Wonderworld of Space

WRITTEN BY RON SHAW

THE ACTIVITIES IN THIS BOOK ADDRESS MANY OUTCOMES IN THE SYLLABUS

Wonderworld of Space
Intelligent Australia Productions

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Much of the material -text and graphics- have been reproduced with kind permission from NASA and its www.hubblesite.org site compilers.
NASA's Hubble Space Telescope is the renowned orbiting telescope whose discoveries have forever altered our knowledge of the Universe.

Dedicated to Max

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Intelligent Australia Productions is committed to raising standards in Literacy and Numeracy in Australian schools.

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Contents

Teachers Notes

P6 Space Quiz *Find out who knows the most about Space. This quiz may be given at any time…before, during or after your Space studies. Students circle the correct answers.*
P7 Space Research *Students use the internet to find one-word answers to 10 questions. After that they choose the subject of any one of the questions and write a paragraph about it.*
P8 Space Crossword *The 16 questions in this crossword puzzle cover many aspects of Space, including the Solar System and beyond our galaxy.*
P9 Solar System Myths *After debunking three commonly held beliefs about the Solar System we ask students to comment on topics generated by the myths.*
P10 Comets *A passage about comets is followed by four questions in which students provide full-sentence answers.*
P11 Our Moon *A research sheet covering Moon facts, Moon missions, Moon walkers and Moon mountains.*
P12 Space Puzzle *This worksheet contains 9 words to un-jumble. When that's done students present three things they know about each word.*
P13 The Planets *research: Complete the table by finding, for each planet, its orbital period, number of moons, and distance from the Sun.*
P14 The Hubble Telescope *A passage about the orbiting Hubble telescope is followed by four questions in which students provide full-sentence answers.*
P15 Galaxies *A passage about galaxies is followed by four questions in which students provide full-sentence answers.*
P16 Black Holes *A passage about Black Holes is followed by four questions in which students provide full-sentence answers.*
P17 Space Questions *An internet research sheet covering eight different Space topics.*
P18 Early Astronomers *A reading comprehension worksheet explaining the work of the great astronomer Nicolaus Copernicus.*
P19 Early Astronomers *A reading comprehension worksheet explaining the work of the great astronomer Galileo Galilei.*
P20 Early Astronomers *A reading comprehension worksheet explaining the work of the great astronomer Tycho Brahe.*
P21 Early Astronomers *A reading comprehension worksheet explaining the work of the great astronomer Johannes Kepler.*
P22 My Weight and Age on Other Planets *Using a Conversion Table students use a calculator to ascertain their weight and age on each planet.*
P23 Light Year *Students are given 10 questions to reinforce their understanding of a Light Year.*
P24 Space Detectives (**Short written answers)** *Children from places far and wide have asked questions about Space. Your students research and find the answers to any three questions. They write 4-6 sentences for each.*
P25 Space Detectives (**1-2 minute talks)** *Children from places far and wide have asked questions about Space. Your students choose one question, research the answers, and give a class talk on it for 1-2 minutes.*
P26 Space Detectives (**Small group activity)** *Children from places far and wide have asked questions about Space. Your students work individually, within a small group, to research and find the answer to any one question. They then present their findings to the group.*
P27 Space Detectives (**One page answer)** *Children from places far and wide have asked questions about Space. Your students research and write a one-page response to any question (include a small sketch).*
P28 Incredible Journey *This is a Written Expression exercise. Students tell about their Space adventure in the year 2040.*
P29 Space Haikus *Using four Space topics students create haikus for each.*
P30 Space Acrostic *The task is to write an acrostic poem using the word 'Astronomy'.*
P31 Space Art *Create an imaginative piece of art from the squiggles, lines and boxes.*
P32 Space Dilemma *A cross-curricula lesson (Science; Health; Society & Environment; Technology & Enterprise) in which students are asked to present justifications for continuation of the Space programme.*
P33 Constellations *A passage about constellations is followed by seven questions in which students provide full-sentence answers.*
P34 The Galaxy Song *A fun and thought-provoking song about the vastness of Space.*
P35 Finding Planets *A passage about finding planets is followed by eight questions in which students provide full-sentence answers.*
P36 Albert Einstein (and $E=mc^2$) *A passage about Albert Einstein and his famous formula. On completion of reading, students are invited to ask four questions.*
P37 Dorothea Klumpke Roberts & Annie Jump Cannon *A passage about these two female astronomers is followed by seven questions in which students provide full-sentence answers.*
P38 Is there Life out there? *See Teachers Notes on next page.*

Teachers Notes

for

Is there Life out there? (page 38)

Ask students: What is life?
Answer: *Organisms –animals /plants/ fungi/ bacteria - whose cells grow and replicate according to their embedded DNA.*
Ask students: How did the first life originate?
Answer: *Scientists speculate that certain chemicals combined to form the first single celled organisms billions of years ago.*

The universe is 13.7 billion years old. It is composed of many billions of galaxies. There has been a lot of time for life to form and evolve, and -very probably- a lot of worlds (planets) upon which this could have occurred.
Ask students: Could life have evolved on planets whose atmospheric conditions are unlike ours?

Humans have sent radio signals into Space but have not received any response.
Ask students: Does this surprise you? Explain.

What about UFOs?
Ask students: Do you think Aliens have visited Earth?
Some people believe there are Aliens amongst us, masquerading as humans.
Ask students: Could that be? If yes, why would they? If no, why not?

Ask students: If there is other life 'out there' is it likely or unlikely that there is a human-like race? Explain your answer.

There is no doubt that humans have become 'cleverer', at least as far as technology is concerned, and it seems equally clear that we will become even cleverer (more technologically advanced).
Ask students: Could it be that 'out there' there are beings who have surpassed human technological achievements? If so, what might their civilizations be like?

Ask students: If alien beings should visit Earth in the future do you think they would be hostile? Explain your answer.

Scientists have already talked about possible visits to Mars and they've even discussed the possible setting up of a new (human) civilization there one day.
Ask students: What are your thoughts about this….do you think this would be a good thing? Why/why not?

