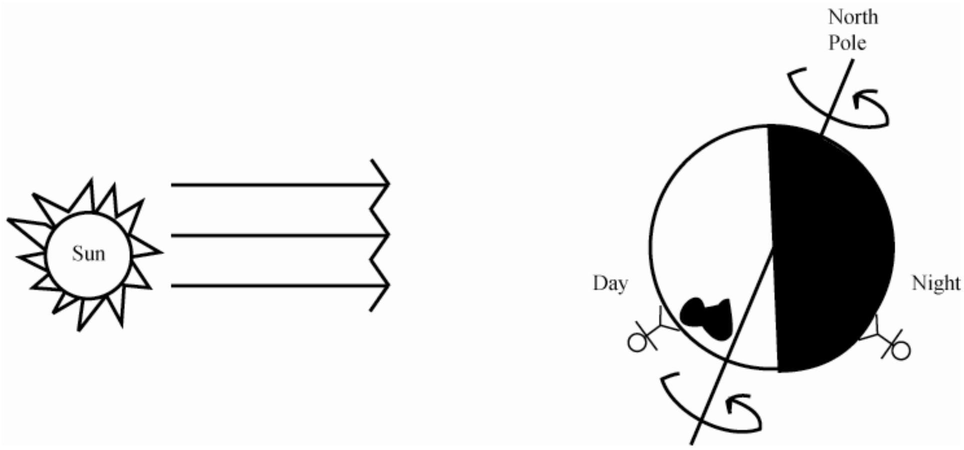
Ask the students how we get day and night. Demonstrate day and night through shining torchlight onto a globe of Earth.

How much of Earth is in daylight (illuminated)? Where should the torchlight be shining if it is midday in Melbourne? Where should it be shining if it is midnight in Melbourne?

Which way does Earth spin? (Hint: the east coast of Australia experiences sunrise before the west coast.)

Discuss with the students what time it would be in other locations on Earth when it is midday in Melbourne.

Explanatory note: The regular observations of day and night are due to Earth's rotation about its axis every 24 hours. This is termed 'diurnal motion'. Earth is (approximately) spherical (it's actually flattened at the poles), so the Sun will always illuminate half of Earth. As Earth rotates on its axis observers on the surface of Earth will experience regular periods of day (illumination) and night (darkness). By using a globe of Earth and a torch in a darkened room you can simulate when particular locations on Earth will be in daylight. Earth rotates from east to west so in this simulation the east coast of Australia will be illuminated first. Try it!



ACTIVITY: WHY DON'T WE SEE STARS DURING THE DAY?

Key idea: Stars are present in the sky always—day and night.

You will need:

- **a torch**
- **a bright window.**

Shine the torch into a dark corner or onto a dark surface (e.g. the blackboard). Encourage the children to explain what they see (i.e. the bright light of the torch). Now shine the torch onto the bright window. What has happened? The bright starlight (i.e. the torchlight) can be seen again as it moves away from the window—why? This is what happens to stars in the sky!

Explanatory note: The Sun is a star that is very close to Earth. When the Sun is shining brightly the light from stars that are further away are very hard to see. That is because these stars are so far away that their light is not strong enough to be seen during the day. So the other stars are always there but they just can't be seen very easily. Incidentally, some people believe that one can see stars during the day from deep in a well. This is not true!

ACTIVITY: EXPLAINING THE SEASONS

Key idea: The seasons are due to Earth's tilt and its yearly orbit of the Sun.

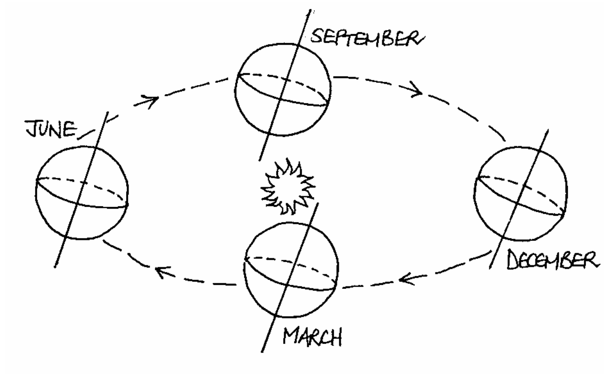
You will need:

