YEAR 5
SOLAR SYSTEM

Australian Curriculum Earth Science activities

with links to other subjects.

PALMS
PRIMARY AUSTRALIAN LITERACY MATHEMATICS AND SCIENCE

Santos & ESWA supporting earth science education

EARTH SCIENCE WESTERN AUSTRALIA

Santos

YEAR 5 - TEACHER INTRODUCTION

The Primary Australian Literacy Mathematics & Science (PALMS) Program aims to enrich and support the teaching of earth science from Kindergarten to Year 5 across Australia. This will be achieved by providing, within the mandated Earth and Space Science curriculum, hands-on activities integrating aspects of Chemical Sciences, Physical Sciences and Biological Sciences as well as relevant components of English, Mathematics and other subjects into teaching packages.
These teaching packages will be made available at www.palms.edu.au.

Solar System

*Activities marked **PPP** (PALMS PARENT POWER) are ones you may wish to send home with the students to do with their parents or by themselves. They replay the concepts recently covered in Science. Studies demonstrate that if a student describes what they have learned to another, they deepen their own understanding and retain it longer.*

Topic No.	Topic	Activities	Student worksheet	Subjects	Page No.
1	Formation of the Universe	Expanding Universe		Science	1
		Static Electricity	X	Science	3 + 8
		Gravity	X	Science	12 + 17
		Planet Shape	X	Science & Maths	21 + 24
		We are Star Stuff		Science & English	27
2	Meet the Neighbours	Names of the Planets	X	Science & English	29 + 32

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YEAR 5 - TEACHER INTRODUCTION

Topic No.	Topic	Activities	Student worksheet	Subjects	Page No.
2	Meet the Neighbours	My Planet Rules!	X	Science	33 + 36
		The Problem with Pluto	X	Science	38 + 41
		The First Martian?	X	STEM awareness	45 + 50
3	Do the Math!	Copernican Revolution	X	STEM awareness	56 + 63
		Orbit Shapes and AU		Maths & Science	67
		Patterns in the Sky	X	Maths & Science	72 + 75
		Toilet Paper Scale	X	Science & Maths	77 + 83
4	Energy from the Sun	Energy for Planets	X	Science & HASS	88 + 94
		Heat and Yeast	X	Science	101 + 108
		Magnetosphere	X	Science	114 + 120
5	Critical Thinking	Planets and Beliefs	X	Science & HASS	125 + 128
		Making Your Mark	X	Science	131 + 133
		We Know Where Your Live	X	Science HASS	135 + 139
6	PPP	Finding Your Way	X	Science & HASS	144

YEAR 5 - TEACHER INTRODUCTION

Australian Curriculum (WA) - Earth and Space Sciences
The Earth is part of a system of planets orbiting around a star (the sun) (ACSSU978)

Major concepts also included:

Science

- Science involves testing predictions by gathering data and using evidence to develop explanation of events and phenomena and reflects historical and cultural contributions.
- Scientific knowledge is used to solve problems and inform personal and community decisions.
- Decide variables to be changed and measured in fair test, and observe measure and record data with accuracy using digital technologies as appropriate.
- Reflect on and suggest improvements to scientific investigations.

Mathematics

- Solve problems involving multiplication of large numbers by one- or two-digit numbers using efficient mental, written strategies and appropriate digital technologies.
- Construct displays, including column graphs, dot plots and tables, appropriate for data type, with and without the use of digital technologies.

English

- Understand that patterns of language interaction vary across social contexts and types of texts and that the help to signal social roles and relationships
- Present a point of view about particular literary texts using appropriate metalanguage, and reflecting on the viewpoints of others.

HASS

- Locate and collect information and/or data from a range of appropriate primary resources and secondary sources

Expanding Universe - Teacher's Notes

The Beginning of the Universe

According to the ***Big Bang Theory***, (the scientific theory, not the TV show) about 13.7 billion years ago an explosion blew a hot plasma away from a single point to fill Space. In the first moments it was too hot to form atoms but it released light. As it cooled the hydrogen from which all matter was formed appeared as atoms. The Universe began to assemble.

Light released back then is still travelling though our Universe now. Astronomers call it cosmic microwave radiation. Using an optical microscope, the astronomer Edwin Hubble measured how much light was being stretched as galaxies moved away from the origin. When white light

is stretched or travels through a medium it separates out into its different wavelengths or colours. The longer it travels or the denser the medium it travels through, the more the light separates into its different colours. This is known as "red shift". From Hubble's calculations the beginning of the Universe was estimated as 13.7 billion years ago.

Using a radio telescope, Goddard Space Flight Centre scientists in 2003 looked at maps of background microwave radiation and noticed patterns that mark the beginning, and have since estimated that it took a further 200 million years before the first stars began to shine.
We can estimate that our Solar System was formed about 5 billion years ago by measuring the age of meteorites by radioactive decay. Planet Earth became solid about 4.56 billion years ago, but the oldest rocks we can measure are only around 3.8 billion years old. Early Earth was bombarded

by asteroids and meteors melting the surface many times. Some minerals, such as the zircons found in rocks near Jack Hills in WA can be dated back to 4.2 billion years old.

Expanding Universe – Teacher Demonstration

The expansion of a Universe with unchanging mass/matter can be illustrated if the teacher makes many little dots on the surface of a deflated balloon with a permanent marker and then inflates it. The same amount of matter is still there. The dots in the expanded universe are just further apart and fill a greater space.

Before **After**

Scientists are still measuring the movement of stars today and they all still appear to be moving away from that same point. Indeed some estimate that rather than their movement slowing, it is actually speeding up.
It is from these original dispersed hydrogen atoms that the galaxies, solar systems, stars, planets, moons and other space debris that we have now were created. Most of Space however is still empty space and the most common element in the Universe is still hydrogen.

Static Electricity - Teacher's Notes

Forces which formed our Solar System

There are four forces that cause change in the Universe. Strong nuclear forces (which hold the nuclei of atoms together), weak nuclear forces (which cause radioactive decay), electromagnetic forces (which cause materials to be attracted and repelled from each other) and gravitational forces (which pull a less massive object towards a more massive object). The first pair of forces only act across minuscule distances. The effects of the second pair can be seen to act across the Universe and affect our everyday lives. If we are sitting on a stool, we can feel gravity pulling us down but the electromagnetic forces acting between the atoms in our chair stops us being pulled through the chair onto the ground.

In short:

A force is a push or a pull which can affect objects.

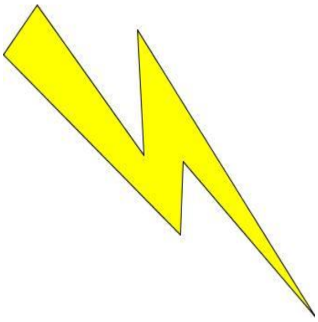
1. ***Both magnetic (or static fields) and gravity are forces which act at a distance.***
2. ***Gravity is a very weak force which acts over immense distances and is a force of attraction.***
3. ***Static electrical fields are strong forces but only act over very short distances and can be a force of attraction or repulsion.***

Static electricity is the first weak force that pulled parts of the Universe together. It was the first force to assemble our Solar System.

Static Electricity

If two objects are rubbed together and if the outer electrons in their atoms are not strongly bound to their nuclei, electrons can be transferred within the objects and from one to the other. The objects or parts gaining electrons develop a negatively charged field and those losing electrons develop a positively charged field. These fields are similar to magnetic fields and can cause the objects to be pulled together or to move apart.

The charge between them is called static electricity. It differs from current electricity that we get from the domestic electricity supply because it does not flow easily but discharges in single dramatic events like the discharge caused by lightning.



The blue flash and crackle you may have noticed when removing clothing in the dark is caused by static discharge. Similarly lightning is the result of static discharge. Dry skin tends to give up electrons and polyester clothing tends to gain electrons. When you move they cling together. When, however, the polyester clothing is dragged away the electrons discharge back to the skin with a flash of light and a crackle.

Students are probably also aware that if they don't clean their bedrooms, wind from doorways or fans will blow dust under their beds. Dust and hair particles will rub together to make dust "bugs" or "mice".

Six Experiments or Demonstrations

Materials per group

- 1 balloon inflated and tied off
- A generous student with a good head of fine hair or a woolen scarf or a dry microfiber cloth
- A clean plastic comb
- Smooth wall or roof
- A pile of small pieces of paper
- Chads from a hole punch or a finely shredded tissue
- An aluminium cool drink can

Method

A. Balloon and wall or ceiling

1. Rub the inflated balloon vigorously on hair or a scarf or a microfibre cloth to "charge" it.
2. Place it firmly against the wall or ceiling. If it does not stick, repeat.
3. Record observations.

B. Balloon and shredded paper

1. Rub the inflated balloon vigorously on hair or a scarf or a microfibre cloth to "charge" it.
2. Hold the balloon a short distance above the shredded paper.
3. Record observations.

C. Balloon and hair

1. Rub the inflated balloon vigorously on hair or a scarf or a microfibre cloth to "charge" it.
2. Hold it above the head of another student with fine hair.
3. Record observations.

Static Electricity - Teacher's Notes

D. Balloon and fine stream of water

1. Rub the inflated balloon vigorously on hair or a scarf or a microfibre cloth to "charge" it.
2. If you have a goose necked tap, let a very fine stream of water run and approach it from the side with the charged balloon. Note: If the balloon is touched by the water it will instantly lose all its charge. It must be rubbed again to pick up a new charge
3. Record observations.

E. Comb, hair and shredded paper or chads

1. Vigorously comb hair to charge the comb.
2. Hold the comb just above the shredded paper.
3. Record observations.

F. Comb and aluminium can

1. Vigorously comb hair to charge the comb.
2. Approach the can laid on its side. Note: If the comb and can touch repeat combing to recharge it.
3. Record observations.

<u>Teacher Notes</u>

Static electricity completely loses its charge at once. The charged object will not hold any charge until it is recharged.

Balloon and wool	The balloon collects electrons and gains a negative charge.
Comb and hair	Comb collects electrons from hair. Each strand of hair now has a positive charge and is forced away from other strands since like charges repel. People, cats and dogs can suffer from "fly away hair" after brushing.
Sparks or "boots"	If you brush your hair in the dark, once a few electrons

scraped off the outer hair strands move across to the comb they create heat which expands the air and makes it glow.

Sitting on a car seat and moving about can build up quite a static charge. Metal conducts electricity, so that when you touch the metal body of the car you can get an electrical discharge or "boot".

Students living in dry desert areas will know that shoes rubbing as they walk across a carpet is sufficient friction to cause a static charge to build up. Touching a metal door handle releases the charge and the "boot".

Static charges began clumping together dust and gas in the early Universe. When hydrogen atoms spread outwards after the "Big Bang" they rubbed together, built up a static charge and started to form larger clumps of matter and gas.

"From little things big things grow" Paul Kelly

PALMS
PRIMARY AUSTRALIAN LITERACY MATHEMATICS AND SCIENCE

Name ___________________________

Static Electricity - Student Worksheet

If two objects are rubbed together and if the outer electrons in their atoms are not strongly bound to their nuclei, electrons can be transferred within the objects and from one to the other. The objects or parts gaining electrons become develop a negative field and those losing electrons develop a positively charged field. These fields are similar to magnetic fields and can cause the objects to be pulled together or to move apart. This could happen if you repeatedly brush or comb your hair and it stands on end.

Please Note: *Static electricity is not like domestic electricity. It completely discharges all at once. The charged balloon needs to be recharged every single time.*

Materials per group

- 1 balloon inflated and tied off
- A generous student with a good head of fine hair or a woolen scarf or a dry microfiber cloth
- A clean plastic comb
- Smooth wall or roof
- A pile of small pieces of paper
- Chads from a hole punch or a finely shredded tissue
- An aluminium cool drink can

Name ___________________________

Static Electricity - Student Worksheet

Method

A. Balloon and wall or ceiling

1. Rub the inflated balloon vigorously on hair or a scarf or a microfibre cloth to “charge” it.
2. Place it firmly against the wall or ceiling. If it does not stick, repeat.

Observations

B. Balloon and shredded paper

1. Rub the inflated balloon vigorously on hair or a scarf or a microfibre cloth to “charge” it.
2. Hold the balloon a short distance above the shredded paper.

Observations

Name ___________________________

Static Electricity - Student Worksheet

C. Balloon and hair

1. Rub the inflated balloon vigorously on hair or a scarf or a microfibre cloth to "charge" it.
2. Hold it above the head of another student with fine hair.

Observations

D. Balloon and fine stream of water

1. Rub the inflated balloon vigorously on hair or a scarf or a microfibre cloth to "charge" it.
2. If you have a goose necked tap, let a very fine stream of water run and approach it from the side with the charged balloon. Note: If the balloon is touched by the water it will instantly lose all its charge. It must be rubbed again to pick up a new charge

Observations

Name ____________________________

Static Electricity - Student Worksheet

E. Comb, hair and shredded paper or chads

1. Vigorously comb hair to charge the comb.
2. Hold the comb just above the shredded paper.

Observations

F. Comb and aluminium can

1. Vigorously comb hair to charge the comb.
2. Approach the can laid on its side. Note: If the comb and can touch repeat combing to recharge it.

Observations

Gravity - Teacher's Notes

Gravity – the second weak force that built the Universe.

Gravity is "the glue that binds the Universe together". It is weak but acts across great distances.
What was the first force that started pulling matter together? **Static electricity**

As the clumps of nebula dust held together by static electricity increased in mass, they would also have been attracted together by the much stronger force of gravity. The more mass a body has, the greater is its gravitational pull. Matter moved to the center of the disc and crashed together to become our massive Sun. Over 99% of all the matter in our Solar System is within the Sun. The planets, moons, Asteroid Belt and other objects became assembled from what was left over. It was held in place by the gravitational pull of the Sun and nearby planets.

"Honestly Miss, It is gravity that pulls us together"

Student may realise that each one of their bodies has a gravitational pull on the others. Their bodies have so little mass however that the attractive pull is negligible!

Gravity - Teacher's Notes

Note

The ***mass*** of a body is the amount of matter or atoms it contains. The weight of an object however is the mass multiplied by the force of gravity where it is being measured. Your body is made of a certain amount of matter. This is its mass. If you ***weighed*** yourself on Earth and then moved to the Moon you would find that you weighed more on Earth. This is because the Earth is much more massive than the Moon and has a stronger gravitational pull.

The mass of a body causes the space and time around it to bend and curve.

Gravity and weight on other planets

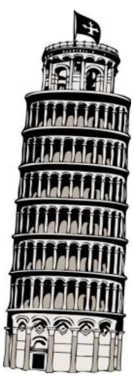
Students might like to visit this site and note that although their body has a constant mass, their weight varies from planet to planet because of the different gravitational pull that each planet has.

http://www.schoolsobservatory.org.uk/discover/activities/weight_on_planets

Someone who weighs 35kg on Earth is: 9.8kg on Mercury, 31.9kg on Venus, 13.3kg on Mars, a whopping 81.9kg on Jupiter, 32.6kg on Saturn, 27.7kg on Uranus and 39.2kg on Neptune.

NOTE: Some students are very wary about declaring their weight in public. They may wish to use 35kg as the weight of an average year 5 student.

A brief history of Gravity Theory

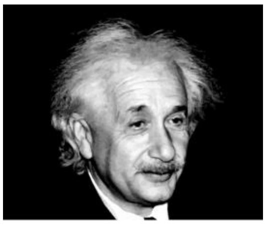


Gravity gets its name from the ancient Roman virtue of "gravitas". Which referred to the capacity to cope with heavy or solemn ideas. A good citizen treated all things with due gravitas.

Gravity – Teacher's Notes

Legend has it that ***Galileo Galilei*** (1564-1642) first recognized the force of gravity when dropping balls from the Leaning Tower of Pisa. This is incorrect. He first considered this universal force when watching hailstones of different sizes fall at the same speed during a thunderstorm. If students visit the Gravity Discovery Centre at Gingin they can copy Galileo's experiments.