Billions of dollars are spent every year in efforts to unlock the great mysteries of the universe.
Ask students: Do you think NASA and other Space exploration programs should cease? Would not the money be better spent here on Earth? (consider having a class discussion or class debate about this).

This lesson is available for students as 'Life in the Universe' in the Nature's Kids section on Intelligent Australia's website: http://www.intelligentaustralia.com

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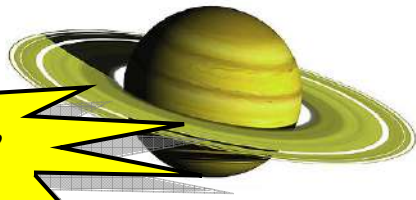
Name ..... Date .....

Space *Quiz*

How much do you know?



1. Which is our Solar System's largest planet?	*Earth*	*Saturn*	*Jupiter*	*Mars*
2. A light year is a ...	*period of time*	*distance*	*speed*	*light beam*
3. Which is the biggest.....?	*Earth*	*Sun*	*Jupiter*	*Moon*
4. The Hubble Telescope is in....	*England*	*Australia*	*NASA Control Centre*	*Space*
5. How many moons has planet Saturn?	*more than 20*	*15*	*10*	*4*
6. Black Holes have a lot of....	*space*	*gravity*	*diameter*	*volume*
7. Pluto isn't a planet because it is too....	*small*	*big*	*far away*	*bright*
8. A famous Italian astronomer was Galileo	*Brahe*	*Kepler*	*Galilei*	*von Braun*
9. Which has the least gravitational force?	*the Sun*	*Earth*	*the Moon*	*Jupiter*
10. The first person to walk on the Moon was	*John Glenn*	*Neil Armstrong*	*Andy Thomas*	*Buzz Aldrin*
11. Earth's seasons are caused by its	*revolution*	*latitudes*	*rotation*	*longitudes*
12. Constellations are groups of	*planets*	*stars*	*galaxies*	*comets*
13. The Milky Way is a	*galaxy*	*constellation*	*star*	*asteroid*
14. Which can be in the shape of a spiral?	*star*	*planet*	*meteor*	*galaxy*
15. Which has a well-known red spot?	*Mars*	*Jupiter*	*Saturn*	*Mercury*
16. 4.2 light years is the distance from Earth to	*the Sun*	*the Moon*	*Proxima Centauri*	*Pluto*
17. Planets' orbits are	*circular*	*elliptical*	*uncertain*	*irregular*
18. Day and night are caused by Earth's	*revolution*	*orbits*	*gravitation*	*rotation*
19. Deep inside a planet is its	*crust*	*strata*	*ionosphere*	*core*
20. The more mass, the more	*gravity*	*light*	*radiation*	*sound waves*
21. Light from the Sun to Earth takes how long?	*8 hours*	*8 light years*	*8 minutes*	*8 years*
22. A Solar eclipse is when the Moon blocks out	*the Sun*	*the Earth*	*stars*	*planets*
23. In our Solar System comets orbit	*planets*	*the Sun*	*other stars*	*asteroids*
24. How many years old is the universe?	*10 -20 thous'*	*10-20 mill'*	*10-20 bill'*	*10-20 trill'*
25. A comet's tail always faces away from the	*Earth*	*Sun*	*Moon*	*horizon*
26. The first satellite to orbit Earth was from	*Russia*	*Japan*	*USA*	*China*
27. Shooting stars are	*asteroids*	*meteors*	*comets*	*stars*
28. Earth spins around once every	*24 hours*	*month*	*season*	*year*
29. The word lunar refers to the	*Sun*	*Earth*	*Stars*	*Moon*
30. Which is the smallest?	*constellation*	*solar system*	*universe*	*star*

Name ..... Date .....

Space Research

Search and Learn

1. What is Jupiter's diameter?	
2. How fast does light travel?	
3. How far away is the Sun?	
4. How often does Halley's comet appear?	
5. Which star is nearest to our Solar System?	
6. Andromeda is a long way away. What is it?	
7. How many moons does Mars have?	
8. Name two of Saturn's moons.	
9. Who was the first person to go into Space?	
10. What is Neptune made of?	

When you have completed the questions above choose one of the topics and write an interesting paragraph about it.

Chosen Topic: .....

.....

.....

.....

.....

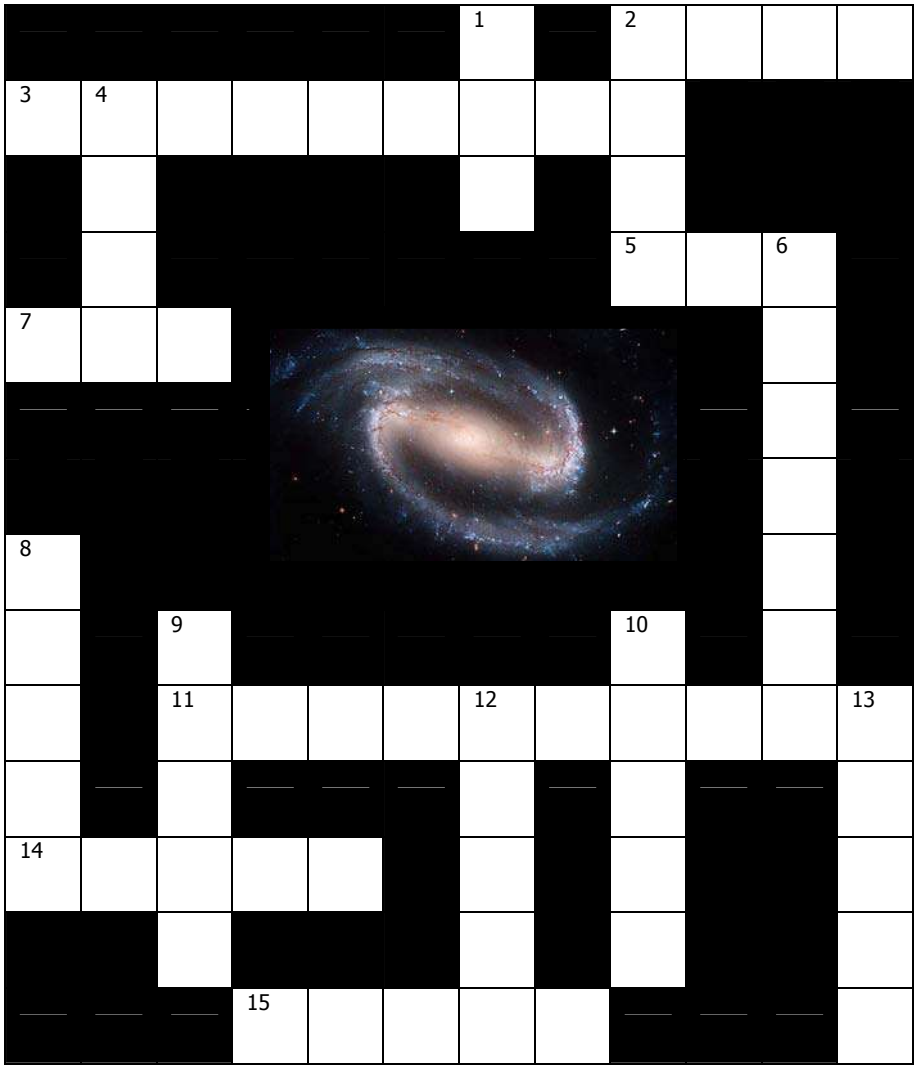
.....