- **a globe**
- **a torch**
- **a protractor.**

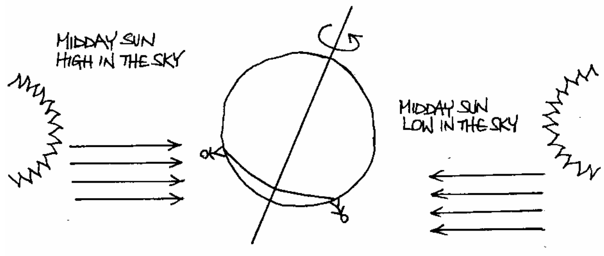
Ask students for their ideas about why we have seasons.

Explanatory note: The reason for seasons is not that Earth is closer to the Sun in summer than in winter. How can this reason be disputed? (Hint: does everywhere on Earth have summer at the same time?)

The reason is that Earth is tilted to the plane of its orbit around the Sun. As Earth revolves around the Sun there will be one part of the year when the North Pole of Earth is tilted towards the Sun and another part of the year when it is tilted away from the Sun (see the figure opposite).



For observers in Australia this will result in the midday sun being high in the sky during summer and low in the sky during winter. This makes the days longer in summer—more time to heat up Australia.



Also, during summer the concentration of the Sun's rays is higher than in winter.

To show this effect, shine a torch at an angle of 75° to the horizontal onto a sheet of white paper. This represents the midday summer sun shining down on a location in Melbourne. Draw around the outline of the illuminated shape (ellipse) made by the torchlight. Now move the torch so that it shines onto the paper at a 28° angle to the paper (keep the torch the same distance from the paper as before). This represents the midday winter sun shining on a location in Melbourne. Draw around the illuminated shape on the paper made by the torchlight. Compare the size of the two illuminated shapes.

The solar system and beyond

ACTIVITY: OUR MOON

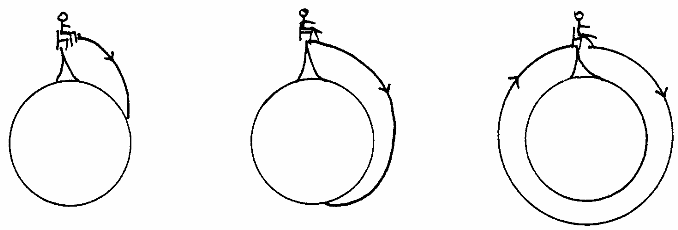
Key idea: The Moon has gravity because it has mass. Objects with mass are attracted to each other; this is called 'gravitational attraction' or simply 'gravity'.

The Moon's gravity is much less than Earth's gravity, which means there is no water or atmosphere on the Moon. This in turn means there is no weather or sound on the Moon. Gravity can also be referred to as 'Earth-pull' or 'Moon-pull'. To get across the idea that gravity is less on the Moon, ask students to make a standing jump and put a mark against a wall at their highest reach when they jump. Measure these marks and multiply them by six. If the same jump was done on the Moon that is how high the jump would take you.

Explanatory note: A common alternative conception is that there is no gravity in outer space and no gravity on the Moon. On the Moon the gravitational force is about one-sixth that of Earth. Gravity is just the force of attraction between two masses; the size of this force is related to the total mass of objects that are attracted and how far apart the masses are from their centres (this is called the ‘separation distance’). The greater the mass, the greater the force; however, the greater the separation distance, the less the gravity. Gravity on the Moon is less than gravity on Earth because the Moon weighs less than Earth.

In space stations and shuttles there is still a significant amount of gravity because the separation distance is only marginally increased (a few hundred kilometres from Earth’s surface). However, astronauts do feel weightless as if there was no gravitational force pulling them to the floor of the space station. The gravitational force from Earth pulls both the space station and the astronauts continually sideways to their forward motion. This results in the space station and the astronauts moving into circular orbits around Earth. In a sense, the space station and the astronauts are continually falling sideways: they are in continual free-fall. This effect can be experienced on Earth in a freely falling lift: as the lift falls to the ground you feel weightless.