"What goes up must come down"
Isaac Newton (1643-1727) was the first modern scientist who tried to work out the laws of gravity. His statements relied on observation and measurement. It is said that he first noticed this Universal force when an apple fell on his head from the tree he was sitting under. He realised that objects must attract each other and that explained why the Moon stays orbiting the Earth. Although gravity is weak, its pull can act over enormous distances.
He worked out that the force of gravity is inversely proportional to the distance of a planet to the Sun. His laws remained useful for almost 300 years.



Albert Einstein (1879-1955) said in 1905 that mass distorted the space-time continuum.
"Matter tells space how to curve and space tells matter how to move."

Gravity and Orbit – Teacher Demonstration

Space tells matter how to move
A massive object produces a dip in the space-time continuum. Objects with less mass are pulled down

towards the more massive one. Massive objects, like the Sun, attract less massive objects such as planets, comets and asteroids towards it. Their movement energy will allow them to orbit the Sun for a while but in time they will be drawn closer and closer by gravitational force until they crash into it. This activity is also available at the Gravity Discovery in Gingin.
More information at: http://gravitycentre.com.au

The plastic sheet representing the space-time continuum is undistorted until mass is added. The heavy weight/mass in the center represents a massive sun and the lighter mass spinning round it a planet. The larger the stretched circular surface is, the better the demonstration will be. Plastic stretched over a hula hoop is excellent.

Lead weight placed in center

Marble spun round center in an ellipse

Materials

- Large sheet of plastic uniformly stretched over a circular container. Garbage bags can be cut into single sheets.
- A rubbish bin or hula hoop.
- Tape or elastic
- A massive/heavy round or spherical object such as a lead fishing weight or metal nut (nuts & bolts).
- A very much lighter/less massive spherical object such as a marble

or pea.

Method

1. Wrap the single plastic sheet tightly over the bin or hoop and fix in place with tape or elastic
2. Place the lead weight or nut in the centre of the plastic and ask students to observe any changes. The weight made the centre of the plastic sheet depress. Mass changed the surface.
3. Flick the less massive ball round the inner edge of the plastic sheet. *This may need some practice as too much force will just send it over the edge.* The ball spun round the large central mass in an elliptical orbit but was soon pulled down to the central massive body. *Gravity pulls the less massive pieces towards the more massive ones.*
4. Gently flick the marble across the depressed plastic sheet. Observe the pattern of its movement around the center. The marble moved in an elliptical orbit, not a concentric circle. *Planets also move in elliptical orbits round the Sun.*

Name ____________________________

Gravity - Student Worksheet

Gravity is "the glue that binds the Universe together". It is weak but acts across great distances.

What was the first force that started pulling matter together?

____

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"Honestly Miss, It is gravity that pulls us together"

Name ____________________________

Gravity - Student Worksheet

Your weight is your mass and the gravitational pull of the planet or moon you are standing on. If you ***weighed*** yourself on Earth and then moved to the Moon you would find that you weighed more on Earth. This is because the Earth is much more massive than the Moon and has a stronger gravitational pull.

Gravity and weight on other planets

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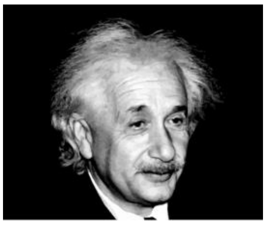

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Gravity and Orbit – Teacher Demonstration

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Name ____________________________

Gravity - Student Worksheet

gravitational force until they crash into it.

Observations

What effect did placing the heavy object in the center of the plastic have?

____

____

What effect did flicking the marble around the inside edge of the plastic sheet have?

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Describe the orbit of the marble

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Planet Shape- Teacher's Notes

How planets and other objects in the Solar System get their shape

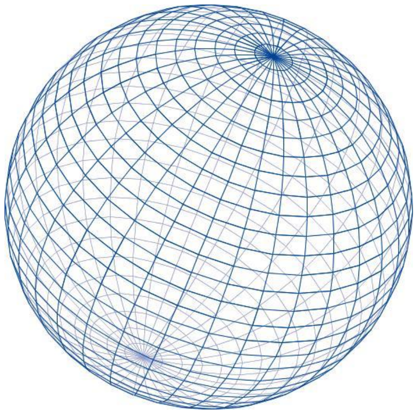
Both stars and planets appear round or more correctly spheroidal. They spin or rotate in the same direction as the original dust cloud from which they formed.
Why can't we say that the Earth is round? The Earth has three dimensions and so must be described in all three. "Round" only describes a two dimensional shape.

Note

You may remember how in Year Three we noticed if a ship was sailing towards you from over the horizon only the topmost parts will appear at first but gradually as it gets closer more of the lower parts of the ship become visible.

Moons, asteroids and some dwarf planets can be very unevenly shaped. Massive bodies are so "heavy" that gravity pulls all material close to the center of the spinning mass. ANU (Australian National University) astronomers have calculated that the borderline between taking a spherical shape and an irregular shape is a diameter of 600 km. If the body is solid rock (such as asteroids inhabiting the Asteroid Belt between Mars and Jupiter) gravity will eventually pull it into a spherical shape. In detail the surface may have mountains, and valleys but in general it is spherical. If the object is made of frozen gas, such as some planet's moons or comets from the outer edges of our solar system, they are easier to compress and will still remain spherical until they are less than 600km across.
Because the rock keeps spinning however, over time it takes on a slightly flattened shape known as an oblate spheroid.

Planet Shape- Teacher's Notes



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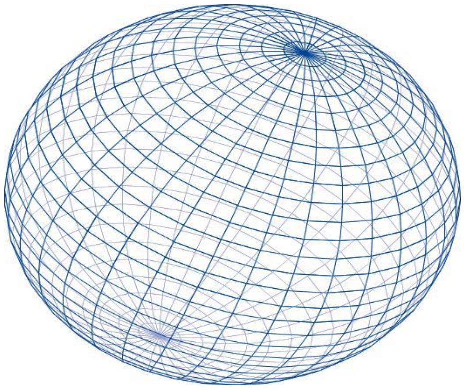

Oblate spheroid

Our Earth is a slightly flattened sphere. The distance from Earth's centre to the Equator is 6,378km whereas the distance from its poles to the Equator is 6,357km. 21km makes all the difference.

What shape are these heavenly bodies?

Materials

- Access to the Internet or astronomy books

Method

Collect data on these objects in our solar system, then decide what shape they are liable to be.

Name	Made of	Location	Diameter (km)	Shape
Ida	Rock	Asteroid Belt	58	Uneven & elongated like a potato
Mercury	Rock	Planet closest to Sun	4,879	Sphere

Planet Shape- Teacher's Notes

Name	Made of	Location	Diameter (km)	Shape
Ceres	Rock	Asteroid Belt	940	Oblate spheroid
Halley's comet	Frozen gas and dust	Orbits Earth every 17,000 years	16 X 8	Elongate
Uranus	Gas Giant	Second furthest out planet	51,118	Sphere

Name ____________________________

Planet Shape - Student Worksheet

How planets and other objects in the Solar System get their shape

Both stars and planets appear round or more correctly spheroidal. They spin or rotate in the same direction as the original dust cloud from which they formed. Why can't we say that the Earth is round?

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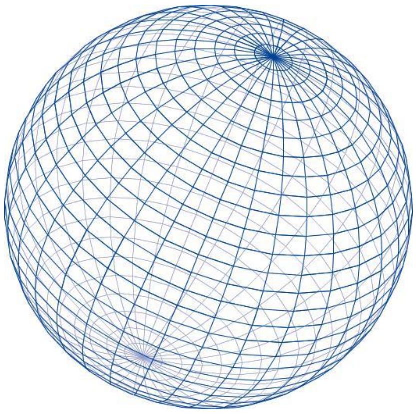
Planet Shape - Student Worksheet



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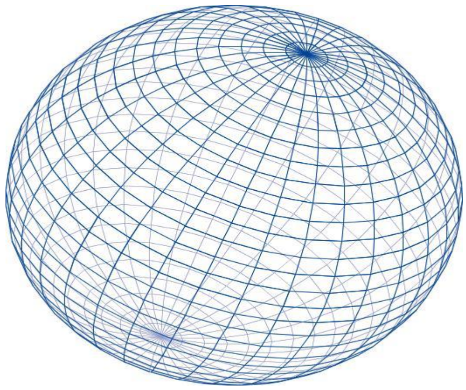

Oblate spheroid

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Name	Made of	Location	Diameter (km)	Shape
Ida				
Mercury				

Name ____________________________

Planet Shape - Student Worksheet

Name	Made of	Location	Diameter (km)	Shape
Ceres				
Halley's comet				
Uranus				

PALMS
PRIMARY AUSTRALIAN LITERACY MATHEMATICS AND SCIENCE

We are Star Stuff - Teacher's Notes

The quote "We are all star stuff" was made famous by the astronomer Carl Sagan although it had been used earlier. It became popular with the "Hippie" movement after Joni Mitchell wrote a song with the same title in 1969. It became a massive hit around the world.

We are star dust
Billion year old carbon
Caught in the Devil's bargain
And we've got to get ourselves back to the garden.

Our bodies are the product of the food we ingest. Our food gets its nutrients from our planet's rocks. We are made of atoms sourced from the nebulaic explosion of at least one star more than 5 billion years ago. That star got its atoms after a previous star exploded … and so on over billions of years

A short (2m 41s) clip of Carl Sagan can be viewed on You tube at: https://www.youtube.com/watch?v=tLPkpBN6bEI

Students may wish to create a poem, song or graphic using the scientific information we have on how the Solar System, Earth and ourselves are all made of the same "stuff".

Before Earth began a star exploded.
Its debris spread out across the Universe.
Clumped by static and pulled by gravity the fragments grew to form our solar system and our own planet.
Our bodies are made from this star.
We are all star stuff.

Some Suggestions of Books and Videos for Teachers

Great science books with humour:

1. Out of this world (All the cool bits about space)
   Buster Books ISBN:978-1-907151-94-1
2. Horrible Science
   The Horrible History Group
3. Space Stars and Slimy Aliens
   Hippo Books Scholastic ISBN 0-97866-1
4. The Journal by Anke den Duyn
   An adventure story with SKA information.

Videos

How to build a planet-
James May
The Wonders Collection BBC-
Brian Cox
The Universe-
Brian Cox

Names of the Planets – Teacher's Notes

An excellent introduction to this topic would be Brian Cox's video produced by the BBC on the planets.

Our own solar system, the Milky Way, is only one of millions in our galaxy. There are billions of galaxies that make up the Universe. Although our Solar System came into being about 5 billion years ago, it had already taken billions of years to develop. It is centered on our sun whose immense mass creates gravity that binds matter together. It is called a system because everything in it is affected by everything else.

The Sun – Our Star

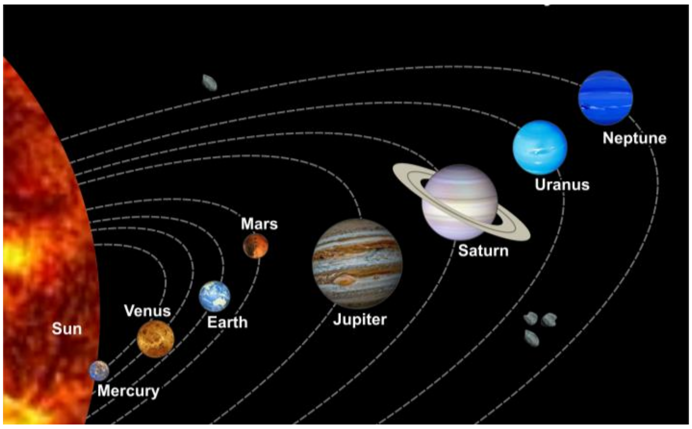
Our sun contains 99.9% of all the mass (matter) in our solar system. That means that all the planets, moons, asteroids and comets are made from the remaining 0.4%. It is a huge thermo-nuclear reactor that smashes together hydrogen atoms to create the gas helium, and a little light and heat as a byproduct (Helios is the ancient Greek name for the Sun).

The solar wind that emanates from the Sun "blows" cosmic radiation and photons (light) across our solar system. At the outer edge of the solar system lies the heliopause. Here the Sun's radiation or the "solar wind" is no longer active against cosmic ions and particles from deep space.
There is a lot of space between the planets of the solar system. Only stars produce their own energy, planets and moons reflect light from the Sun.

The Planets

Orbiting round our Sun are four rocky or terrestrial planets, a belt of fragments called asteroids and then four outer gas planets. The planets are named by the ancient Greek words "planetes" which means wanderers. Early astronomers noticed that although stars seem to follow fixed tracks across the sky as the year progresses the planets do not. Sometimes their tracks seem to double back on their tracks.

Remembering the Names of the Planets



Early astronomers had to rely on their eyesight to recognise and describe planets. By medieval times they had already seen and named Mercury, Venus, Mars, Jupiter and Saturn. Good telescopes and mathematics helped later astronomers to find Uranus (1781) and Neptune (1846) and to also find rings, moons, dwarf planets, asteroids and comets. Mathematicians had already predicted where to find Neptune and the dwarf planet Pluto (1930) long before they were seen through a telescope.

A mnemonic is a short phrase that reminds you of something important. When you were trying to learn the colours of the rainbow (Red, Orange, Green, Blue, Indigo and violet) you may have memorised phrases like "ROY G BIV" or "Richard of York gained battles in vain" because they contain the first letters of the colours you have to remember in the correct sequence.

Names of the Planets - Teacher's Notes

Ask students to create a phrase that uses the first letters of the planets in the correct sequence. They could then share their phrase with other members of the class.

Mercury **V**enus **E**arth **M**ars **J**upiter **S**aturn **U**ranus **N**eptune

M____

V____

E____

M____

J____

S____

U____

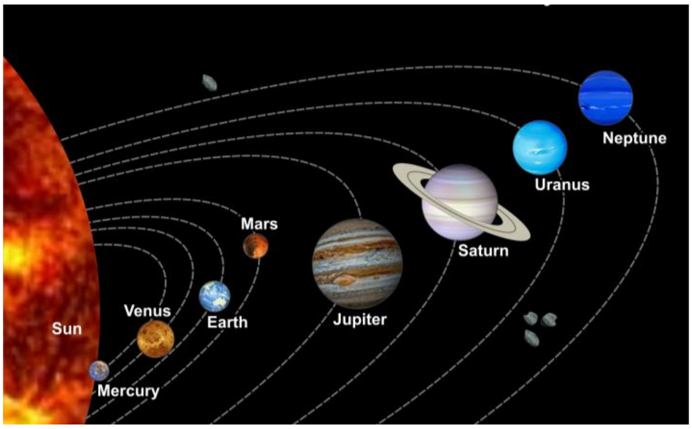
N____

Some examples:
My **V**ery **E**ducated **M**other **J**ust **S**erved **U**s **N**oodles
My **V**ery **E**xcited **M**onkey **J**ust **S**erved **U**s **N**uts

If the weather is good, students can walk round the oval chanting their mnemonic to develop a kinesthetic memory as well.

Name ___________________________

Names of the Planets - Student Worksheet



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A mnemonic is a short phrase that reminds you of something important. Work out a short phrase in which each word starts with the same letter as a planet, in order by distance from the Sun.

Mercury **V**enus **E**arth **M**ars **J**upiter **S**aturn **U**ranus **N**eptune.

M________ V________ E________ M________

J________ S________ U________ N________

PALMS
PRIMARY AUSTRALIAN LITERACY MATHEMATICS AND SCIENCE

My Planet Rules! – Teacher's Notes

M  R

"My Kitchen Rules "is an Australian TV competitive cooking program where teams of two contestants vie for superiority in cooking special dishes. Their efforts are judged by two experts and there is also "Peoples' Choice" input from the audience.
The activity below is inspired by this format.

Materials per student pair

1. The worksheet
2. Access to information, posters, the Internet and/or boxes of books.

Method

1. Student pairs are given or select one planet from the four rocky planets and one from the four gas planets that circle our Sun.
2. They then research the diameter, average distance from the Sun, ingredients (things the planet is made up of) and special features for each – filling in the data sheet provided.
3. They should then turn their attention to convincing their classmates that their planets have the Wow Factor!

ASIDE: You may wish to have a short discussion on whether the Asteroid Belt should be included as a proto-planet which never had enough mass to create the gravity necessary to create a fifth rocky planet.

My Planet Rules! - Teacher's Notes

To support this activity the following might be discussed as a class.