Web Source: .....

Name .....

Date .....

Space *Crossword*



Down

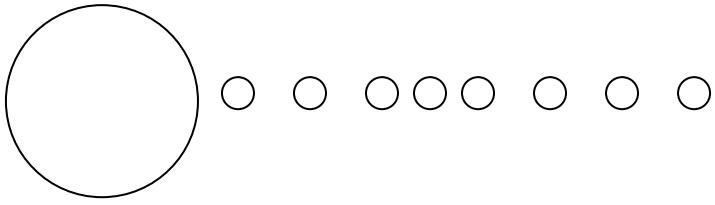
1 The colour of Jupiter's spot.
2 The 4th planet from the Sun.
4 National Aeronautics and Space Administration. *initials*
6 This planet has the same name as the Roman god of the Sea.
8 Halley is one and so is Hale-Bopp.
9 This planet lies between Venus and Mars.
10 To do with the Sun.
12 The path of a planet around the Sun.
13 Planet Saturn has spectacular.....?

Across

2 This revolves around planet Earth.
3 The nearest spiral galaxy to the Milky Way.
5 The centre of our Solar System.
7 Our galaxy is the Milky …?
11 Someone who studies stars, planets etc.
14 Saturn's largest moon.
15 Until 2006 this was a planet.

Challenge

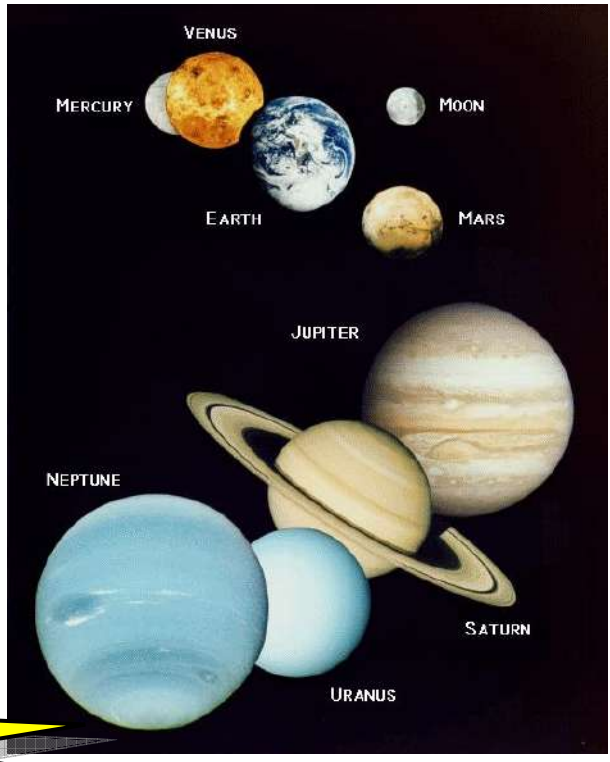
The large circle is the Sun.
Write the planets' names underneath them.
Note: sizes and distances are not to scale.



Name .....

Date .....

Solar System *Myths*



Myth 1 *The Earth is the largest object in the Solar System.*

Reality The largest object in the Solar System is the Sun. It contains 99 percent of the mass of the Solar System. Jupiter is the largest planet in the Solar System, and Earth is the fifth-largest.

Myth 2 *The rings of Saturn are solid disks.*

Reality Thousands of rings, made of pieces of ice, orbit the planet. The pieces of ice are about one metre apart, and can be as small as dust specks or as big as a house. The ice pieces collect into ring shapes because of gravity. The rings are usually divided into seven regions, labeled A to G. The total mass of the rings is that of a 100-kilometre-sized comet.

Myth 3 *Spacecraft can land on the surfaces of Jupiter, Saturn, Uranus, and Neptune.*

Reality These giant planets are made mostly of gas. They may have solid cores, but the temperature and pressure of the gas would increase as the spacecraft moved toward the core. It would be destroyed before it reached that solid surface.

Your Thoughts

1. Why do you think people long ago thought that Earth was the biggest object in the Solar System?

.....

.....

.....

2. Saturn's rings are made up of ice. If Mercury had rings they would not be made of ice. Explain.

.....

.....

.....

3. Jupiter, Saturn, Uranus and Neptune are far from the Sun so we would expect them to be cold planets. So why would a spacecraft burn up if it approached the core of any of these planets?

.....

.....

.....

Name ..... Date .....

Comets

Comets have been known since ancient times. There are Chinese records of Comet Halley going back to at least 240 BC. The famous Bayeux Tapestry which commemorates the Norman Conquest of England in 1066, depicts an image of Comet Halley.