Another way to understand weightlessness as similar to free-falling is to imagine sitting on a chair on top of a very high mountain. As you sit on the chair your can feel the chair underneath you. Now imagine being pushed sideways off the mountain with some speed. As you fall you will not feel the chair underneath you and you and the chair will trace out a curved path before you and the chair hit the ground (see the figure below). The greater your initial sideways speed, the greater the distance you will travel away from the top of the mountain (see the middle picture in the figure below). However, if you and the chair are given an enormous initial sideways speed then you and the chair will keep falling right around the entire Earth. If there is no mountain to get in the way on the return journey and there is no air resistance (no atmosphere) then, given the right altitude above Earth’s surface, and the right speed, an object can continually free-fall around Earth. In practical terms, to send spacecraft into orbit around Earth you need to send them to an altitude of a few hundred kilometres with a speed of around 30 000 kilometres per hour. Without this speed you cannot get away from the surface of Earth into space.



ACTIVITY: ROLE-PLAY: EARTH, MOON AND SUN

Key idea: Earth rotates each day on it axis and revolves around the Sun each year.

Choose a student to represent the Sun, another student to represent Earth and another student to represent the Moon.

First establish the motion of Earth on its axis. Discuss with the students how the role-play acts out situations that replicate day and night.

A further discussion may be undertaken to replicate the motion of the Moon around Earth with respect to the Sun. One side of the Moon always faces Earth—this can be modelled by the student Moon always looking at the student Earth as it orbits Earth.

What arrangements of the Sun, the Moon and Earth give rise to a half moon, full moon and new moon?

Explanatory note: Does the Moon spin on its axis if one side of it always faces Earth? Yes it does; it completes one full turn every complete orbit of Earth. To understand this idea, act out being the Moon. As you revolve around the student Earth, look behind this student to the walls of the classroom. As you complete a full revolution you will have seen all four walls of the classroom once. One side of the Moon always faces Earth because the Moon has slightly more of its mass on its Earth-facing side than on its other side. The gravitational pull of Earth on the Moon is greater for the side with the heavier mass. If the Moon was balanced by having equal mass on both sides it would spin freely and we would get to see the other side of the Moon.

ACTIVITY: SOLAR SYSTEM

Key ideas: Earth rotates each day on it axis and revolves around the Sun each year. Then Moon revolves around Earth every month. Earth revolves around the Sun every year.

You will need:

- **a basketball**
- **a slightly smaller but still large ball (e.g. a soccer ball)**
- **a tennis ball.**

Using the materials provided, devise a demonstration of Earth, the Moon and the Sun with respect to each other for:

- **day and night**
- **one month**
- **one year.**

ACTIVITY: SIZE OF PLANETS AND THE SUN

Key idea: The planets of the solar system differ in size.

You will need:

- **butcher's paper**
- **cardboard**
- **scissors**
- **a compass.**

To get some idea of the true scale of the solar system, cut a circle 12 mm in diameter out of butcher's paper to represent Earth. Compared to this, how big is the Moon? How big is the Sun? (One is only 4 mm, while the other is 1.382 m in diameter.)

Cut out the other planets to this scale as well: Mercury (5 mm), Venus (12 mm), Mars (7 mm), Jupiter (139 mm), Saturn (115 mm), Uranus (51 mm), Neptune (50 mm) and Pluto (6 mm).

Lay the solar system down on the floor to get some idea of how the planets differ in size.

ACTIVITY: EARTH AND MOON SYSTEM

Teaching note: This activity is designed to test students' perceptions of the relative sizes of the Moon and Earth as well as their separation compared to their relative sizes.

Key idea: Earth is about fifty times the volume of the Moon and is thirty Earth diameters away.

You will need:

- **modelling clay (handful)**
- **a ruler**
- **a calculator.**

Take a handful of modelling clay and divide the clay into two spheres so that one approximates the size of Earth and the other the size of the Moon, so that both are in relative proportions to the actual Earth and the Moon.

In terms of actual volume, Earth is fifty times that of the Moon. Therefore, to approximate the relative sizes of Earth and the Moon, divide the handful of modelling clay into fifty equal parts. One part is used to form the Moon, while the other forty-nine parts are combined to form Earth. Compare this model with the initial attempt.