Name the four innermost rocky planets and the four outermost gas planets?

Innermost rocky planets	Mercury, Venus, Earth and Mars
Outermost gas planets	Jupiter, Uranus, Saturn and Neptune

What ingredients would you need to create our Solar System?
Every planet needs

1. The Sun. Why? The gravitational pull from the Sun holds it in position. The Sun also provides energy in the form of heat, light and other electromagnetic radiation. Planets do not create their own energy.
2. Other planets near it. Why? Their gravitational pull also holds it in position.
3. A moon or moons. Why? Moons help their planets from developing wobbly rotations because gas lags behind solid. Before Earth had its Moon it wobbled creating great heat and terrible winds. The surface was molten. The arrival of the asteroid impact that remelted our surface and created our moon meant Earth's rotation stabilised, the surface solidified and life could begin.
4. An orbit which takes it round the Sun

My Planet Rules! - Teacher's Notes

Ingredients to Build a Planet

Gases such as:

Ammonia, Argon, Carbon dioxide, Helium, Hydrogen, Hydrogen cyanide, Neon, Nitrogen, Oxygen and Steam or water vapour.

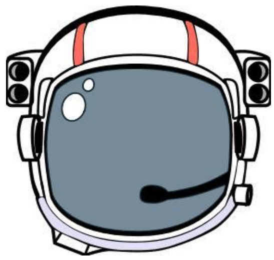
Liquids such as:

Sulphuric acid, Ammonia,Water

Solids which make up rocks and dust such as:

Aluminium, Gold, Iron, Magnesium, Nickel, Sodium, Silicon, Ice

Of course each planet is different so you will not use all of these ingredients and indeed may have to add some extra yourself.



Wow Factor – People's Choice Input

Each planet is unique. What is especially interesting about your planet?

Student answers will vary

Student's worksheets can be boarded to provide reference material for the rest of the class.

You may wish to discuss whether distances should be given in kilometres (km) or in Astronomical Units (AU). 1AU is the distance of the Earth from the Sun.

PALMS
PRIMARY AUSTRALIAN LITERACY MATHEMATICS AND SCIENCE

Name ____________________________

My Planet Rules! - Student Worksheet

Task

Work in pairs to research one planet from the four rocky planets and one from the four gas planets that circle our Sun. Use this information to fill in the data sheet provided and to convince your classmates that your planets are the most interesting.

Data Sheet

Planet	Diameter	Average distance from the Sun	Ingredients (what it is made up of)	Special features
Rocky				
Gas				

Name ______________________________

My Planet Rules! - Student Worksheet

M  R

Wow! Factor

Each planet is unique. What is especially interesting about your planet?

The Problem with Pluto – Teacher's Notes

Students are asked to read the following text twice. The first time is to gain meaning and the second to select information, which will support or reject the proposition that **"PLUTO IS A PLANET".** Teachers may wish to lead students through the first reading.

On the second reading they may use two different highlighters or coloured pencils to mark statements that support Pluto as a planet in one colour and statements to reject Pluto as a planet in another. They then review their work and make their decision based on information available at this time.

Poor Pluto?

Image of Pluto from the New Horizons space mission

If you asked your grandparents about the Solar System, they would tell you that it consisted of nine planets orbiting the Sun. These were Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus and Pluto.

Before it was first observed by Clyde Tombaugh in 1930, the location of Pluto had already been predicted by astronomers and mathematicians. Pluto lies in the Kuiper Belt in the outer reaches of the Solar System. It was named after the Roman god of the underworld. Being the farthest planet from the Sun its orbit takes 249 years and is strongly elliptical. It is about two-thirds the size of the Moon, its diameter of 2,302km is less than the width of Australia and it is spherical. It consists of a rocky core surrounded by frozen water, methane and carbon monoxide. Pluto orbits the Sun, has three moons and an atmosphere and even has polar ice caps. It is not much different from other planets.

As technology improved and probes travelled further into space, more small bodies were found in the Kuiper Belt and beyond that in the Oort Cloud. In the Kuiper Belt, Eris was found, in 2006, followed by Sedna, Makemake and

Quaoar. In total twelve significant bodies have been found. So far all are smaller than Pluto.
These discoveries were problematic. If something as small as Pluto could be called a planet, should all the others be planets too? What about Ceres the largest asteroid in the Asteroid Belt. Should it be declared a planet too?
This problem was discussed at the 2006 International Astronomical Union (IAU) Conference. Although 2,700 astronomers attended the conference only one tenth attended the discussion and participated in subsequent voting.

It was decided that to be classified a planet:

1. ***A body needs to orbit the Sun.*** All the eight planets, Pluto and the other bodies in the Kuiper Belt and the asteroid Ceres orbit the Sun.
2. ***A body needs to be large enough so its gravitational force pulls it into a spherical shape.*** Pluto and Ceres are spherical. Most asteroids are very much smaller and irregular in shape. Comets have long tails.
3. ***A body needs to be larger than a typical asteroid.*** The IAU decided that Ceres (diameter 945km), and Pluto (diameter 2,302km) were too small to be considered planets.
4. ***A body needs to have enough gravitational force to clear other bodies from its orbital path.*** After a planet forms its gravitational force either pulls in smaller bodies into itself or slings them out into space. Until Pluto or Eris crash into all the other objects that share their orbit and either absorb or deflect them they cannot be considered a planet. Ceres is one of many asteroids in the Asteroid Belt.

After voting, the IAU declared that Pluto and Ceres were not planets but "dwarf planets".
Many astronomers disagree with these decisions and signed petitions to

change this reclassification.

What is your opinion? How would you, as a scientist, vote and why?

Name ___________________________

The Problem with Pluto - Student Worksheet

Task

To decide whether Pluto should be classified as a planet or not, in your opinion.

Method

1. Read the text below carefully.
2. Read the text again, this time highlighting statements that support Pluto as a planet in one colour and those that reject it in another.
3. Review these points and decide which you would like to support. Make your statement about Pluto's status as a planet in the space provided.

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Image of Pluto from the New Horizons space mission

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The Problem with Pluto - Student Worksheet

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Name ___________________________

The Problem with Pluto - Student Worksheet

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Many astronomers disagree with these decisions and signed petitions to change this reclassification.

What is your opinion? How would you, as a scientist, vote and why?

Name ______________________________

The Problem with Pluto - Student Worksheet

Please write a short paragraph below giving your reasons.

STEM Awareness

Mars

Earth

Mars is slightly more than half the size of Earth. It is a rocky planet and its surface has signs that liquid water once flowed across it. This suggests that, like Earth, this planet may once have supported an atmosphere and possibly life. Indeed there may still be life if liquid water is trapped within the soil. (See end of teacher notes)

For this activity students view
https://www.ted.com/talks/nagin_cox_what_time_is_it_on_mars

We recommended that students read the question sheet before viewing the video to help focus their attention on information they might need.

Mars Time

When you are trying to contact someone on the other side of Australia or on the other side of Earth, you have to consider what is the difference in time between here and there. A lunchtime call from here will wake a caller in the UK at 4am. If you call a shop in Sydney at 4pm in the afternoon WA time it is liable to have closed one or two

hours ago.
If we are communicating with another planet on another orbit it becomes even more difficult because our days are of different lengths.

How long is one day (one rotation) on Earth? 24 hours

How long is one day (one rotation) on Mars? 24 hours ~40 minutes

Rovers need to shut down at night. Why? Needs to recharge her batteries and weather the cold martian night

Why does Nagin need to know when it is night on Mars? She works the 'martian night shift'

If it is nightfall at 5.00pm (Earth time) on the first day, at what time will

night fall happen on Mars the second day? 5:40pm

What does Nagin use to remind her about local time on Mars? The Mars watch

Mars Language

The engineers had to invent a new language for Mars time so they could all mean the same thing.
What name did the spacecraft engineers give for a day on Mars? Sol, (Tosol (today), Yestersol (yesterday) and Nextersol or Solorrow (tomorrow))

Why do you think that they gave it this name? To stop confusion between Earth and Mars days

The First Martian? - Teacher's Notes

What word is used for today on Mars? Tosol

Why do you think they used this word? To make it clear it is a Mars day

Why do you think that the "Mars Rover" people developed different words from the space probe people? Local language

Helping the Mind Cheat the Body

Because times can become markedly out of synch, engineers can trick their bodies into feeling night is day, or day is night. What tricks can they use? Put the blinds down (no natural light), foil the windows

How does this difference in time affect the families of the Mars rover engineers? They have to live on 'Mars Time' too

After Viewing

Can you think of other people on Earth who do not have their meals or sleep at the same time as their neighbours? Nurses and doctors on night shift, truck drivers on night shift, etc. etc.

Do you think the people who work on Mars time should call themselves Martians? Explain why. Answer will vary

STEM Careers

We talk of how we need to study STEM subjects in school to be able to get an interesting job later.

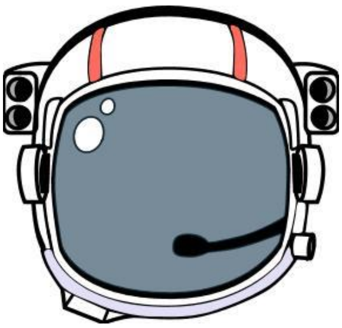
What does STEM stand for? Science Technology Engineering and

The First Martian? - Teacher's Notes

Mathematics

Does Nagin use STEM every day in her work? Yes. Science comes up with ideas to test, Engineers design the equipment, Technology makes the equipment work and Mathematics provides the language (measurements) that they all use.

Did you think this was an interesting talk? Explain your answer. Answer will vary



Some of your students may have seen the movie "The Martian" about an Astronaut who is stranded on Mars and how he has to "Science" his way out of his predicament until he is rescued. One factor wasn't explored however, the difference in time between the day and night of the astronaut based on Mars and the rescuers on Earth.

Extension for Experts

Jupiter is more than eleven times the size of Earth.

1 day on Jupiter lasts 9 hours and 56 Earth minutes.

If you start with daybreak on both planets being at 6am Earth time on Saturday, after 3 Jupiter days, what will the day and time on Earth?

9 hours and 56 minutes = 596 minutes

3 x 596 minutes = 1,788 minutes/60 = 29 hours and 48 minutes = 1 day 5 hours and 48 minutes

Sunday at 11:48am

Extra information

Three billion years ago Mars had liquid water, which has since disappeared. Scientists suggested that carbon dioxide in its early atmosphere built up the heat from a weaker Sun and the water boiled away. Probes have detected no carbon dioxide in the present weak atmosphere. Curiosity rover has investigated Gale Crater, which was thought to be an ancient lake. No traces of carbonates were found in the rocks; this is not what scientists were hoping for. If the data does not support the hypothesis we need to rethink the evolutionary history of Mars and test again.

Name ____________________________

The First Martian? - Student Worksheet

Mars

Earth

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Read the questions below before viewing the linked TED talk.
Visit
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Name ___________________________

The First Martian? - Student Worksheet

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____

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____

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____

Name ___________________________

The First Martian? - Student Worksheet

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The engineers had to invent a new language for Mars time so they could all mean the same thing.

What name did the spacecraft engineers give for a day on Mars

____

Why do you think that they gave it this name? ______________

____

What word is used for today on Mars? ________________

Why do you think they used this word? ________________

____

Why do you think that the "rover" people developed different words from the space probe people?

____

Name ______________________________

The First Martian? - Student Worksheet

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Name ____________________________

The First Martian? - Student Worksheet

STEM Careers

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What does STEM stand for? ______________________________

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Does Nagin use STEM every day in her work? ________________

____

Did you think this was an interesting talk? Explain your answer.

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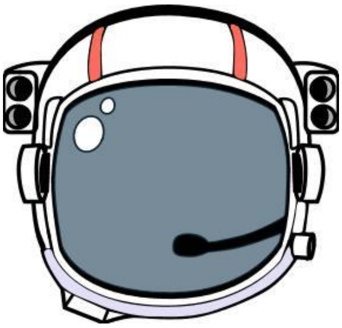

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____

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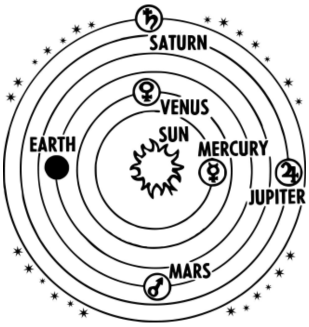
____

Post Renaissance Science – The Age of reason



Although most astronomers still believed the heavens rotated round the Earth until late Renaissance times, the idea that all planets might revolve around the Sun was first raised by the mathematician and astronomer Aristarchus of Samos (310-230BC). He correctly identified the Sun as the "central fire" and correctly placed the planets round it. He also wrote that stars are probably other suns. This heliocentric idea (Helios =Sun, centric =centered) came in and out of favour with astronomers but not with the general public or with major religions who continued to purport that the Universe revolved around Man and the Earth. When mathematicians and astronomers carefully measured the movements of the planets, they discovered that it was impossible to predict to where they might move to if they used the Earth as the centre of their orbits. Their progressive movements could only be explained if they moved round the Sun and we moved with them.

Nicolaus Copernicus (1473-1543) was a priest who used mathematical

measurements and models to assert that the Sun was at the center of the solar system. He wrote his famous paper "On the revolutions of the Heavenly Spheres" but it was only published towards the end of his life. Do you think you could be as brave as Copernicus? Any personal opinion. When he died he was buried in an unmarked grave under the floor of Fromberk cathedral. His ideas weren't commonly accepted for another two hundred years.

Copernican Revolution - Teacher's Notes

Using STEM to Find the Body of Nicholas Copernicus

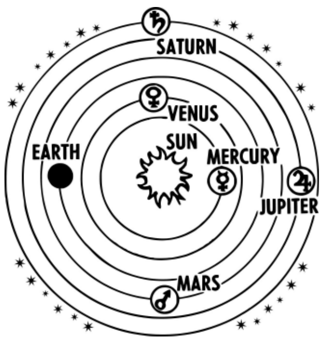
What do the letters in STEM stand for? Science, Technology Engineering and Mathematics.

For some classes, teachers may need to make a word wall of unfamiliar names and spelling, for example.

Archaeologists study evidence of the history of Man.
Astronomers study evidence of the history of the Universe.
DNA experts compare and contrast DNA evidence from different sources.
Forensic scientists provide evidence for use in courts.
Geophysicists use evidence from the physical properties of materials to sense what they cannot see.
Mathematicians use numbers, data, and space to study change and make models.
Heretics are people who hold opinions at odds with general beliefs.

Read the following true story and answer the questions.
Note: If you recant you publicly state you have changed your mind back to conventional belief.

Copernicus was a brave man to counter conventional wisdom that the Earth was the centre of the Universe. People had been burned at the stake and tortured for saying just that. Copernicus had "done his math's" and had observations which supported his idea. Even so his findings were declared heretical, by the church, he was counseled to recant. His papers did not get published until the year of his death. He was buried in an unknown unmarked grave along with



fourteen other bodies under the floor of Fromberk Cathedral. He was only a priest and his death wasn't noted in the cathedral's records, only that a replacement for him had been found.

Why do you think that the planets Uranus and Neptune along with the dwarf planet Pluto are not present on the Copernican diagram on the previous page? All the planets on this diagram can be seen by the naked eye. You need a telescope to see the others. (Uranus 1781, Neptune 1846 and Pluto 1930). Copernicus had to rely on naked eye observations.

His ideas were generally unacceptable for many years. Galileo Galilei (1564-1642), the famous Italian astronomer, was later threatened with torture for supporting and spreading them. He also was declared a heretic. To escape torture by the Inquisition he had to publicly recant and change the direction of his own research. He spent the rest of his life under house arrest. He was eventually pardoned of heresy in 1992.

Four hundred and seventy three years after Copernicus' death, some scientists, clerics and politicians wanted to erect a special granite memorial dedicated to "the man who turned the Universe inside out". They thought that a solitary tomb would be more acceptable for the great Polish national hero. But how could they find one grave amongst many under the floor of the Cathedral? They used a STEM approach.

Geophysicists used ground-penetrating radar to outline areas of disturbed soil lying under the tiles on the cathedral floor. This work was difficult because they had to pause for religious services, as this was still a working cathedral. Why did they use geophysics radar first and not just start digging?