Comets are sometimes called dirty snowballs. They are an ice-dust mixture that for some reason didn't become planets when the solar system was formed. This makes them very interesting as samples of the early history of the solar system.
All comets consist of these parts…

nucleus: solid and stable, mostly ice and gas with a small amount of dust and other solids
coma: dense cloud of water, carbon dioxide and other neutral gases
tail: up to 10 million km long and composed of smoke-sized dust particles driven off the nucleus by escaping gases; to the unaided eye this is the most prominent part of a comet

Due to the glare of the Sun comets are usually visible only at sunrise or sunset.
Many are discovered by amateur astronomers.

Comets are invisible except when they are near the Sun. Most have orbits which take them far beyond the orbit of Pluto; these are seen once and then disappear for millennia. However there are some which appear to us at regular intervals. For example the most famous comet, Comet Halley, visits us every 76 years.

After 500 or so passes near the Sun most of a comet's ice and gas is lost leaving a rocky object very much like an asteroid in appearance. (about half of the near-Earth asteroids may be 'dead' comets)

Comet Questions

1. How long ago did the ancient Chinese see Comet Halley?

.....

.....

2. What would be reasons for Comet Halley being so famous?

.....

.....

3. Why do you think it is that comets are only visible when they are near the Sun?

.....

.....

4. What change can occur when a comet has passed close to the Sun many times?

.....

.....

Name ..... Date .....

Our Moon

Research

Moon Walkers

Some people who have walked on the Moon are (name and year)....

.....

.....

.....

.....

Moon Facts

diameter:

.....

mass:

.....

distance from Earth:

.....

time to rotate:

.....

time to revolve around Earth:

.....

Names of 6 US manned Moon missions (with landings) *(incl' year)*

.....

.....

.....

.....

.....

.....

.....

Something interesting about the Moon's

mountains .....

.....

craters .....

.....

Name ..... Date .....

Space *Puzzle*

Research

Each word below is something that is found naturally in Space. Someone has jumbled up the letters. See if you can work out what these objects are. Then write three things about each one. *Note: A capital letter indicates first letter.*




Jumbled Word	Un-jumbled	Three things I know about this.
mteero		
glayax		
ruiJtpe		
rats		
dorsatei		
tmoce		
nelpat		
aurnSt		
oalesocntltin *begins with c*		

Name .....

Date .....

The Planets

Research

Complete this table of distances and orbital periods by searching on the World Wide Web.

Then write two more interesting facts about each planet ....(be brief and write small)
Example (Neptune): ***surface temp' is over 200° below zero***

Mercury

no. moons:.....

dist' from Sun:.....

orbital period:.....

1)
2)

Two Facts

Venus

no. moons:.....

dist' from Sun:.....

orbital period:.....

1)
2)

Two Facts

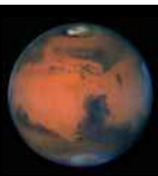
Earth

no. moons:.....

dist' from Sun:.....

orbital period:.....

1)
2)



Mars

no. moons:.....

dist' from Sun:.....

orbital period:.....

1)
2)

Jupiter

no. moons:.....

dist' from Sun:.....

orbital period:.....

1)
2)

Two Facts

Saturn

no. moons:.....

dist' from Sun:.....

orbital period:.....

1)
2)

Uranus

no. moons:.....

dist' from Sun:.....

orbital period:.....

1)
2)

Neptune

no. moons:.....

dist' from Sun:.....

orbital period:.....

1)
2)

Name .....

Date .....

The Hubble Telescope

The Hubble Telescope is revealing many secrets of the universe.

Read the passage and then answer the questions that follow.

Information courtesy NASA

Named after the astronomer Edwin Hubble (1889-1953) the Hubble Space Telescope is an observatory in orbit around Earth. It has revolutionized astronomy by providing deep and clear views of the Universe, ranging from our own solar system to extremely remote galaxies formed not long after the Big Bang 13.7 billion years ago.

Hubble orbits far above the distorting effects of the Earth's atmosphere and returns data of unique scientific value. Though not large by ground-based standards Hubble achieves heroically in space.
The farthest objects it has seen are galaxies well over 12 billion light years away.

Hubble, with its 2.4m diameter primary (main) mirror, was the first optical telescope to provide convincing proof of a Black Hole several billion times the mass of the sun in the early 1990's.

Hubble's orbit is 575 kilometers above the Earth's surface, with one orbit taking 97 minutes.

Questions *(answer in full sentences)*

1. What do you think is meant by the phrase 'revolutionized astronomy'?

.....

.....

2. What advantage does an Earth-orbiting telescope have over a ground-based telescope?

.....

.....

3. Hubble *achieves heroically*. What does this mean?

.....

.....

4. The Hubble telescope is not as large as many Earth-based telescopes. Why do you think this might be?

.....

.....

5. Someone has said that Edwin Hubble is *remembered in the best way possible*. What do you think they meant?

.....

.....

Name ..... Date .....

Galaxies

A galaxy is a massive system consisting of stars, gas and dust, and dark matter.
Dwarf galaxies contain as few as ten million stars while giant galaxies are home to a trillion stars. The stars in every galaxy orbit a common centre of gravity. Galaxies can contain many multiple star systems, star clusters, and interstellar clouds.

Galaxies are categorized according to their shape.
A common form is the elliptical galaxy, which has an ellipse-shape. Spiral galaxies are disk-shaped, with curving, dusty arms. Galaxies with irregular or unusual shapes are known as peculiar galaxies, and usually result from disruption by the gravitational pull of neighbouring galaxies. Such interactions between nearby galaxies, which may eventually result in galaxies merging, may cause many new stars to form, producing what is called a starburst galaxy.

There are probably more than one hundred billion galaxies in the observable universe. Intergalactic Space (the space between galaxies) contains a tiny amount of gas, with an average density less than one atom per cubic metre.

Dark matter accounts for around 90% of the mass of most galaxies. But the nature of these unseen components is not well understood.