Now predict the ratio of Earth's diameter to that of the Moon, based on your observation of the models of Earth and the Moon. Based on the actual diameters (Moon 3500 km and Earth 12 800 km) the ratio is approximately 4:1 (or, more accurately, 3.7:1).

Using the models of Earth and the Moon (50:1 ratio), place them at a distance to represent the actual distance between Earth and the Moon. The actual distance is about thirty times Earth's diameter. Place the models at this distance and compare them with the estimated distance. Most students are amazed at the relative sizes of Earth and the Moon and their separation. The students should now appreciate that eclipses are rare events.

Where would the nearest planet (Venus) be in relation to the model formed? At its closest approach, Venus is about 3000 Earth distances away!

ACTIVITY: SOLAR SYSTEM DISTANCES

Key idea: The solar system is a big place of mostly space.

You will need:

- **a metre rule or tape measure**
- **a ball of string**
- **markers showing the names of the planets**
- **two or three rolls of toilet paper.**

Various models can be made to represent planetary distances and sizes. This activity suggests just a few.

Using the distances between the planets and the Sun in Astronomical Units (AU) (in the table below, 1 AU = distance from Earth to the Sun), produce a distance model where 1 m = 1 AU. Fix the end of the string in a suitable position and place the Sun marker over this position. Using the values in the table below, measure the distances of the planets from the Sun along the string. Mark the positions of each

planet. In this model the nearest star would be 260 km away (it is actually over forty million million km away).

Another model can be made out of units of toilet paper. On this scale one sheet of toilet paper = ten million km. Using the table below, mark the Sun and measure the distances from the Sun along the toilet paper. In this model one would require more than four million sheets of toilet paper—that is, 10 000 rolls!

planet	Sun distance (million km)	Sun distance (AU)	scale distance (m)	scale distance (sheets of toilet paper)
Mercury	57.9	0.40	0.4	6
Venus	108.2	0.70	0.7	11
Earth	149.6	1.00	1.0	15
Mars	227.9	1.50	1.5	23
Jupiter	778.3	5.20	5.2	78
Saturn	1 427.0	9.50	9.5	143
Uranus	2 869.6	19.20	19.2	287
Neptune	4 496.7	30.0	30.0	450
Pluto	5 899.0	39.50	39.5	590

ACTIVITY: SOLAR SYSTEM DISTANCES AND SIZES

Key idea: The solar system is a big place consisting mostly of space.

You will need:

- **two marbles**
- **two tennis balls**
- **a ping-pong ball**
- **a volleyball**
- **a basketball**
- **two baseballs**
- **a measuring tape**
- **aluminium foil.**

To determine how spread-out the solar system really is, cut a circle 5.5 cm in diameter out of silvery paper and stick the circle at the end of a corridor or hall. Take 475 steps away from this circle. This is how Earth looks from the Sun.

Use different types of balls to put this into perspective against the other planets. For example:

- **Mercury is a marble and 1 m from the Sun**
- **Venus is a tennis ball and 2 m from the Sun**
- **Earth is a tennis ball and 2.5 m from the Sun**
- **Mars is a ping-pong ball and 4 m from the Sun**
- **Jupiter is a basketball and 13 m from the Sun**

- **Saturn is a volleyball and 24 m from the Sun**
- **Uranus is a baseball and 50 m from the Sun**
- **Neptune is a baseball and 77 m from the Sun**
- **Pluto is a marble and 100 m from the Sun.**

ACTIVITY: LUNAR LANDINGS

Key idea: You will not reach the Moon if you point your rocket in a direction where the Moon is at the start of your journey.

You will need:

- **a bucket or wastepaper basket**
- **a metre rule or tape measure**
- **a globe of Earth**
- **a ping-pong ball.**

Place the globe of Earth on a table and spin it slowly with your hand. Earth spins 365 times in one year: this is why there are 365 days in a year. Pretend to be the Moon and walk around Earth by walking around the table with the globe on it: the Moon moves around Earth once every month. Now walk around like the Moon while you spin Earth—make sure you always face Earth. This gives you an idea of the movements of Earth and the Moon.