This might narrow down possible gravesites without lifting the tiles.

Archaeologists and priests excavated under the floor of the cathedral to check the possible sites. Digging in sandy areas was difficult. When the organ played, its vibrations would shake loose sand, which would fall back collapsing excavation holes. They eventually found over 100 possible gravesites. Many had multiple bodies. Why do you think so many people were buried under the floor inside the church? People used to believe that the closer to the altar you were buried, the faster you got into heaven. Only the very rich or religious were buried there. How did Copernicus get to be buried there? He was a priest.

They soon found the skull and parts of the skeleton of a seventy-year-old man. Copernicus had died at seventy years. Is this sufficient evidence to say these were the remains of Copernicus? No. It could be from another man about the same age. It could be used to support other evidence however.

Police forensic pathologists examined the skull and used computer programs to make measurements of it. These were used by experts in forensic facial reconstruction to create a model of what the head and face of the person with this skull would have looked like. Their model displayed a broken nose, a scar into the bone above its left eye and the same facial features that could be seen in a portrait that Copernicus had drawn of himself. Is this sufficient evidence to say the body belonged to Copernicus? It certainly supports the data from the archaeologists.

DNA experts wanted to find descendants of Copernicus to match their DNA with his to be completely sure. Unfortunately Copernicus had no children. Priests and forensic pathologists then examined some of Copernicus own mathematical books, which were still held in a library. They found his hairs trapped between the pages. The DNA scientists compared the DNA from a tooth and a bone to find a perfect match with DNA from the hair. Is this sufficient evidence to say the body was Copernicus? Yes.

The case is complete.

List the pieces of evidence, which put together, convincingly proved the skeleton and skull to be Copernicus?

1. The skeleton was of a 70 year old man. Copernicus died at 70. This alone was not convincing It could have been from another 70 year old man.
2. The skull had a scar, broken nose and facial features which were similar to those of Copernicus. This alone would not prove they belonged to Copernicus.
3. The DNA of Copernicus' hair matched DNA from the skull and skeleton. This is convincing evidence, which is well supported by the two above.

Which STEM trained scientists were involved with solving the case? Place an X in the appropriate box

Geophysicists, archaeologists, forensic pathologists and forensic reconstruction experts, DNA experts. I can't comment on the priests, as I have no data on whether they had expertise in this area or not. In good Science, if you don't know you have to say so rather than give out misinformation.

Expert's area	Science	Technology	Engineering	Mathematics
Geophysics	X	X	X	X
Archaeology	X	X	X	X
Forensic pathology	X	X	X	X
DNA experts	X	X	X	X

Geophysics. Remote sensing using physical behavior of the ground to

RADAR, gravity and electric currents

Science Good technique for data collection (Observable Measurable Repeatable & Reportable).

Technology Effectively using ground penetrating radar.

Engineering Using equipment suitable for the physical characteristics of the area

Mathematics Mapping and interpreting the numerical data.

<u>**Archaeology**</u> The study of the history of mankind

Science Good technique for data collection (Observable Measurable Repeatable & Reportable).

Technology Use of trowels, brushes, sieves, photography, labeling, measurement and preservation of finds.

Engineering Excavating tools, support of established structures, correct replacement of excavated materials.

Mathematics Mapping and interpreting the numerical data.

<u>**Forensic pathology**</u> Collecting evidence from dead bodies

Science Good technique for data collection (Observable Measurable Repeatable & Reportable).
Knowledge of muscle and skeletal tissues

Technology Effective use of computer programs for facial recognition and reconstruction

Engineering Choice of materials for skull and face reconstruction.

Mathematics Assessment and choice of probable features of skull

<u>**DNA analysis**</u> Using fragments of cell nuclei to determine similarities

Science Good technique for data collection (Observable Measurable Repeatable & Reportable). Selection of material.

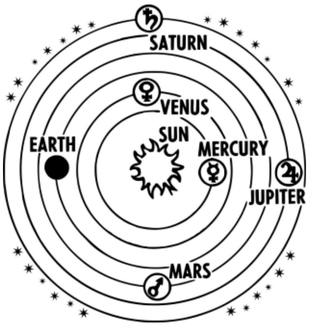
Technology Use of computers and appropriate programs. Obtaining good untainted samples

Engineering As above
Mathematics Understanding of probability of good match.

Name ___________________________

Copernican Revolution - Student Worksheet

Post Renaissance Science – The Age of reason



Although most astronomers still believed the heavens rotated round the Earth until late Renaissance times, the idea that all planets might revolve around the Sun was first raised by the mathematician and astronomer Aristarchus of Samos (310-230BC).
When mathematicians and astronomers carefully measured the movements of the planets, they discovered that it was impossible to predict to where they might move to if they used the Earth as the centre of their orbits. Their progressive movements could only be explained if they moved round the Sun and we moved with them.

Nicolaus Copernicus (1473-1543) was a priest who used mathematical

measurements and models to assert that the Sun was at the center of the solar system. He wrote his famous paper "On the revolutions of the Heavenly Spheres" but it was only published towards the end of his life. Copernicus was threatened with torture but maintained his belief that the planets orbited the Sun and the stars lay outside the Solar System.
Do you think you could have been as brave as Copernicus? _______________
When he died he was buried with fourteen others in an unmarked grave under the floor of Fromberk cathedral. His ideas weren't commonly accepted for another two hundred years.

Name ____________________________

Copernican Revolution - Student Worksheet

Four hundred and seventy three years after Copernicus' death, some scientists, clerics and politicians wanted to erect a special granite memorial dedicated to "the man who turned the Universe inside out". They thought that a solitary tomb would be more acceptable for the great Polish national hero. But how could they find one grave amongst many under the floor of the Cathedral? They used a STEM approach.

Using STEM to Find the Body of Nicholas Copernicus

What do the letters in STEM stand for?

____

Why do you think that the planets Uranus and Neptune along with the dwarf planet Pluto are not present on the Copernican diagram on the previous page?

____

Geophysicists used ground penetrating radar to outline areas of disturbed soil lying under the tiles on the cathedral floor. This work was difficult because they had to pause for religious services as this was still a working cathedral. Why did they use geophysics first and not just start digging?

____

Archaeologists and priests excavated under the floor of the cathedral to check the possible sites. Digging in sandy areas was difficult. When the organ played, its vibrations would shake loose sand which would fall back collapsing excavation holes. They eventually found over 100 possible grave sites. Many had multiple bodies. Why do you think so many people were

Name ____________________________

Copernican Revolution - Student Worksheet

buried under the floor inside the church?

____

How did Copernicus get to be buried there?

____

They soon found the skull and parts of the skeleton of a seventy-year-old man. Copernicus had died at seventy years. Is this sufficient evidence to say these were the remains of Copernicus?

____

Police forensic pathologists examined the skull and used computer programs to make measurements of it. These were used by experts in forensic facial reconstruction to create a model of what the head and face of the person with this skull would have looked like. Their model displayed a broken nose, a scar into the bone above its left eye and the same facial features that could be seen in a portrait that Copernicus had drawn of himself. Is this sufficient evidence to say the body belonged to Copernicus?

____

DNA experts wanted to find descendants of Copernicus to match their DNA with his to be completely sure. Unfortunately Copernicus had no children. Priests and forensic pathologists then examined some of Copernicus own mathematical books, which were still held in a library. They found his hairs trapped between the pages. The DNA scientists compared the DNA from a tooth and a bone to find a perfect match with DNA from

Name ___________________________

Copernican Revolution - Student Worksheet

the hair. Is this sufficient evidence to say the body was Copernicus?

____

List the evidence which put together convincingly proved the skeleton and skull to be Copernicus?

____

____

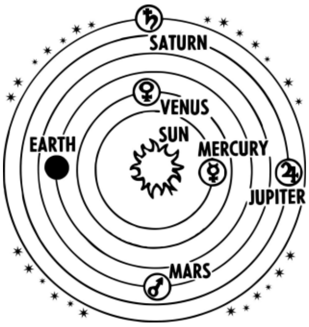
____

Which STEM trained scientists were involved with solving the case? Place a X in the appropriate box

Expert's area	**Science**	**Technology**	**Engineering**	**Mathematics**

Orbit Shapes and AU - Teacher's Notes

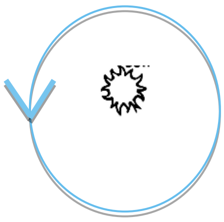
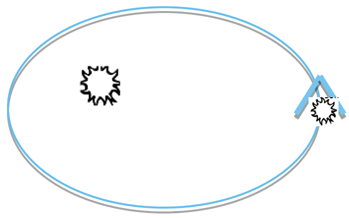
Orbit shapes



To the Copernican heliocentric model of the Solar System, further refinements were added by later astronomers and mathematicians. These were only possible using better telescopes and better mathematical techniques.

Johannes Kepler (1571-1630) used observations and measurements of his own and from his mentor Tycho Brahe to demonstrate that planets actually travel in elliptical orbits, not circular ones. This explained the earlier observations that planets seem to vary in distance from the Sun during their orbits and sometimes appeared to move backwards.

An ellipse is a curved shape with two centers or loci.

Circular orbit	Elliptical orbit
	

Kepler also proposed that the further a planet's orbit is from the Sun the more elliptical it becomes. See following teacher demonstration.

This means that when we measure the distance from the Sun for any planet we have to measure the mean or average distance as the true distance varies if they travel in an elliptical path.

Orbit Shapes and AU - Teacher's Notes

Astronomical Measurements

The Astronomical Unit (AU)
We humans are used to using measurements in millimeters, centimeters, metres and kilometers. Once we start measuring across the enormous distances of the Solar System however, we need to use another standard. We use the distance of the Earth from the Sun as one Astronomical Unit (1AU).

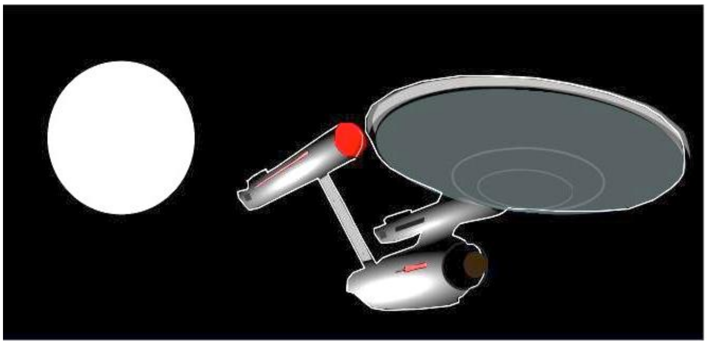
1 Astronomical unit is 149,597,870.7km

Planet	Distance from Sun (AU)
Mercury	0.39
Venus	0.72
Earth	1.00
Mars	1.52
Jupiter	5.2
Saturn	9.54
Uranus	19.2
Neptune	30.06

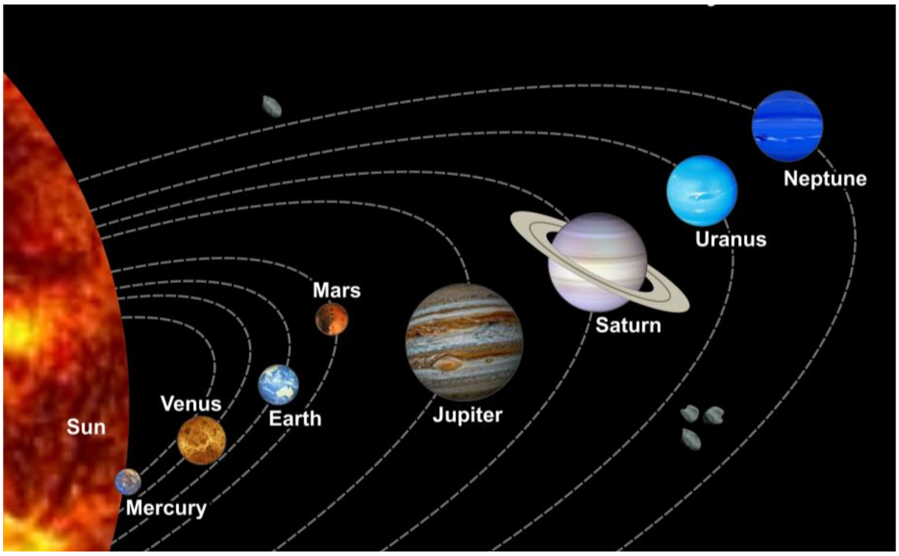
Of course when we start measuring distances across the Milky Way or further still, across the Universe we need to use measurements in light years or parsecs.

One light year is the distance light can travel in one year or 9.4607×10^{12}km.
One parsec (beloved of Star Wars fans), is roughly equivalent to 3.26 light years.

Orbit Shapes and AU - Teacher's Notes



In Space, things which are moving tend to keep moving unless acted on by another force (Newton's First Law). There is almost no friction to slow things down because space is mostly empty. If a spacecraft has sufficient energy to exceed the gravitational pull of the Sun, once it is out of range it needs very little power because it will continue under its own momentum. It can pick up "free" energy by using the gravitational pull of a large object such as a planet. This can be used like a slingshot to fling it further into space. This technique saves precious fuel. Planets would also continue straight out into space unless they were acted on by the Sun's gravitational force.



Orbit Shapes and AU - Teacher's Notes

Drawing Elliptical Planetary Paths

Astronomers suggested that planetary orbits become more elliptical as they move further from the Sun. This activity demonstrates that this is true.

Ellipses have two loci to influence their shape. The constant thumbtack represents the Sun, the centre of our solar system. The second thumbtack represents the farthest position of each planet from the Sun in its orbit. As the planet approaches the Sun, the pull of gravity first speeds it up until it passes and the gravitational force pulls it back again.

Planets and other materials travel in elliptical orbits until they expend their energy and slowly progress, spiraling towards the Sun.

Orbit Shapes and AU - Teacher's Notes

Materials

- A sheet of cardboard or polystyrene larger than A4. I used a handy cool drink box. It was easy to stick the pins in to anchor the paper.
- A sheet of A4 paper, or A3 if you have a big box.
- Four thumbtacks or sticky tape to hold the paper on the surface of the cardboard.
- Two thumbtacks to act as the loci.
- Coloured pens, felt tip pens or coloured pencils.
- String, thread or wool.
- Scissors.
- A ruler.

Method

1. Attach the paper to the box or polystyrene sheet.
2. Draw a horizontal line across the middle of the sheet.
3. About a third of the way along the line stick in your first drawing pin or thumbtack. This is the centre of the Sun and its centre of gravity. (In the photo it is the yellow thumb tack)
4. Using the table provided, select three planets. I recommend using Earth, Jupiter and Saturn. Mark their distances from the Sun on the central horizontal line. If you select a scale of 1cm = 1AU, then Earth is at 1cm, Jupiter at 5.2cm and Saturn at 9.5cm.
5. Place a thumbtack at Earth's position and make a string loop to fit neatly between the planet and the thumbtack representing the Sun.
6. Insert a pen into the loop and draw the orbit of the Earth. It will be almost circular.
7. Repeat for Jupiter and Saturn. These will be noticeably more elliptical.

Astronomers used to believe that the Solar System moved like clockwork and could be understood using mathematics.

The astronomical unit (1 AU)

We humans are used to using measurements in millimeters, centimeters, metres and kilometres. These are measurements that can be applied on a human scale. Once we start measuring across the enormous distances of the Solar System however, we need to use another standard for our calculations. We use the distance of the Earth from the Sun. The distances given below are when each planet is farthest from the Sun during its elliptical orbit.

1 Astronomical unit is 149,597,870.7km

Estimate the distance of each planet from the Sun in Astronomical Units. A calculator will help

PLANET	Distance from the Sun (million km)	Distance from Sun (AU)	Time taken to complete 1 orbit of the Sun
Mercury	57.91	0.39	88 Earth days
Venus	108.2	0.72	224.7 Earth days
Earth	149.6	1.00	365 Earth days
Mars	227.9	1.52	687 Earth days
Jupiter	778.3	5.2	4,331 Earth days
Saturn	1,427	9.54	10,747 Earth days
Uranus	2,871	19.2	30, 589 Earth days
Neptune	4,498	30.06	60,189 Earth days

From the data in the table, how long would it take between your 8th birthday and ninth birthday if you lived on Jupiter? 4,331 Earth days or almost 12 years!.