Observational data suggests that super-massive black holes may exist at the centre of many, if not all, galaxies. The Milky Way galaxy, home of Earth and the solar system, appears to have at least one such object at its centre.

<u>Questions</u> *(answer in full sentences)*

1. What is a starburst galaxy?

.....

.....

2. What do you think is meant by the *observable universe*?

.....

.....

3. Write the sentence that tells us there is a very small amount of gas between galaxies.

.....

.....

4. What would you say is meant by *observational data*?

.....

.....

Name .....

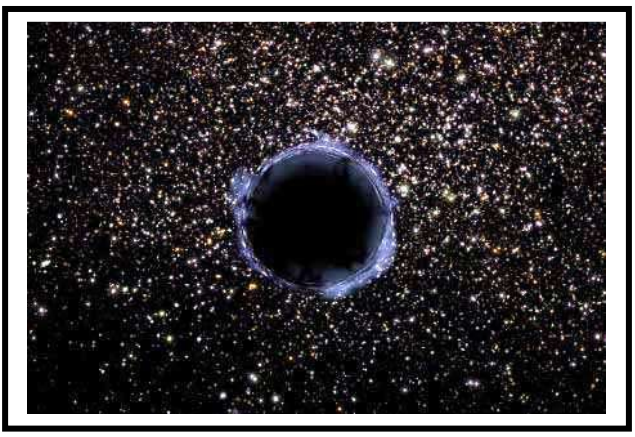
Date .....

Black Holes

Earth's escape velocity is 11 km/s.
What does this mean?
Anything that wants to escape earth's gravitational pull must go at least 11 km/s, no matter what the thing is — a rocket ship or a cricket ball.

The escape velocity of a planet, star or other celestial body depends on how compact it is.
Consider a small planet that is made of a heavy substance. It will have a very high escape velocity; an object needs to travel at great speed to lift off from its surface.
On the other hand a large planet which happens to be composed of a light substance will have a very low escape velocity; an object only needs to travel at a moderate speed for effective lift off.

A black hole is a former star (that exploded and then collapsed under its own weight) that is so compact - extremely dense and extremely small, with matter packed in unimaginably tightly- that even the speed of light is not fast enough to escape it.



A star with a mass greater than 20 times the mass of our Sun may produce a black hole at the end of its life. In the normal life of a star there is a constant tug-of-war between gravity pulling in and pressure pushing out. Nuclear reactions in the core of the star produce enough energy to push outward.

For most of a star's life, gravity and pressure balance each other exactly, and so the star is stable. However, when a star runs out of nuclear fuel, gravity gets the upper hand and the material in the core is compressed even further. The more massive the core of the star, the greater the force of gravity that compresses the material, packing it in tighter and closer together.

The core compacts down to a pinpoint with virtually zero volume but retaining the same great mass. When this happens, escape would require a velocity greater than the speed of light. No object can reach the speed of light. Anything, including light, that passes near to the black hole gets sucked in and is forever trapped.

Questions *(answer in full sentences)*

1. In your own words say what escape velocity is.

.....

.....

2. Two planets, A and B are made of the same substance. A is much bigger than B. Which has the lesser escape velocity, and why?

.....

.....

3. Explain in your own words the reason that most stars are stable for most of their lives.

.....

.....

4. Now that you know what black holes are what do you think would be a good alternative name for them?

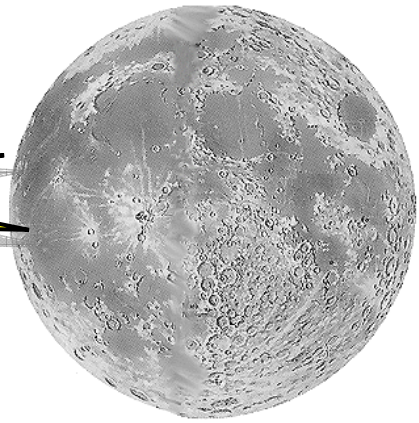
.....

Space Questions

Name .....

Date .....

Internet Research



For each question write a good whole-sentence answer.

Question	Answer
1. What is the difference between a meteor and a meteorite?	.....
2. When was Comet Hale-Bopp last visible from Earth?	.....
3. In astronomy, what is an aurora?	.....
4. Where in space are most of the asteroids?	.....
5. How long does it take planet Neptune to orbit the Sun?	.....
6. Who discovered a comet in 1847?	.....
7. What is the diameter of the Hale telescope at Mt Palomar in the USA?	.....
8. Where is the world's most powerful X-ray telescope located?	.....

Name ..... Date .....

The Founder of modern Astronomy

Early Astronomers

Nicolaus Copernicus

Nicolaus Copernicus is said to be the founder of modern astronomy.

Nicolaus Copernicus
(1473-1543)

Born in Poland in 1473 he became interested in mathematics and optics at an early age.
His investigations were carried on quietly and alone, without help or consultation.
He made 'bare eyeball' observations of the night sky atop the wall of a cathedral ...a hundred more years were to pass before the invention of the telescope.
In 1530 Copernicus asserted that Earth rotated on its axis once daily and traveled around the Sun once yearly…an astonishing finding.
Up to the time of Copernicus people believed the theory of the ancient astronomer Ptolemy, that the Sun revolved around Earth.

Copernicus' writings were lost to the world for 300 years, and located in Prague only in the middle of the 19th century. Copernicus had been reluctant to publish his findings because they were bound to be controversial.

The thought that Earth was not at the centre of things went against long-held religious beliefs. How would society cope with the thought that humans are simply part of nature and not superior to it? (this was certain to upset the politically powerful churchmen of the time).

Questions *(answer in full sentences)*

1. What is *optics* ?

.....

.....

2. Why do you think Copernicus preferred to work alone?

.....

.....

3. Why are Copernicus' observations even more remarkable than those of astronomers who followed him?

.....

.....

4. How could Copernicus have decided that the Earth spins once a day and revolves around the Sun in one year?
***This is a very challenging question!*

.....

.....

.....

.....

.....

Name ..... Date .....