Using a ping-pong ball as a rocket, fire a 'rocket' and try to land it on the Moon by pretending you are Earth and another student holding the bucket is the Moon. Then ask the student holding the bucket (the Moon) to move 3 m away from you (Earth). Have ten tries to land the ball (rocket) in the bucket. Count the number of times the rocket lands safely on the Moon.

Try to do this another ten times, but this time the Moon must move *slowly* around you as you throw (remember to keep a distance of 3 m at all times). Count the number of safe landings.

To make it a little more real, try again while the Moon is moving and you are spinning around on the spot. (Don't forget that distance of 3 m.) Again, count the number of safe landings.

ACTIVITY: SPACE TRAVEL AND LIVING IN SPACE

Key idea: Space travel and living in space are very difficult.

What do astronauts need to keep them alive in space? How does a spacecraft escape Earth's gravity? There is a limit to the weight that the spacecraft and its contents can have in order for it to escape Earth's gravity. Each astronaut can take one item of personal value. What would you take?

ACTIVITY: RESEARCH STATION ON THE MOON

Key idea: Space travel and living in space are very difficult.

Imagine you are chosen to form a team to establish a research station on the Moon. Plan your mission. Address these questions to get started:

a) **The following people have applied to go: astrophysicist, doctor, minister of religion, nursing aid, teacher, butcher, student of geology, wise woman, politician, comedian. Only five can fit in the spacecraft. Who will you choose and why?**

b) **What materials would you use for the astronauts' clothing and to construct the space station? Which properties will make them most useful?**

c) The Moon's atmosphere is inhospitable. How will you create an environment to meet the astronauts' needs?

ACTIVITY: TIMELINES

Key idea: Space travel has been undertaken by humankind for around fifty years.

Explore past, present and future events significant to you on a time line. For example:

- **when you were born**
- **your next birthday**
- **when you will finish formal education**
- **when you expect to retire.**

Include significant events in space exploration as listed below (add to the list important milestones in space travel since 1989).

1957 ***Sputnik 1*, first artificial satellite, successfully launched by Russia**

1961 **first person (Yuri Gagarin, Russian cosmonaut) orbits Earth**

1964 ***Mariner 4* sends the first pictures of the cratered, moon-like surface of Mars**

1969 **first person (Neil Armstrong) steps on the moon**

1971 ***Pioneer 10* sends close-up pictures of the Great Red Spot of Jupiter**

1973 ***Mariner 10* has first multiple planet encounter, sending full-disc pictures of Venus; *Mercury Pioneer II* sends pictures of Jupiter's polar regions before travelling on to photograph Saturn**

1977 ***Voyager 1* films time-lapse movie of volcanic action on one of Jupiter's moons**

1981 ***Voyager 2* discovers five new satellites around Saturn**

1986 ***Voyager 2* has first encounter with Uranus, recording ten new moons, two new rings and a tilted magnetic field**

1989 ***Voyager 2* encounters Neptune.**

ACTIVITY: CONSTELLATIONS

Key idea: A constellation is a group of stars in the same region in the sky when viewed from Earth.

You will need:

- **aluminium foil**
- **black cardboard**
- **coloured textas or pencils**
- **star charts**
- **glue or sticky tape**
- **white chalk, pencil or crayon.**

Ancient civilisations such as the Egyptians and Greeks divided the sky into regions containing distinct groups of stars. These groups, called 'constellations', were given names, and stories were attached to them, perhaps to aid in remembering them.

Research a particular constellation for its graphic interpretation and mythology. Contrast the interpretations of the constellations held by different civilisations.

From star charts, select the prominent stars within a constellation and construct your own graphic interpretation. Make up a story to match the graphic interpretation.

Make models of constellations with black cardboard, aluminium foil and white pencil, chalk or crayon. Select a constellation and make 3-D stars out of foil by rolling pieces into spheres; ensure that the brighter stars are larger than the less bright. Stick the stars to the cardboard and label them with the name of the constellation. With a white pencil, chalk or crayon, draw lines joining the stars so that the constellations can be more easily identified.

Explanatory note: While the constellations are defined as groups of stars close to each other, this is only when viewing from Earth. The individual stars within a constellation may be quite large distances apart from each other.