Time Taken to Orbit the Sun

We will only be using data from the first five planets to see if there is a direct (straight line) relationship between the distance of the planet from the Sun and the time it takes to complete one orbit. Teachers might wish to demonstrate this using an Excel spreadsheet in their computer while explaining that astronomers such as Copernicus and Newton had only pen and paper.

Materials

- Graph paper
- Pencil, ruler & eraser

Or

- Excel spreadsheet and Smartboard or projector

Discussion

Can you see a direct relationship between the time taken to complete an orbit of the Sun and the distance between the planet and the Sun? No

Why do you think we did not include data from Uranus and Neptune?
Because we would need enormous pieces of graph paper.

Without the benefits of electric lighting and computers, in about 1621, the astronomer Johannes Kepler worked this out for himself using candlepower for light and pencil and paper for manual calculations.
With mathematical “proofs” Kepler devised the three laws of planetary motion.

1. The orbit of every planet is an ellipse with the Sun at a focus
2. A line joining a planet sweeps out equal

areas during equal intervals of time.

3. The square of the orbital period of a planet is directly proportional to the cube of the semi major axis.

Name ____________________________

Patterns in the Sky - Student Worksheet

Astronomers used to believe that the Solar system moved like clockwork and could be understood using mathematics.

The astronomical unit (1 AU)

We humans are used to using measurements in millimeters, centimeters, metres and kilometres. These are measurements that can be applied on a human scale. Once we start measuring across the enormous distances of the Solar System however, we need to use another standard for our calculations. We use the distance of the Earth from the Sun. The distances given below are when each planet is farthest from the Sun during its elliptical orbit.

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Estimate the distance of each planet from the Sun in Astronomical Units. A calculator will help.

PLANET	Distance from the Sun (million km)	Distance from Sun (AU)	Time taken to complete 1 orbit of the Sun
Mercury	57.91		88 Earth days
Venus	108.2		224.7 Earth days
Earth	149.6	1	365 Earth days
Mars	227.9		687 Earth days
Jupiter	778.3		4,331 Earth days

Name ____________________________

Patterns in the Sky - Student Worksheet

Saturn	1,427		10,747 Earth days
Uranus	2,871		30, 589 Earth days
Neptune	4,498		60,189 Earth days

From the data in the table, how long would it take between your 8th birthday and ninth birthday if you lived on Jupiter?

____

We will only be using data from the first five planets to see if there is a direct (straight line) relationship between the distance of the planet from the Sun and the time it takes to complete one orbit

Materials

- Graph paper
- Pencil, ruler & eraser

Or

- Excel spreadsheet and SmartBoard or projector

Discussion

Can you see a direct relationship between the time taken to complete an orbit of the Sun and the distance between the planet and the Sun? ______________________________

Why do you think we did not include data from Uranus and Neptune?

____

Toilet Paper Scale - Teacher's Notes

It is difficult to imagine the immense distances between the planets of our solar system. Compared to these distances planets are small.
So much of Space is, well ………… space.

Astronomers use astronomical units (AU) (the distance of the earth from the Sun) to minimise the size of the numbers concerned but it is still difficult to get a sense of scale.

"*The numbers are hard to reach and still harder to grasp*" E Bertram.

The distance flying direct from Perth to Sydney is 3,290km.
The distance from the Sun to the Earth is 149,597,890km.
The distance from the Sun to the outermost planet, Neptune, is 4,498,252,900km.

My mind just boggles.

A fun way of realising the relative distance from the Sun to each planet and their relative sizes requires a toilet roll and a dry day or access to a long veranda or corridor if the weather is windy or rainy.

Toilet Roll Data

1. Toilet rolls usually have 1,000 sheets if one ply (1 thickness) or 500 sheets if 2 ply.
2. Thicker or 2 ply toilet paper is not necessarily more absorbent than 1 ply.
3. The large rolls found in public toilets usually have 2,000 sheets. This is not only because they are used more but also the extra thickness of the roll will dissuade the public from stealing them, as they do not fit into household dispensers. (In some tertiary education institutions in the 1970s, it was suggested that more than one third

of toilet rolls disappeared off campus).

4. Each year the average first world adult uses 49 rolls of toilet paper or 49,000 sheets.
5. The average sheet of toilet paper is 10cm by 10cm.

Teachers may wish to visit https://au.whogivesacrap.org to find more information on how buying toilet paper can fund building toilets in third world countries.

When scientists find data difficult to represent or explain, they may use simple models. We will discuss the good points and bad points of this model we are about to use after the experiment.

A 'Toilet Roll' Model of the Solar System

Materials/situation

- A dry, relatively windless day on the school oval or access to a long corridor or school veranda.
- At least one toilet roll is required if this is to be a teacher demonstration or one for each group. If students wish to use their own rolls they may bring one from home to minimise cost.
- A pencil or rod to place in the core of the toilet paper to enable it to be rolled out or dispensed easily.
- Books, rocks or even willing students to hold down the paper and mark the location of each planet and of the Sun.
- A pair of scissors.
- A calculator.

Toilet Paper Scale - Teacher's Notes

Method

1. Weigh or fix the end of the roll to the ground and mark this location as the Sun.
2. Place the rod or pencil in the hollow cardboard tube of the roll and start unrolling.
3. Using the table provided, count out the sheets and mark the position of each planet.
4. Leave the unrolled strip and answer the first set of questions. Keep any unused sheets for the second activity.

Estimate the number of sheets of toilet paper which are needed to represent these distances.

PLANET	Distance from Sun km	Sheets of toilet paper
Mercury	57,909,175	6
Venus	108,208,930	11
Earth	149,597,890	15
Mars	227,936,640	23
Asteroid Belt		
Jupiter	778,412,020	78
Saturn	1,426,752,400	140
Uranus	2,870,972,200	290
Neptune	4,498,252,905	450

1. What scale (roughly) is this model? One sheet of toilet paper represents about 100 million km.
2. Did this model help you realise the immense distances between planets and our Sun? Explain your answer. Yes. There is a lot of empty space between the planets.
3. What problems did you have with this model and how can they be fixed? The model should work well unless wind, rain, stray dogs, birds

and stray students affect the laying of the paper. If you have a large gymnasium of undercover area these might be better options.

Extending the 'Toilet Roll Model' to Demonstrate Differences in Planet Size

This can be done inside.
One sheet of toilet paper represents about 100 million km.
I have worked out the diameter of the largest planet for you. It is 1/10 of a sheet of toilet paper.

PLANET	Diameter of planet Km	Part of one sheet of toilet paper which would represent the diameter of each planet
Mercury	4,879	0.0035 or 3.5 thousandths
Venus	12,104	0.0085 or 8.5 thousandths
Earth	12,756	0.0089 or 8.9 thousandths
Mars	6,786	0.0048 or 4.8 thousandths
Jupiter	142,984	0.1 or 1/10th
Saturn	120,536	0.084 or 8.4 hundredths
Uranus	51,118	0.042 or 4.2 hundredths
Neptune	49,528	0.035 or 3.5 hundredths

Which planets could be represented relatively accurately at this scale?
Only the biggest planets such as Jupiter and Saturn can be represented. The others would be tiny scraps of paper you would need a microscope to see.
Since at this scale the planets are too small to see from a distance, can we change to a different scale of size but keep to old scale for size and make

accurate comparisons? (Hint – The diagram below may help you with your answer). No

The baby girl
Scale 1 cm = 90 cm

The baby boy
Scale 1cm = 45cm

Are the boy and girl the same size? Both the boy and girl are the same size. The picture of the girl has been scaled down to half the size.

Please clean away the used toilet paper into a recycling bin.
Another interesting piece of information on toilet paper was published in the West Australian on March 22 2017. China is attempting to prevent the theft of toilet paper from one of its busiest public lavatories by installing facial recognition cameras. Visitors will only be provided with 60cm of paper. They will be denied access to the toilets within 9 minutes of their first scan.

Toilet Paper Scale - Teacher's Notes

This activity is based on one by Dynamic Earth.
http://www.dynamicearth.co.uk/media/1246/toilet-paper-solar-system.pdf

Name ____________________________

Toilet Paper Scale - Student Worksheet

It is difficult to imagine the immense distances between the planets of our solar system. Compared to these distances planets are small.
So much of Space is, well ………… space.

When scientists find data difficult to represent or explain, they may use simple models. We will discuss the good points and bad points of this model we are about to use after the experiment.

A 'Toilet Roll' Model of the Solar System

Materials/situation

- A dry, relatively windless day on the school oval
- At least one toilet roll.
- A pencil or rod to place in the core of the toilet paper.
- Students to hold down the paper and mark the location of each planet and of the Sun.
- A calculator.

Method

1. Weigh or fix the end of the roll to the ground and mark as the Sun.
2. Place the rod or pencil in the hollow cardboard tube of the roll and start unrolling.
3. Using the table provided, count out the sheets and mark

Name ___________________________

Toilet Paper Scale - Student Worksheet

the position of each planet

4. Leave the unrolled strip and answer the first set of questions. Keep any unused sheets for the second activity.

Estimate the number of sheets of toilet paper which are needed to represent these distances.

PLANET	Distance from Sun km	Sheets of toilet paper
Mercury	57,909,175	6
Venus	108,208,930	
Earth	149,597,890	
Mars	227,936,640	
Asteroid Belt		
Jupiter	778,412,020	
Saturn	1,426,752,400	
Uranus	2,870,972,200	
Neptune	4,498,252,905	

1. What scale (roughly is this model? ____________________

____

2. Did this model help you realise the immense distances between planets and our Sun? Explain your answer.

____

Name ______________________________

Toilet Paper Scale - Student Worksheet

3. What problems did you have with this model and suggest how they can be fixed?

____

____

Extending the 'Toilet Roll Model' to Demonstrate Differences in Planet Size

One sheet of toilet paper represents about 100 million km.

I have worked out the diameter of the largest planet for you. It is 1/10 of a sheet of toilet paper.

PLANET	Diameter of planet Km	Part of one sheet of toilet paper which would represent the diameter of each planet
Mercury	4,879	
Venus	12,104	
Earth	12,756	
Mars	6,786	

Name ___________________________

Toilet Paper Scale - Student Worksheet

Jupiter	142,984	0.1 or 1/10th of one sheet
Saturn	120,536	
Uranus	51,118	
Neptune	49,528	

Which planets could be represented relatively accurately at this scale?

____

Can we change the scale for the planets but leave the same scale for the distances and still use the original toilet roll? (Hint – The next question below may help you with your answer)

____

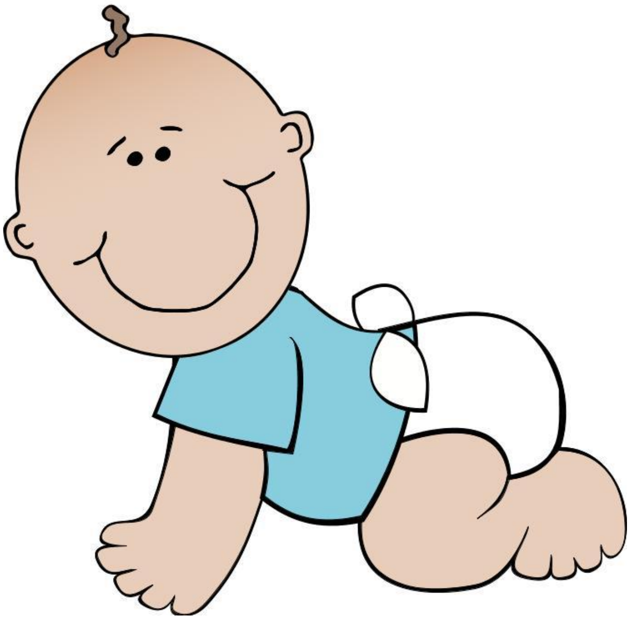
____

PALMS
PRIMARY AUSTRALIAN LITERACY MATHEMATICS AND SCIENCE

Name ___________________________

Toilet Paper Scale - Student Worksheet

The baby girl
Scale 1 cm = 90 cm



The baby boy
Scale 1cm = 45cm

Are these babies different sizes? ________________________

Please clean away the used toilet paper into a recycling bin.

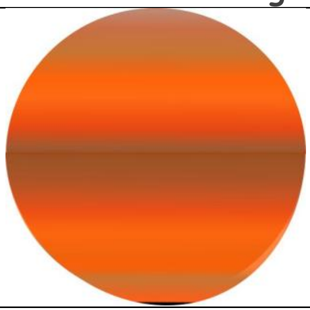
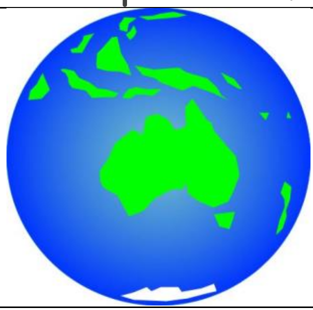
Energy for Planets – Teacher's Notes

Our Sun emits radiation across space and only some of it arrives on Earth. This radiation comes from the thermo nuclear reactions that take place as gravitational forces within our massive sun smashes together hydrogen atoms to form the gas helium and energy is left over. Solar energy is radiated out into space in all directions.

"Goldilocks" Earth is just the right distance from the Sun to be able to have liquid water. It has just the right magnetic field to deflect some of the nastier forms of solar radiation and just the right atmosphere to be able to retain some heat. These three important characteristics mean it can maintain life.

Venus is too close to the sun and is too hot. Mars is further away from the Sun, has lost its atmosphere and is too cold, though things were different in the past.

Average surface temperature of three planets

		
Venus	**Earth**	**Mars**
450°C	13°C	-87°C to 20°C

Most solar energy is deflected past Earth by our magnetic field. Long wave energy is mostly light (both visible and ultra-violet light). Short wave radiation is mostly heat (infra-red energy). Heat energy can pass through high thin cloud but is reflected by low thick cloud and by the surface of the Earth. High thin cloud will return outgoing heat back to Earth. This is a delicate balance that requires just the right proportion of gases in our atmosphere.

Common Student Misconception

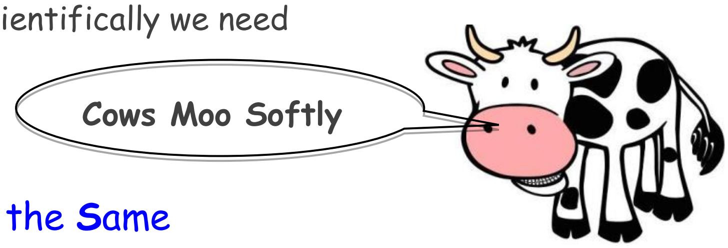
The Greenhouse effect is BAD!

Without clouds reflecting back heat from the Sun and gases retaining heat, our Earth would be too cold for life.
Like greenhouses in icy parts of the world, they keep plants warm enough to grow. Living things' body processes depend on enzymes, which only work within a narrow range of temperatures.

To Find if the Sun Heat the Atmosphere and Which School Location is the Warmest

If we want to experiment scientifically we need to follow the same rules:

Change one thing
Measure one thing
S Everything else **S**tays the **S**ame



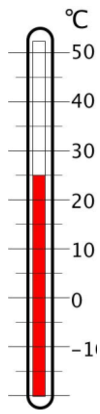
We also need to be able to use technology that will give us accurate and precise measurements. What technology can we use to measure heat? A thermometer or thermo-probe. There is more information and activities on using a thermometer in PALMS2 p39-53.

Improving the safety and accuracy of using a glass thermometer.

1. Never hold it by the bulb end. Why? If you hold the thermometer by the bulb you will be taking the external temperature of your body, not of the atmosphere.

2. Carry the thermometer horizontally across your body when moving. Why? If you slip you won't poke the glass rod into someone else or fall on it cutting yourself.
3. Always raise the thermometer so that your eyes are level with the fluid when you read the temperature. Why? This avoids parallax (misreading at an angle).
4. How accurately can you estimate the temperature using this technology? Most students should be able to estimate to half a degree Celsius. Thermo-probes should however give readings to two decimal places

If students work in groups of three, one can be the experimenter and hold the thermometer, one the note taker and the last kneels or bends down to read the thermometer with eyes level with the liquid.