Early Astronomers
Galileo Galilei

Great advances with the telescope

Galileo was born in Pisa, Italy, in 1564.

After teaching himself the art of lens grinding he produced a powerful telescope that magnified distant objects 20 times.
His telescope showed many more stars than are visible with the naked eye.

In 1609 Galileo saw that the Moon's surface is not smooth, as had been thought, but is rough and uneven.
A year later he discovered four moons revolving around Jupiter. He then observed that the puzzling appearance of Saturn was caused by rings surrounding it.

Prior to Galileo some had believed that sunspots were moons of the Sun but Galileo argued that the spots are on or near the Sun's surface.

Galileo was able to show that Venus and Mercury, as well as Earth (which he said was also a planet), revolve around the Sun, thereby disproving the long-held belief that the Sun revolves around Earth.

Galileo died near Florence, Italy in 1642.

Questions *(answer in full sentences)*

1. If a star measured 0.5 mm in diameter with the naked eye how big would it be in Galileo's telescope?

.....

.....

2. You probably know something about the Moon's surface. You know it's not smooth. Say what you do know.

.....

.....

3. How might Saturn have appeared through telescopes less powerful than Galileo's?

.....

.....

4. Galileo lived about 400 years ago. What, in astronomy, might we know much more about in 400 years time?

.....

.....

.....

.....

Name ..... Date .....

Early Astronomers
Tycho Brahe

Accurate measurements

Tycho Brahe (1546-1601) was born in Denmark.
As a young adult he bought several astronomical instruments, convinced that the improvement of astronomy depended upon accurate observations.

Tycho Brahe's contributions to astronomy were enormous.
He not only designed and built instruments, he also calibrated them and periodically checked their accuracy.
Tycho stated correctly that Mercury, Venus, Mars, Jupiter and Saturn all revolve about the Sun.
Earlier astronomers had observed the positions of planets and the Moon at certain important points of their orbits; Tycho and his assistants observed these bodies at *many* points in their orbits.

Years earlier Tycho had accepted an offer from King Frederick II to fund an observatory. He was given the little island of Hven near Copenhagen, and there he built his observatory, which became the finest in Europe.
It was from here that Tycho carrried out nightly observations, leading to many of his important discoveries.

Questions *(answer in full sentences)*

1. Tycho *calibrated* his instruments. What does this mean?

.....

.....

.....

2. Why might Tycho have not mentioned the orbits of Uranus and Neptune?

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3. Earlier astronomers observed planets at just one point in their orbits. Why do you think they didn't 'track' these planets?

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4. What advantages might an observatory on an island have?

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.....

.....

Tycho Brahe
(1546-1601)

Name ..... Date .....

Early Astronomers
Johannes Kepler

The Founder of Modern Optics

Johannes Kepler, a contemporary of another great astronomer, Tycho Brahe, was born in Germany in 1571.
Kepler used the precise measurements of Tycho Brahe to accurately predict a pair of transits of the Sun, one by Mercury and the other by Venus.
He provided tables for calculating planetary positions for any past or future date….an amazing feat for the time.

Kepler earned the title of Founder of Modern Optics. He was the first to:

- investigate the formation of pictures with a pin hole camera
- explain the process of vision by refraction within the eye
- design eyeglasses for nearsightedness and farsightedness
- explain the use of both eyes for seeing 3-D objects clearly
- explain the principles of how a telescope works

He was also the first to:

- correctly explain planetary motion (Kepler's First, Second and Third Laws)
- explain that the tides are caused by the Moon
- suggest that the Sun rotates about its axis

Questions *(answer in full sentences)*

1. What do you think a transit might be? (see 4th line)

.....

.....

2. What do we use to overcome nearsightedness and far sightedness these days?

.....

.....

3. How would you say that two eyes enable us to see better than with one eye?

.....

.....

4. Which of Kepler's 'firsts' would you say was his most important contribution to science. Why?

.....

.....

.....

.....

.....

Name ..... Date .....

My Weight and Age on other Planets

To find what you would weigh in the gravitational field of another planet, multiply your weight on Earth by the gravitational factor listed in the table at right.

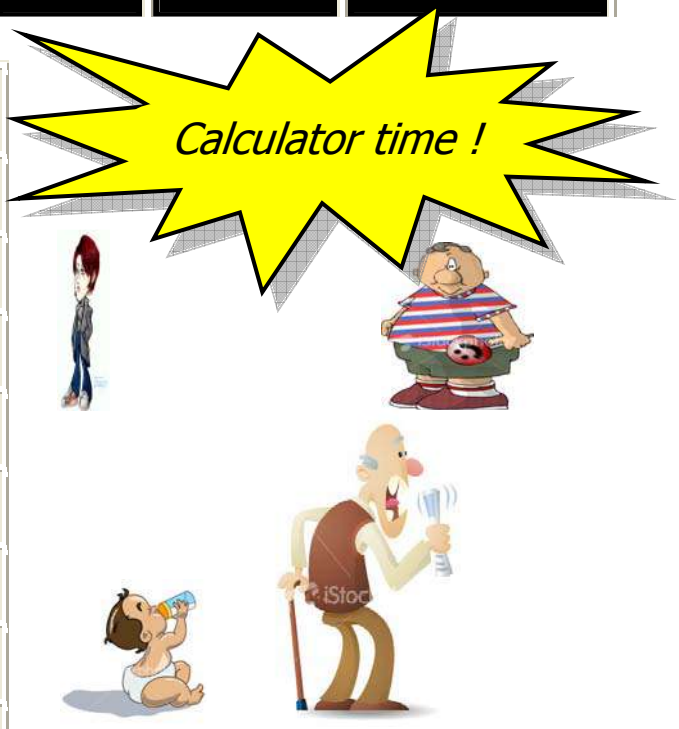
Example: I weigh 40kg on Earth.
On Mercury, I would weigh:
40kg X 0.38 = 15.2kg
On Neptune, I would weigh:
40kg X 1.12 = 44.8kg

To find your age according to the length of another planet's year, divide your age in Earth years by the period of revolution (in Earth years) of the planet listed in the table at right.