The zodiacal constellations (Libra, Cancer, Taurus, etc.) are located in a band in the sky that encircles Earth. Throughout the year the Sun passes in front of each constellation. In astrology the zodiacal constellations have specific dates in the year. These dates match periods of time when the Sun will be directly in front of the constellation. This means that you will not be able to go out at night on your birthday to see your birth sign in the stars overhead (you will have to wait six months before this can happen!).

ACTIVITY: FINDING NORTH

Key idea: Shadows from the Sun are shortest when the Sun is at its highest point in the sky. The shortest shadow will line up in a north–south direction.

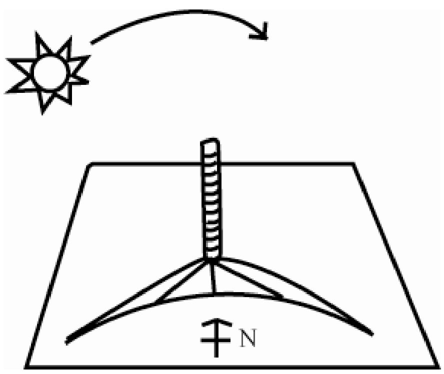
You will need:

- **a straight rod about 50 cm long, connected to a base to hold it vertically on a flat area of horizontal ground (concrete or bitumen)**
- **chalk.**

From Victorian latitudes the Sun is always in a northerly direction to the observer. Even the midsummer Sun is never directly overhead but in a northerly direction. This phenomenon allows us to determine 'true north' by observing shadows formed by the Sun.

Place a straight rod vertically on a flat area of horizontal ground (concrete or bitumen). When the Sun is at its highest point in the sky it will create the shortest shadow from a vertical stick placed in the ground.

Around midday (12 midday on non–daylight saving time days and 10 pm on daylight saving time days), mark the shadow end-points regularly over, say, a two-hour period. Draw a smooth curve through the shadow end-points to determine the closest point to the rod. Then draw a line from this closest point to the rod. This will be the north–south line. This method only works if over the observation period the shadows get shorter and then get longer. Refer to the figure opposite.



Using this approach, how can you work out south, east and west directions?

ACTIVITY: ORBITING SATELLITES

Key idea: Satellites orbit because of a gravitational pull to the central body, and a sideways speed.

You will need:

- **two paperclips**
- **1 m of fishing line**
- **a handful of plasticine**
- **a large cotton reel.**

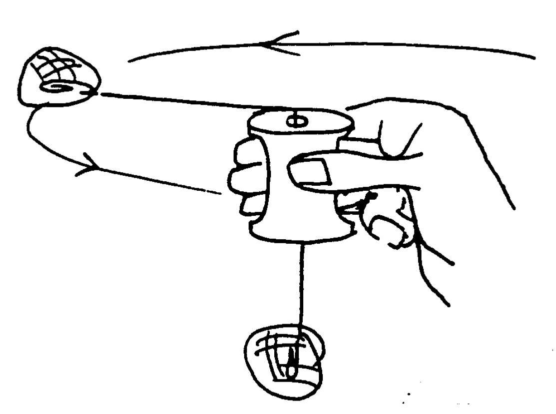
Explanatory note: The natural satellites of the solar system are the planets and their moons. The planets are the satellites of the Sun and, likewise, the Moons are the satellites of the planets. Earth has many artificial satellites, some only a few hundred kilometres from the surface of Earth and others as much as 50 000 km away.

Each satellite orbits the central body because of two factors: a gravitational pull and a sideways speed. If the satellite didn’t have a sideways speed it would fall into the central body. Alternatively, if the satellite had a sideways speed that increased it would move into a larger orbit; if the speed decreased the satellite would move into a smaller orbit. This activity demonstrates these points.

Slip the fishing line through the cotton reel and tie a paperclip to each end.

Stick a lump of plasticine around each paperclip (twisting the paperclips will create a better grip for the plasticine).

Make one of the lumps of plasticine about four times as large as the other.



Hold the cotton reel with the smaller lump of plasticine on top and spin the top lump around.

Swing the top lump of plasticine in a circle at a speed so that the top lump moves in a circle without you having to hold onto the lower lump (see figure above).

This activity shows that all that is needed to keep the top lump of plasticine in circular motion is to give it a sideways speed and pull it to the centre of its circular motion—just like satellites.