Materials per group

- A thermometer (laboratory thermometers - no mercury)
- A worksheet and pen
- A roll of masking tape
- A ruler
- A map of the school with three locations marked on it.

Method

1. Measure a height of 1m on the classroom wall or door and mark with masking tape.
2. One student in each group lines up with the measured mark and places a piece of masking tape on himself or herself at exactly the same (1m) height as the marking on the wall. This student is in charge of the thermometer.
3. Care must be taken to ensure to select similar locations but one in full sun and the other in shade. As much as possible everything else

should be the same (closeness to buildings or dark surfaces, both out of wind etc.)

4. At the first location, the student in charge of the thermometer holds it vertically away from their body with the bulb level with their 1m mark. After waiting one minute, three readings are taken and entered in the worksheet.
5. Students move to the second location and repeat.
6. Calculate the average temperature of the readings in shade and those in full sun.

Observations for location 1

	Shade (°C)	Full sunlight (°C)
Reading 1		
Reading 2		
Reading 3		
Average Reading		

Observations for location 2

	Shade (°C)	Full sunlight (°C)
Reading 1		
Reading 2		
Reading 3		
Average Reading		

Observations for location 3

	Shade (°C)	Full sunlight (°C)
Reading 1		
Reading 2		
Reading 3		
Average Reading		

Conclusion A conclusion is the idea that our collected data leads us to state.
Which location about the school is the warmest? Will depend on school/day.
What can you conclude from this data? Sunlight heats the atmosphere. The Sun produces heat energy.
Why did we hold the thermometer 1m above the surface? We wanted to measure the temperature of the atmosphere and not the ground.
Why did we take three readings and not just one? Nature isn't constant. The more readings we take the better our data will be.

Extra for Experts

Weather scientists take readings from stations set 1.2m above ground to minimise the effect of heat radiated back from the ground. The equipment is held behind double louvered walls to minimise the cooling effect of wind or rain and under double roofs. The box is called a Stevenson Screen. Students may wish to return to their reading locations and contrast readings when the reading is taken close to the ground, with a wet thermometer bulb or if "wind" is blown onto the bulb.

Why wouldn't you erect a weather station near the barbeque? The local air would be heated when the barbeque was on.
Why aren't weather stations erected under the eaves of a building? They are in shade, getting less heat from the sun and would be cooler than general atmospheric temperature.
Why wouldn't you paint the walls of the station black? Black surfaces absorb heat and the temperature reading would be too high.

Is There Anybody Out There?

Scientists have been looking at other solar systems to see if any have exoplanets suitable for life. By early 2017 they had found 3,449 of them. Most were gas planets. However in February 2017 they found a star in the constellation of Aquarius called Trappist1. It lies 40 light years away from us. By conventional spacecraft it would take 700,000 years to reach. Although the energy it emits is 2,000 times fainter than our sun, it is surrounded by 7 rocky exoplanets, which orbit within the habitable "Goldilocks zone".

More information can be found at:
https://www.theguardian.com/science/2017/feb/22/thrilling-discovery-of-seven-earth-sized-planets-discovered-orbiting-trappist-1-star

Name ____________________________

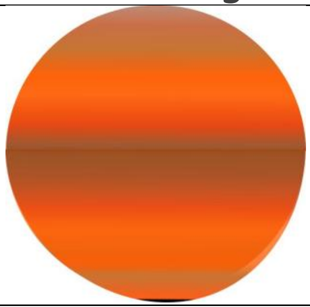
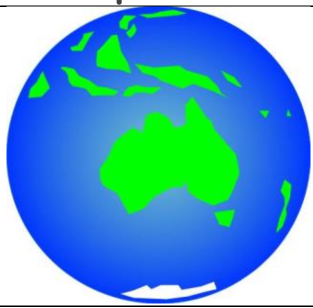
Energy for Planets - Student Worksheet

Our Sun emits radiation across space and only some of it arrives on Earth.

"Goldilocks" Earth is just the right distance from the Sun to be able to have liquid water. It has just the right magnetic field to deflect some of the nastier forms of solar radiation and just the right atmosphere to be able to retain some heat to keep water liquid. These three important characteristics mean it can maintain life.

Venus is too close to the sun and is too hot. Mars is further away from the Sun, has lost its atmosphere and is too cold, though things were different in the past.

Average surface temperature of three planets

		
Venus	**Earth**	**Mars**
450°C	13°C	-87°C to 20°C

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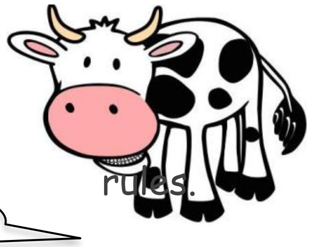
Energy for Planets - Student Worksheet

The Greenhouse Effect

Without clouds reflecting back heat from the Sun and gases retaining heat, our Earth would be too cold for life.
Like greenhouses in icy parts of the world, they keep plants warm enough to grow. Living things' body processes depend on enzymes, which only work within a narrow range of temperatures.

To Find if the Sun Heat the Atmosphere and Which School Location is the Warmest



If we want to experiment scientifically we need to follow the same rules.

C ____

M ____

S ____

We also need to be able to use technology that will give us accurate and precise measurements. What technology can we use to measure heat?

____

Name ____________________________

Energy for Planets - Student Worksheet

Improving the safety and accuracy in using a glass thermometer.

1. Never hold it by the bulb end. Why?

____

2. Carry the thermometer horizontally across your body when moving. Why?

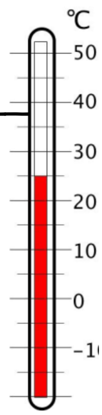
____

3. Always raise the thermometer so that your eyes are level with the fluid when you read the temperature. Why?

____

4. How accurately can you estimate the temperature using this technology?

____



Materials per group

- A thermometer (laboratory thermometers - no mercury)
- A worksheet and pen
- A roll of masking tape

Name ___________________________

Energy for Planets - Student Worksheet

- A ruler
- A map of the school with three locations marked on it.

Method

1. Measure a height of 1m on the classroom wall or door and mark with masking tape.
2. One student in each group lines up with the measured mark and places a piece of masking tape on himself or herself at exactly the same (1m) height as the marking on the wall. This student is in charge of the thermometer.
3. Care must be taken to ensure to select two similar locations but one in full sun and the other in shade. As much as possible everything else should be the same (closeness to buildings or dark surfaces, both out of wind etc.)
4. At the first location, the student in charge of the thermometer holds it vertically away from their body with the bulb level with their 1m mark. After waiting one minute, three readings are taken and entered in the worksheet.
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6. Calculate the average temperature of the readings in shade and those in full sun.

Name ___________________________

Energy for Planets - Student Worksheet

Observations for location 1

	Shade (°C)	Full sunlight (°C)
Reading 1		
Reading 2		
Reading 3		
Average Reading		

Observations for location 2

	Shade (°C)	Full sunlight (°C)
Reading 1		
Reading 2		
Reading 3		
Average Reading		

Observations for location 3

	Shade (°C)	Full sunlight (°C)
Reading 1		
Reading 2		
Reading 3		
Average Reading		

Conclusion A conclusion is the idea that our collected data leads us to state.

Which location about the school is the warmest? ____________

Name ____________________________

Energy for Planets - Student Worksheet

What can you conclude from this data?

____

Why did we hold the thermometer 1m above the surface?

____

Why did we take three readings and not just one?

____

____

Extra for Experts

Weather scientists take readings from stations set 1.2m above ground to minimise the effect of heat radiated back from the ground. The equipment is held behind double louvered walls to minimise the cooling effect of wind or rain and under double roofs. The box is called a Stevenson Screen.
Students may wish to return to their reading locations and contrast readings when the reading is taken close to the ground, with a wet thermometer bulb or if "wind" is blown onto the bulb.

Why wouldn't you erect a weather station near the barbeque?

____

Name ______________________________

Energy for Planets - Student Worksheet

Why aren't weather stations erected under the eaves of a building?

____

____

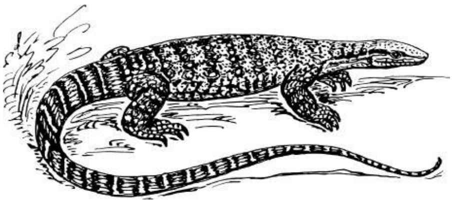
Why wouldn't you paint the walls of the station black?

____

____

Life Depends on Enzyme Activity to Survive

Most living things depend on chemical reactions within their bodies to release energy for growth, movement, repairing damage and reproduction. Enzymes are biological catalysts. They accelerate the speed of necessary reactions without being used up. Because enzymes are proteins they only work effectively between narrow ranges of temperature. Most human enzymes work best at about 37°C and our bodies work hard to maintain that as a core temperature. If we become too hot or too cold our efficiency is affected. Without enzymes we die. This is the same for most "warm bloodied animals".



"Cold bloodied" animals such as reptiles and amphibians however cannot control their body temperature. If it is a cold morning they will slowly crawl out of their nests in the cold ground to sunbathe, raise their core temperature and get their bodies working better. If it is too hot they will crawl into the shade. Many find dark hot road surfaces perfect for this purpose and end up as road-kill.

Yeasts are simple fungi. They are single cells about 3/1000ths of a metre long that divide to create new cells and for that and any other process, they need energy. Their energy comes from breaking down food such as sugars and complex carbohydrates just like us. During the process of respiration (creating energy) carbon dioxide gas is released. Different varieties of yeast are used for brewing beer, making wine and baking bread.

Heat and Yeast - Teacher's Notes

To make bread, flour is mixed with sugar, water and yeast to form resilient dough, which is then kneaded. Kneading mixes water with protein in the flour to form long elastic strands. The dough is left in a warm place so that escaping carbon dioxide from the yeast and sugar reaction is trapped within this elastic dough. When it has risen, the dough is placed into a hot oven. The yeast and its enzymes are killed by heat but the bubbles of gas remain trapped by cooked bread. In hot countries, bread dough is usually made to rise early in the morning whereas in cold countries it has to be placed in a warm area to help the enzymes warm enough to make it rise. The optimal water temperature for adding flour and sugar to yeast is just below 40°C.

Dried yeast can be bought from the bakery section of the supermarket. These packets contain little balls of many thousand individual cells. By stirring the yeast in tepid water first, the balls dissolve and the reaction proceeds much faster.

We cannot produce food in Science rooms, so we will only observe part of the reaction.

Heat and Yeast - Teacher's Notes

The rate of reaction depends on temperature. The experiment pictured above was carried out when the temperature inside was 26°C and outside 37°C. The glass was left outside for 3 minutes.

Activity: To observe the effect of heat from the Sun on yeast enzyme efficiency

Materials (Alternative procedure given also)

- Two glasses or beakers of the same size. (The bottoms of two used cool drink bottles can be cut off for each student group).
- One warm sunny location and one cool location (or alternative such as inside a fridge).
- 2 half tablespoons of sugar.
- 2 teaspoons of dried yeast. If you are using live yeast double the quantity
- Tepid water. Tepid water is about the temperature of your elbow.
- Water
- Teaspoon, tablespoon, pop stick to stir the mix.

.

Heat and Yeast - Teacher's Notes

Method

1. Measure the temperature inside and outside in the heat of the Sun.
2. Half fill both containers with tepid water (Same amount of water)
3. Dissolve 1 teaspoon of sugar in each container. (Same amount of sugar).
4. Sprinkle 1 tablespoonful of dried yeast on top of the water then stir in. (Same amount of yeast)
5. Place one container in a sun warmed area and the other in a shaded cool part of the classroom.
6. Observe changes in the two mixtures.
7. Draw your observations in the table provided.
8. While you are waiting and watching answer the last question on how human's use the Sun's heat.

Alternative: Using a water bath instead of heat from the Sun

If the weather is not hot or it is unwise to move in and out of the classroom:

Fill one basin or sink or bucket with hot water (40°C is ideal) and another with cold water. The experimental containers should be able to fit into these water baths.

The warm bath will simulate the heat of the Sun and the cold bath the ambient temperature.

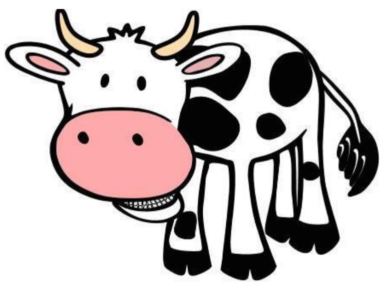
Heat and Yeast - Teacher's Notes

Location	**Inside**	**Outside**
Start		
After 3mins		
After 6 minutes		

Conclusion

Does energy from the Sun affect enzyme efficiency? Yes

Explain your answer. The reaction in the glass in the Sun's heat was very much faster and more vigorous than in the glass which stayed cool inside.



Was this a good scientific experiment? Did the cow moo softly? No.

What one thing did we change? Sun energy

What one thing did we measure? We didn't measure anything.

Did we keep everything the same? Yes.

If we did the experiment again, what would we

have to do to make it a good one? Measure the yeast's production of carbon dioxide gas/height of froth.
What materials would we need to do this? A ruler

Use of Heat from the Sun

Hint: Heat from the Sun also causes winds to blow.

In your group, list and describe five ways ordinary Western Australians benefit from the Sun's heat.

Drying washed clothes outside, sun-drying tomatoes and figs, heating household water (Solar passive and photoelectric),
Tourism both on the coast and in the desert inland.
Wind powers water pumping windmills for farmers and other windmills produce electricity.
Sailing boats use wind energy for recreation.
Heat is necessary for plants and animals to survive. Our native plants and animals, and introduced food plants and animals need heat from the Sun.
Many of our native plants are adapted to our hot climate.
Growing crops in the correct climate zones where the temperature suits their enzymes.

Extra for Experts – Sunny Showers

As an exploration geologist in the early 1970s, I worked from my tent camp out in the desert. Days were hot and dusty, and the nights weren't much better either. I had to find sneaky science ways to make my life more comfortable. Setting up the equipment below allowed me to have a very quick and quite hot shower in the evening. All I needed was a length of garden hose, the shower rose from a watering can, a large cork, water and an S shaped hook. What did I have to do to get my evening wash?

1. Fit the shower rose to one end of the hose. Hook this end of the hose onto a spade or branch so that it is higher than the rest.
2. Fill the hose with water and seal off with the cork.
3. Leave sealed hose lying in an open sunny area
4. At the end of the working day park the truck near the hose, take your clothes off; sling the hose onto the roof of the truck and shower under sunshine heated, gravity fed, water.

Name ____________________________

Heat and Yeast - Student Worksheet

Life Depends on Enzyme Activity to Survive

Most living things depend on chemical reactions within their bodies to release energy for growth, movement, repairing damage and reproduction. Enzymes are biological catalysts. They accelerate the speed of necessary reactions without being used up. Because enzymes are proteins they only work effectively between narrow ranges of temperature. Most human enzymes work best about 37°C and our bodies work hard to maintain that as a core temperature. If we become too hot or too cold our efficiency is affected. Without enzymes we die. This is the same for most "warm bloodied animals".

Yeasts are simple fungi. They are single cells about 3/1000ths of a metre long that divide to create new cells and for that and any other process, they need energy. Their energy comes from breaking down food such as sugars and complex carbohydrates just like us. During the process of respiration (creating energy) carbon dioxide gas is released.

Different varieties of yeast are used for brewing beer, making wine and baking bread.

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Heat and Yeast - Student Worksheet

To make bread, flour is mixed with sugar, water and yeast to form resilient dough, which is then kneaded. Kneading mixes water with protein in the flour to form long elastic strands. The dough is left in a warm place so that escaping carbon dioxide from the yeast and sugar reaction is trapped within this elastic dough. When it has risen, the dough is placed into a hot oven. The yeast and its enzymes are killed by heat but the bubbles of gas remain trapped by cooked bread.
We cannot produce and eat food in Science rooms, so we will only observe part of this reaction.

The rate of reaction depends on temperature. The experiment pictured above was carried out when the temperature inside was 26°C and outside 37°C. The glass was left outside for 3 minutes.

If the temperature is too hot the enzymes stop working.