Example: I am 11 Earth years old.
In Mercury's orbit, I would be:
11 years ÷ 0.241 = 45.6 years old
In Neptune's orbit, I would be:
11 years ÷ 164.8= 0.067 years old

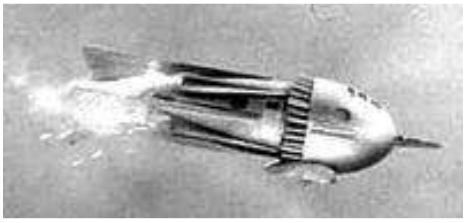
Planet	Gravitational Factor	Period of Revolution (Compared to Earth)
Mercury	**0.38**	**0.241 Earth years**
Venus	**0.91**	**0.615 Earth years**
Earth	**1.0**	**1.0 Earth year**
Mars	**0.38**	**1.88 Earth years**
Jupiter	**2.36**	**11.9 Earth years**
Saturn	**0.91**	**29.5 Earth years**
Uranus	**0.89**	**84.0 Earth years**
Neptune	**1.12**	**164.8 Earth years**

Planet	My Weight	My Age
Mercury		
Venus		
Earth		
Mars		
Jupiter		
Saturn		
Uranus		
Neptune		



Name …… Date ……

Light Year



- Answer all questions in complete sentences -

A light year is not a period of time (as a year is). It is a distance.
A light year is the distance that light travels in a year.

Q1. What do you think a light minute is?

……

Q2. What is a light second?

……

Nothing can travel faster than light. **Light travels at 300 000 km/sec.**
That's seven times around Earth, each second.

Q3. How far is a light second?

……

The light from the Sun takes 8 minutes to reach Earth.
Q4. How many light minutes from Earth is the Sun?

……

Q5. If a ray of sunlight was reflected from Earth back to the Sun how long would its entire journey take?

……

Q6. Apart from the Sun the nearest star to Earth is Proxima Centauri (in the Alpha Centauri star group). Proxima Centauri is 4.2 light years from Earth. If you see this star tonight how old were you when the light left Proxima Centauri on its journey to you?

……

Q7. What would you say a light century is?

……

Q8. How many kilometers in one light year? *No need to calculate: use multiplication signs in your answer.*

……

Q9. How many kilometers away is Proxima Centauri? *No need to calculate: use multiplication signs in your answer.*

……

Q10. Some stars are billions of light years from us. How many kilometers in one billion light years?
No need to calculate: use multiplication signs in your answer.

……

Billy says to Bobby, "What's a million light years?" Bobby replies, "A very long time indeed!"

Something is wrong here. What is it? ……

Space Detectives

Short written answers

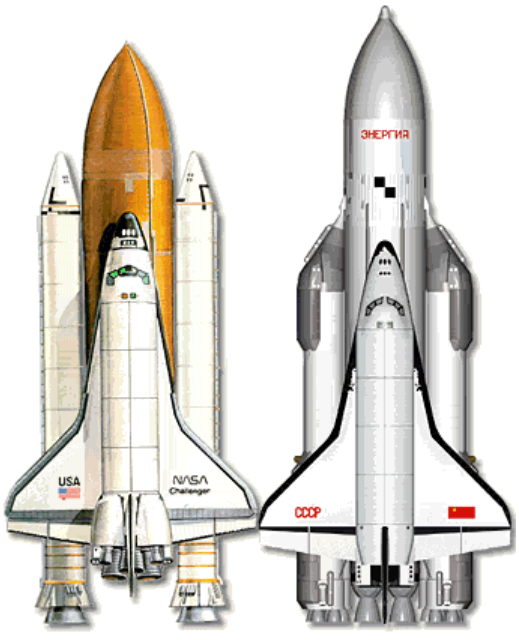
Answer three questions.
Write 4-6 sentences for each.

These Space questions were found on the World Wide Web and were asked by kids.
Can you find some of the answers or maybe suggest some of your own? ↗

Research methods: *1) Do a Web search or 2) Contact one of the observatories below:*

ACT: Mount Stromlo Observatory; **NSW:** Sydney Observatory; **Tas:** Canopus Hill Observatory; **Qld:** Mount Kent Observatory;
Vic: La Trobe University Space Physics Field Station; **WA:** Perth Observatory; **SA:** Cangaroo International Astrophysical Observatory

- **Suppose that this evening you view the star Proxima Centauri, which is 4.2 light-years from Earth, through a telescope. How old were you when the light that you see left this star?** *Estelle, age 13*
- **What do you think is at the edge of the universe?** *Jonathon, age 10*
- **How do astronomers decide where the Milky Way ends and another galaxy begins?** *Emma, age 11*
- **What is the difference between the universe and the so-called multiverse?** *David, age 14*
- **What was the name of the asteroid that killed all the dinosaurs, how big was it and when did it happen?** *Angie, age 9*
- **What are parallel universes?** *Jeremiah, age 12*
- **I've heard that humans have detected cosmic rays from 737 880 000 000 000 000 000 000 km away. How do I say this number?** *Andrew, age 13*
- **What do astronauts eat and drink while in Space?** *Carolyn, age 9*
- **What forces and laws of motion act on a rocket as it travels through space?** *Martin, age 14*
- **Is it possible that there is multi-cellular life on Mars?** *Genevieve, age 14*
- **Would it be possible for a planet to be composed entirely of ice and water?** *Tuan, age 11*
- **How much does a space shuttle (Atlantis, Discovery, Endeavour) cost to build?** *Emily, age 10*
- **I'd like to ask about Time travel. Can anyone now or in the future travel through time into the past or the future?** *Stephen, age 13*
- **What would you do if you encountered an alien from Mars, get scared and hide, or greet him or her with open arms?** *Beth, age 12*
- **Do you think intelligent life exists elsewhere in the universe? If so do you think we will make some kind of discovery that proves it in the next 20 years?** *Simon, age 12*
- **What and where is the largest known crater in the solar system?** *Bonny, age 11*
- **I have a Hubble Telescope question. I heard they had the shutter open for 11 days...how did they get such a clear image? I mean the telescope is orbiting the earth so even the slightest movement will cause blurriness.** *Fortuna, age 13*



Space Detectives

1-2 minute talks

Choose one question. Give a class talk on it for 1-2 minutes.