Name ___________________________

Heat and Yeast - Student Worksheet

Activity: To observe the effect of heat from the Sun on yeast enzyme efficiency

Materials

- Two glasses or beakers of the same size.
- One warm sunny location and one cool location.
- 2 half tablespoons of sugar.
- 2 teaspoons of dried yeast.
- Tepid water. Tepid water is about the temperature of your elbow.
- Teaspoon, tablespoon, pop stick to stir the mix.

.

Method

1. Measure the temperature inside and outside in the heat of the Sun.
2. Half fill both containers with tepid water. Dip your elbow in the water to check it is the correct temperature.
3. Dissolve 1 teaspoon of sugar in each container.
4. Sprinkle 1 tablespoonful of dried yeast on top of the water then stir to dissolve it.
5. Place one container in a sun warmed area and the other in a shaded cool part of the classroom.
6. Observe changes in the two mixtures.
7. Write and draw your observations in the table provided.
8. While you are waiting and watching answer the last question on how humans use the Sun's heat.

Name ___________________________

Heat and Yeast - Student Worksheet

Location	Inside	Outside
Start		
After 3mins		
After 6 minutes		

Conclusion

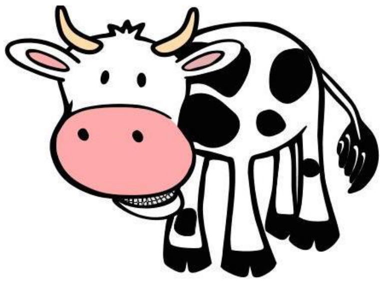
Does energy from the Sun affect enzyme efficiency? ________

Explain your answer

____

Was this a good scientific experiment, a Fair Test? Did the cow moo softly?

____



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Heat and Yeast - Student Worksheet

What one thing did we change?

____

What one thing did we measure?

____

Did we keep everything the same?

____

If we did the experiment again, what would we have to do to make it a good one?

____

____

What materials would we need to do this?

____

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Name ______________________________

Heat and Yeast - Student Worksheet

Use of Heat from the Sun

Hint: Heat from the Sun also causes winds to blow.

In your group, list and describe five ways ordinary Western Australians benefit from the Sun's heat.

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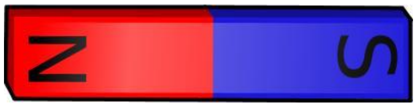
Magnetosphere- Teacher's Notes

Our Solar System's three "Goldilocks" planets, Mars, Earth and Venus are constantly being bombarded by solar winds. Radiation from the Sun contains energy and ionised particles (charged particles that are either positive or negative) that can cause death or mutation to living things.

Earth has a mobile liquid nickel iron outer core which generates a magnetic field which surrounds the planet. This can deflect most of the solar winds round the planet and sends them off into space.

Mars may at one time have had a similar magnetosphere as was suggested by data from the Mars Global Surveyor. Although its rocks have some remnant magnetism in patches, its magnetosphere is 40 times less than Earth's.

Venus has no magnetosphere. At its surface it is hot enough to melt lead. Most magnets will de-magnetise if heated.

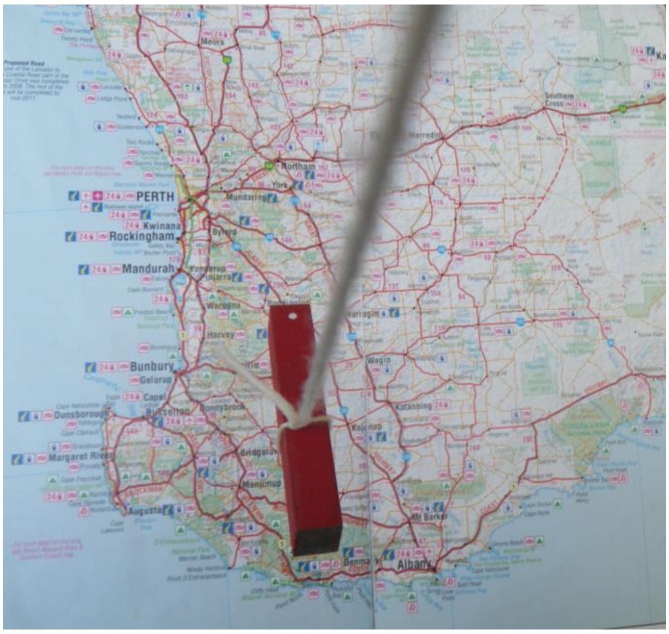


Magnetic Spheres and Magnets

The electrons spinning round the nuclei of some metals can be lined up if they are magnetised. This creates quite strong lines of force running round the magnet that act over a short distance. Earth has magnetic poles that currently lie close to the geographic north and south poles. They can move around over time and even occasionally flip. We know this because many igneous rocks have minerals that are magnetic. When they cool, they crystalise and indicate where the magnetic poles were when they first became solid.

Magnetosphere- Teacher's Notes

Earth's magnetic field can be demonstrated by hanging a magnet on a piece of string. It will align itself with Earth's magnetic field. This explains how a compass can be used to align a map north to south.



Magnet Hints for Teachers

1. The north end of a magnet is usually marked with "N" or a dot. If you do not know which is north, tie some string onto the magnet and let it dangle freely. It will soon align itself north to south. Your school map usually has north at the top; there are many free Apps which give compass directions or Google your location on the Internet.

2. Magnets usually come in pairs laid top to tail on either side of a wooden block and have two metal keepers to place along the ends joining the north poles to the south poles. This arrangement allows the magnets to maintain their magnetic charge.

3. Heating and hitting magnets can cause them to loose charge.
4. If you do not protect your magnets by wrapping them in kitchen film or by keeping them under paper, you may spend many hours trying to wipe iron filings from them.
5. Not all metals are magnetic. Usually magnetic metals may contain iron, nickel and cobalt. More recently rare earth atoms such as neodymium have been used.
6. Magnetic filings can be bought in some hardware shops and at educational material providers. If the dispenser is not a shaker, students can half fill teaspoons with filings and then spread them by gently tapping the spoon.

Data and Inference

We cannot always observe what causes a change but we can ***INFER*** its presence by observing the effect it has on other things.

Can we see the force of gravity? No we cannot see the force of gravity but we can infer that it exists because falling objects fall towards the center of planets even if they are initially thrown upwards.

Magnetosphere- Teacher's Notes

Can you observe the sphere of magnetism around a magnet? No, but we can infer its presence by the effect it has on other objects.
Forces can be attractive if they pull objects together or repulsive if they push objects apart.

Magnets and Magnetosphere

Materials per group

- Two bar magnets separately wrapped in cling wrap.
- A sheet of white A4 paper.
- Magnetic filings (and a teaspoon if required).
- A piece of string or wool about 30cm long.

Method

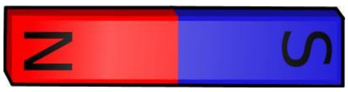
1. First find out the north poles of the magnet. Some have this marked with an "N or dot. If your magnets aren't marked, then tie the string to the magnets and let them hang loosely. And they will align north to south. Untie the string.

2. Holding a magnet in each hand about 10 cm apart, gently move the two north poles together. What did you observe and which sense did you use to make this observation? The magnets were held apart by an unseen force of repulsion. The closer they got together the stronger the force was. The sense was the sense of touch.

3. Again holding the magnets in each hand about 10cm apart, approach the north pole of one with the south pole of the other. What did you observe and which sense did you use to make this observation? The magnets were pulled together by an unseen force of attraction. The sense was again the sense of touch.

4. Place one magnet under a sheet of white A4 paper and gently sprinkle the iron filings over the paper. Draw what you observed.

What can you infer from your observations? Although we still cannot see the force field round the magnet, we can infer where it is by the alignment of the iron filings.



5. Return the filings carefully to the container. Place the two magnets as we did in step 2, only with the north poles only 3 cm apart. Put the sheet of white paper on top and sprinkle the filings on top. Draw what you observed.

Magnetosphere- Teacher's Notes

Data and Inference

Data is what you observe. Inference is working out unseen properties by analysing the data available.
For example.
Data A student runs with a bucket of water and pours it over another screaming student's head. The screaming stopped and the second student thanked them.
Inference The second student was on fire.

Using your observations (data) what can you infer from your observations?
Although we still cannot see the force field or magnetic field round the magnets, we can infer where it is by the alignment of the iron filings.

If Earth is surrounded by a magnetic field, what effect will that have on incoming magnetised radiation? The rays will be repelled.

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Magnetosphere - Student Worksheet

Our Solar System's three "Goldilocks" planets, Mars, Earth and Venus are constantly being bombarded by solar winds. Radiation from the Sun contains energy and ionised particles (charged particles that are either positive or negative) that can cause death or mutation to living things.

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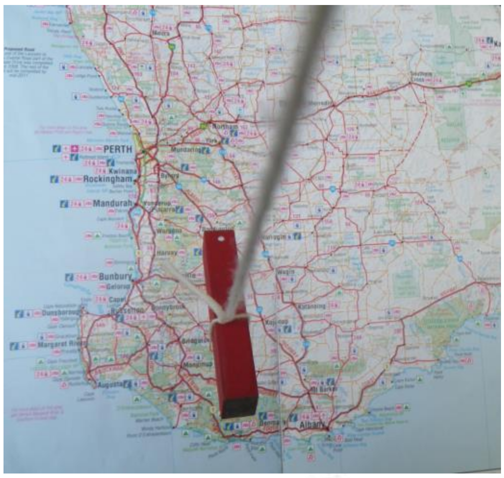
Venus has no magnetosphere. At its surface it is hot enough to melt lead. Most magnets will de-magnetise if heated.

Magnetic Spheres and Magnets

Earth's magnetic field can be demonstrated by hanging a magnet on a piece of string. The magnet's north pole will point to Earth's Magnetic North Pole.



Name ___________________________

Magnetosphere - Student Worksheet

This explains how a compass can be used to align a map north to south.

Our magnetic field repels the parts of cosmic radiation, which can damage life.

Data and Inference

We cannot always observe what causes a change but we can ***INFER*** its presence but observing the effect it has on other things.

Can we see the force of gravity? ___________________________

____

Can observe the sphere of magnetism around a magnet?

____

____

Magnets and Magnetosphere

Materials per group

- Two bar magnets separately wrapped in cling wrap.
- A sheet of white A4 paper.

Name ____________________________

Magnetosphere - Student Worksheet

- Magnetic filings (and a teaspoon if required).
- A piece of string or wool about 30cm long.

Method

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2. Holding a magnet in each hand about 10 cm apart, gently move the two north poles together. What did you observe and which sense did you use to make this observation?

____

____

3. Again holding the magnets in each hand about 10cm apart, approach the north pole of one with the south pole of the other. What did you observe and which sense did you use to make this observation?

Name ____________________________

Magnetosphere - Student Worksheet

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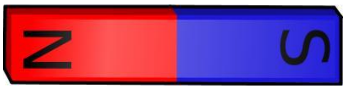
4. Place one magnet under a sheet of white A4 paper and gently sprinkle the iron filings over the paper. Draw what you observed.
   What can you infer from your observations?



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5. Return the filings carefully to the container. Place the two magnets as we did in step 2,only with the north poles only 3 cm apart. Put the sheet of white paper on top and sprinkle the filings on top. Draw what you observed.

____

____

Name ___________________________

Magnetosphere - Student Worksheet

Data and Inference

Data is what you observe. Inference is working out unseen properties by analysing the data available.

Data A student runs with a bucket of water and pours it over another screaming student's head. The screaming stopped and the second student thanked them.

Inference The second student was on fire.

Using your observations, from this experiment (data) what can you infer from your observations?

____

____

If Earth is surrounded by a magnetic field, what effect will that have on incoming magnetised radiation?

____

____

Planets and Beliefs - Teacher's Notes

Human Ideas Change over Time

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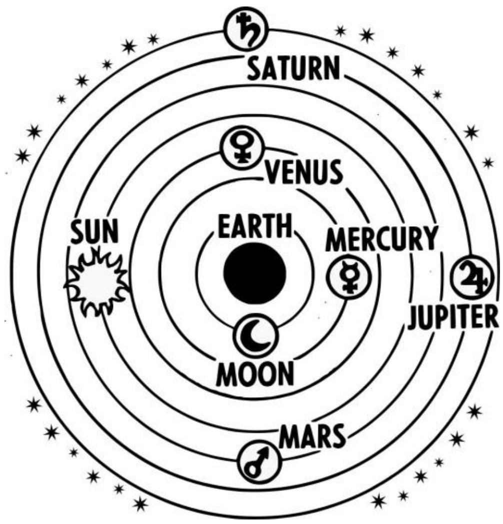


Our understanding of the Solar System changed as new instruments for observing and measuring became available. Our modern ideas on many things are different from those of our ancestors who believed that the Earth was the center of the Universe and planets were gods.

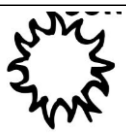
They probably worked this out by personal naked-eye observation. If you lie on your back at night, you will see that the stars appear to circle around the north or south poles but the planets do not follow them. They follow their own wandering paths. These observations led to the belief in a geocentric (Earth at the center) Universe, with heavenly bodies travelling in concentric spheres round Earth. Neolithic man and early Egyptians believed the Sun God crossed the heavens in a barge every day. The Romans thought the Sun god was pulled across the sky on a horse drawn chariot and Aboriginal people believed that the stars were children of the Sun and Moon thrown up into the sky for safety.

Astronomers gave the planets names and symbols. Most people could not read but could interpret symbols. We can only guess how they viewed our world. The legendary Bronze Age poet Homer describes the sea as "wine dark". Some people say that this is because our eyesight has changed in the intervening years. Others say that wine has changed or we are misinterpreting an ancient language. Science does not accept opinions that aren't backed up by observations that are measurable and repeatable.

Planets and Beliefs - Teacher's Notes

Very Early Astronomers' Symbols for the Planets

Using the diagram of the medieval astronomer's Solar System, choose which planet or object is represented by each symbol and explain why.

Symbol	Planet	Possible explanation for symbol
☉	**Earth** (Not considered a planet at this time but the center of the Solar System)	Dot is center of everything? Earth is at the centre of the heavenly spheres?
☾	**The Moon**	It looks like a crescent moon?
☿	**Mercury**	The god Mercury the messenger of the Gods with wings on his hat?
♀	**Venus**	Goddess of love. A high status Bronze Age woman's mirror?
	**Sun or Sol**	Rays of heat and light?
♂	**Mars**	God of war. A shield and spear?
♃	**Jupiter**	An eagle was the sign for Jupiter? (Can't see it myself!)
♄	**Saturn**	The sickle (grain stem cutter) of Chronos, the god of time?

Planets and Beliefs - Teacher's Notes

Common Misconceptions

We are studying Earth and Space Science. Science demands data to support conclusions. Beliefs do not. Both science and belief can change as more information or better technology provides better data. Recent studies have found that 25% of people in the USA and 32% in the European Union believe the Sun travels round the Earth. You may wish to ask for a "eyes shut, hands up" poll of your class on which they think moves round which.

Number of students in our class **30**

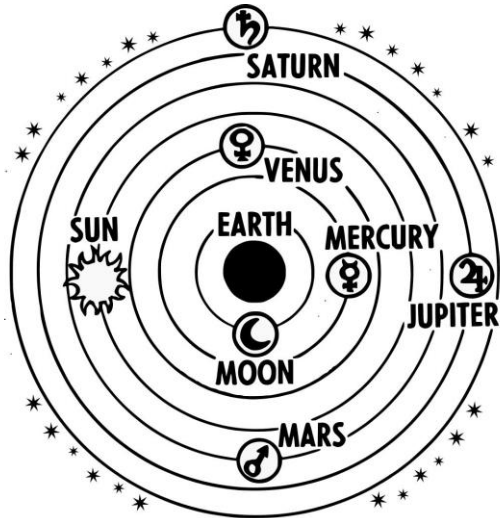
	The Sun moves round the Earth	**The Earth moves round the Sun**	**Don't know**
Number of students	10	18	2
Fraction of students	$\frac{10}{30}$	$\frac{18}{30}$	$\frac{2}{30}$
Percentage of students	33%	60%	17%

Name ______________________________

Planets and Beliefs - Student Worksheet

Human Ideas Change over Time

Our understanding of the Solar System changed as new instruments for observing and measuring became available. Our modern ideas on many things are different from those of our ancestors who believed that the Earth was the center of the Universe and planets were gods. Why do you think that was?



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Very Early Astronomers' Symbols for the Planets

Using the diagram of the medieval astronomer's Solar System, choose which planet or object is represented by each symbol and explain your choice.

Symbol	Planet	Possible explanation for symbol
⊙		

Name ______________________________

Planets and Beliefs - Student Worksheet

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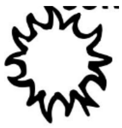
☾		
☿		
♀		
		
♂		
♃		
♄		

Name ___________________________

Planets and Beliefs - Student Worksheet

Common Misconceptions

Recent studies have found that 25% of people in the USA and 32% in the European Union, believe the Sun travels round the Earth.

Number of students in our class

Students	**The Sun moves round the Earth**	**The Earth moves round the Sun**	**Don't know**
Number of students			
Fraction of students			
Percentage of students			

Making Your Mark- Teacher's Notes

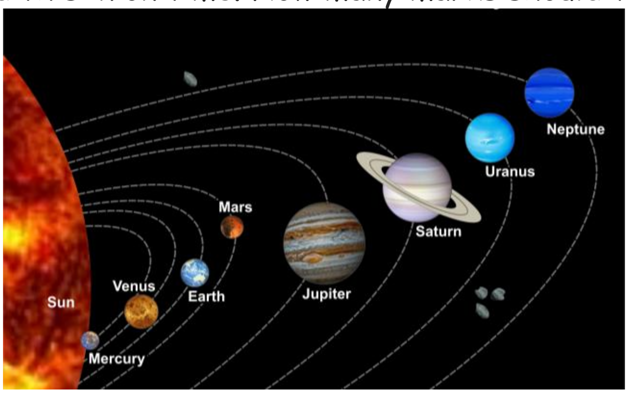
When we make scientific drawings we often have to draw the objects "to scale", so we can fit them on the page. For example, trying to make a drawing of the planet Jupiter, which is so large that you can place 1,321 planet Earths inside and still have a bit left over, can present some problems if you only have a standard sheet of A4 paper.

Learning to answer the questions asked and looking at the marking key are important skills for students to learn. If the key gives three marks then three answers are needed.

Students were asked to draw a scaled drawing of our Solar System.
Marks were awarded for:

1. Keeping to scale (1 mark)
2. Scale written on drawing (1 mark)
3. Correctly labeling the planets and the Sun (9 marks)
4. Give the drawing a title (1 mark)
5. Neat work (1 mark)
6. On time (1 mark)
7. Name of student (1 mark)

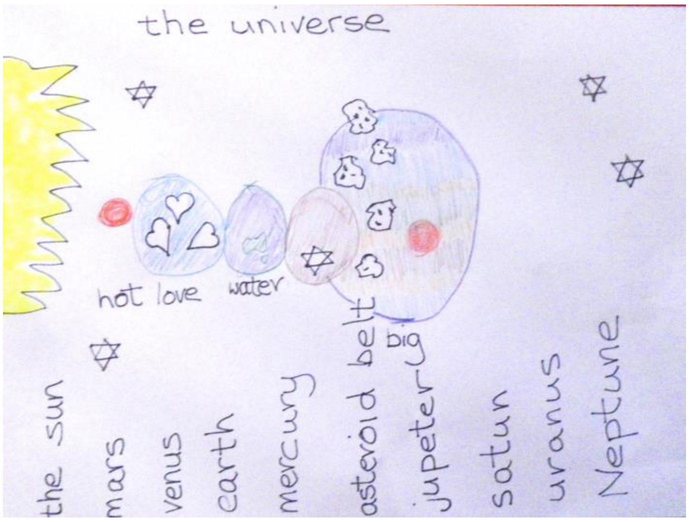
A student handed this in on time. How many marks should they get?



The student should get no marks because they were asked to produce a drawing.

Making Your Mark- Teacher's Notes

Another student handed in this work two days late. What marks should they get? Explain your answer.



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1 Not to scale (0)

2 No scale given (0)

3 Two of the planets' names were misspelled and the Asteroid Belt was not required (7)

4 The title should have been "The Solar System". (0)

5 The planets were not drawn spherical or circular (0)

6 Late (0)

7 No name (0)

Name ____________________________

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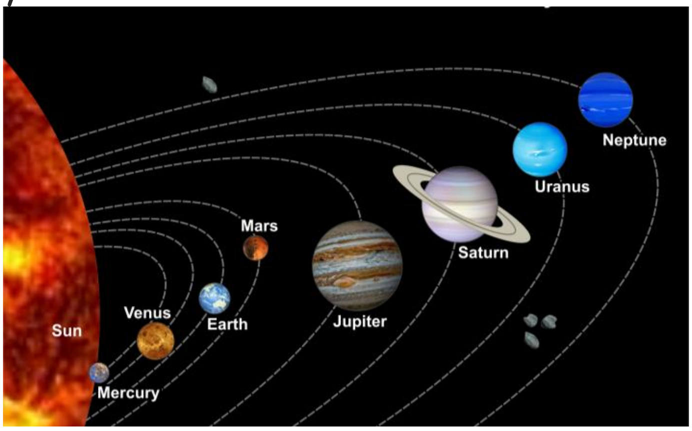

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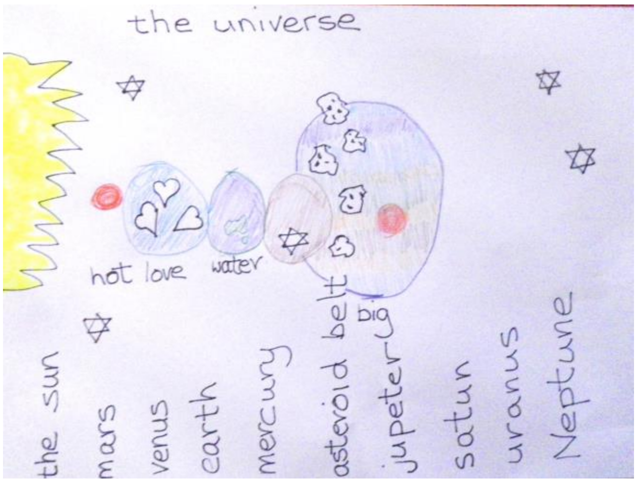

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Santos & ESWA supporting earth science education

We Know Where You Live - Teacher's Notes

Aliens, they know where you live, or do they?

Many students, but not all, will have written their Universal address inside a diary, notebook or school bag.

Name	John Smith
Room	G22
School	XXX Primary School
Suburb or Town	Melville
State	Western Australia
Country	Australia
Hemisphere	Southern Hemisphere
Planet	Earth (third planet from the Sun)
Star System	Solar System
Galaxy	Milky
Location in galaxy	Western spiral arm

Most of the information contained in your Universal address could only be understood by someone who spoke your language and was familiar with Earth and its conventions. This information doesn't describe you, only where you were located at a specific period of time.

Once you have left Earth can you still use terms such as "North or South" for directions? Can we use the points of the compass and a compass itself to find our way on other planets or the Sun? North and south on Earth are only determined by Earth's magnetic field or the plane of its rotational axis. Magnetic field lines run out from the South Magnetic Pole and return through the North Magnetic Pole. The magnetic poles are not the same as the geographic poles. Both Venus and Mars do not have magnetic fields.

We Know Where You Live - Teacher's Notes

North/south is determined by the rotation axis of each planet. Most planets in our Solar System have axes that are nearly parallel to Earth's. An exception is Uranus whose magnetic axis is tipped over 60° to its rotation axis.
The Sun' also rotates on its axis. Its magnetic poles flip regularly, about every eleven years.

How can astronauts accurately plot their location and trajectory in space beyond the Solar System?
Astronauts use the stars to find out where they are and to where they are moving.
The Galaxy itself rotates on an axis; if you're in deep interstellar space, you might use that as a frame of reference.

So far no astronauts have gone far enough out into space to need to find their location by using known stars. However unmanned spacecraft such as Voyager1 & 2 have travelled close to other planets using star locations

How could we communicate with another form of Life?
In 1974, the American astronomer Carl Sagan and others beamed a radio message from Arecibo in Puerto Rica to a star cluster 25,000 light years away.

1 light year = 63239.7Au or 9,461,000,000,000km.

Radio waves travel at the speed of light

At this time there were no personal computers, microwave cookers, mobile phones and Wi-Fi.

We Know Where You Live - Teacher's Notes

The pictorial "Arecibo" message included:

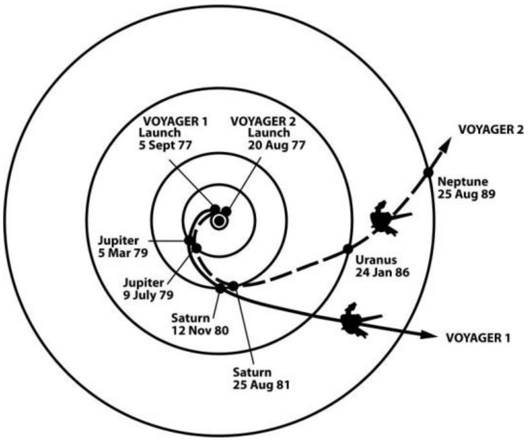
- Our position in our solar system.
- Basic principles we use in mathematics and in science.
- A picture of NASA's radio antenna.
- Pictures of human body shapes and a structure of our DNA.

How might life on the Star cluster know where the message came from?

1. They could follow the radio signal back to its source.
2. They might recognise the pattern of star and planets from their own discoveries.

Why do you think the message was described as a time capsule from Earth?
The message would take 25,000 light years to reach the star cluster, which is a very long distance from Earth. Radio waves travel at the speed of light in space. By the time it arrived the information would have been already 25,000 years old.

Space probes Voyager 1 & 2 were launched in 1977 and had gold plated phonogram records (similar to early vinyl phonogram records) which contained sounds, music and images of not only humans but of other species and of Earth's geography. These are still travelling outwards.



Since the search for exo-planets (planets in other solar systems) began, we now know that there are many exo-planets, some of which may be hospitable to life. In early 2017, NASA announced that its Sptizer Telescope had discovered a sun they called Trappist-1, which is orbited by seven planets. It lies about 39.5 light years away in the constellation of

We Know Where You Live - Teacher's Notes

Aquarius in our own Milky Way Galaxy. Three of its rocky planets are in Earth-like orbits. We may not be alone!

Form groups of two or three. Take five minutes to write down your opinion on the following question.
What would be the advantages and disadvantages of alerting an alien planet to life on Earth.

Advantages	Disadvantages
They may teach us many things which are useful things We may be able to forge political alliances We may be able to trade with them.	They might destroy our planet They might eat us They might carry diseases we have no knowledge about

More information on exo-planets can be found at
https://exoplanets.nasa.gov

Name ____________________________

We Know Where You Live - Student Worksheet

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Room________________________________

School ______________________________

Suburb or Town _______________________

State_______________________________

Country _____________________________

Hemisphere___________________________

Planet_______________________________

Star System___________________________

Galaxy ______________________________

Location in galaxy_____________________

Name ____________________________

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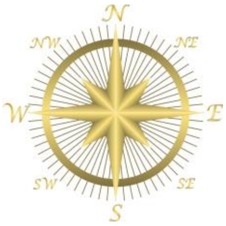

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How can astronauts accurately plot their location and trajectory in space beyond the Solar System?

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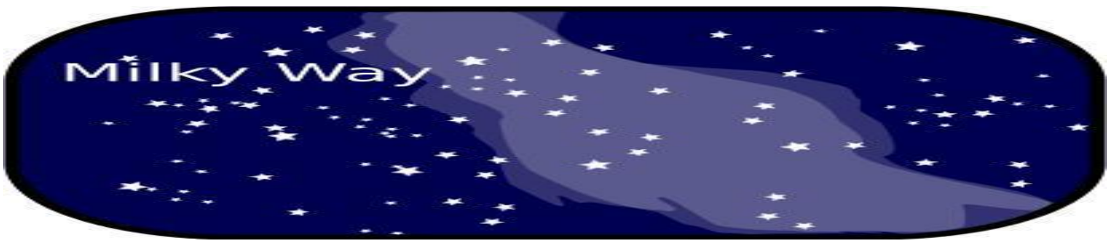

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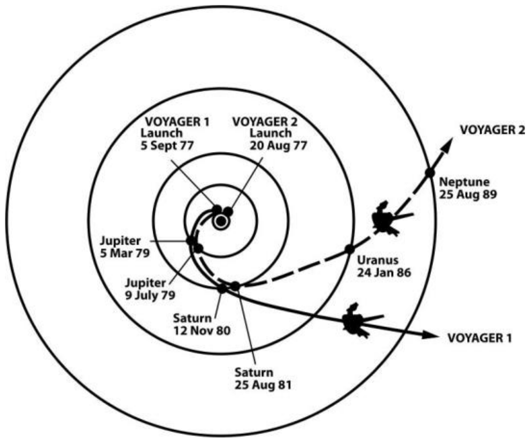

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Name ____________________________

We Know Where You Live - Student Worksheet

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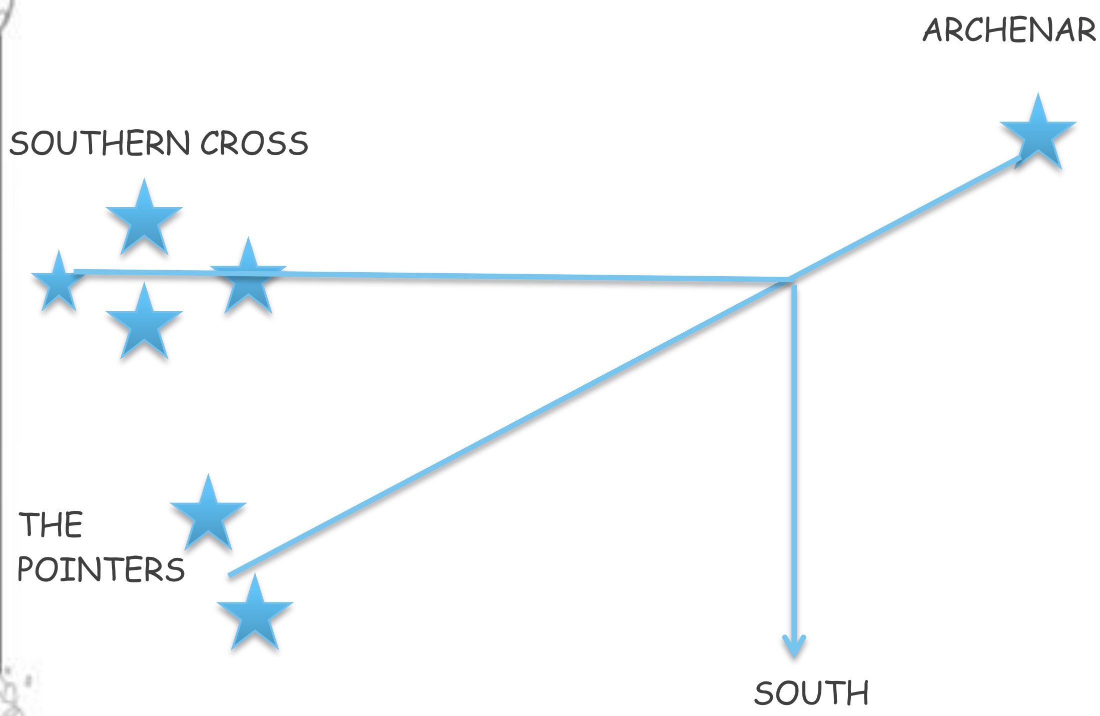
Advantages	Disadvantages

Name ____________________________

Find Your Way - PPP

Try this at home on a starry night

Our ancestors had to find their way about the world and they used the stars which, unlike the planets, take fixed paths across the sky. Unlike countries in the Northern Hemisphere, Australia does not have a Pole Star to work with.
Our ancestors took a straight line from half way between the Pointers to a very bright star called Archenar. Then they visually intersected that line by extending the long axis of the Southern Cross until both lines crossed. If you drop a line down to the horizon from this point this is the direction of south.
Can you find south from your home?



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