These Space questions were found on the World Wide Web and were asked by kids.
Can you find an answer or maybe suggest one of your own? ↗

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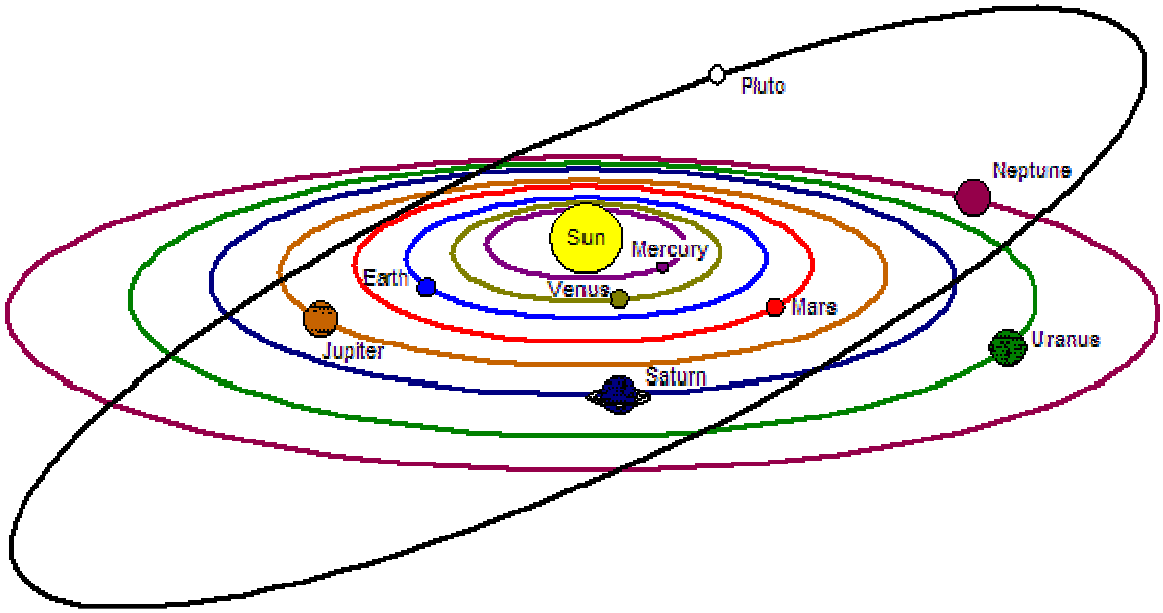
Vic: La Trobe University Space Physics Field Station; **WA:** Perth Observatory; **SA:** Cangaroo International Astrophysical Observatory

- **If you reduced our planet to the size of a watermelon would you be able to feel Mt Everest?** *Kim, age 11*
- **Is it true that the universe is expanding? If so, how and why?** *Danielle, age 12*
- **Last night I was watching a show on the Hubble Telescope. It said that Hubble can see billions of years into the past....I can't seem to understand that....I know how fast light travels and I get that. But if Hubble can look billions of years into a star's past why can't it do the same with Earth to see things that happened to us?** *Sabrina, age 11*
- **What is the possibility of life elsewhere in the universe? Could you give some pros and cons?** *James, age 13*
- **If I found a meteorite would it be harmful?** *Gemma, age 10*
- **How do planets and stars generate a magnetic field?** *Anthony, age 14*
- **What's the difference between astronomy and astrology?** *Suzie, age 11*
- **Is it true that every point in the universe is the centre?** *Rebecca, age 13*
- **What is Dark Matter?** *Pete, age 12*
- **Why does the sun travel across the sky in an arc no matter what time of year it is?** *Jean-Pierre, age 13*
- **Space scientists are talking about travel to Mars in 20 years. What type of fuel would be used?** *Sam, age 12*
- **Is there gravity everywhere in space?** *Mitchell, age 11*
- **At night the sky is black and I understand that. But in the day it's blue. Why is it blue?** *Beatrice, age 10*
- **Do you think there is another planet like Earth with people just like us? Please explain.** *Justine, age 11*
- **How do spacecraft move around in Space if it's a vacuum with nothing to push against? Think about a plane…it sucks in air and makes a force for it to go out and push it giving it speed. What is there in Space which makes that? How does the spacecraft steer?** *Juliette, age 14*
- **Scientists say that the universe is finite but if that is true what would be on the other side…..some say other universes, making a multiverse. But if that were true and we know that our universe is expanding wouldn't the other universes be expanding too? What will happen when universes collide with each other?** *Jay, age 14*
- **How is a black hole created?** *Tommy, age 13*



Space Detectives

Small group activity

Research one question. Present your findings to your group.

These Space questions were found on the World Wide Web and were asked by kids.
Can you find an answer or maybe suggest one of your own? ➚

Research methods: *1) Do a Web search or 2) Contact one of the observatories below:*
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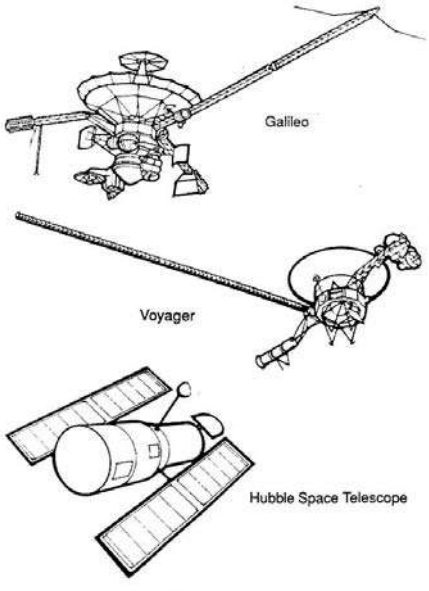
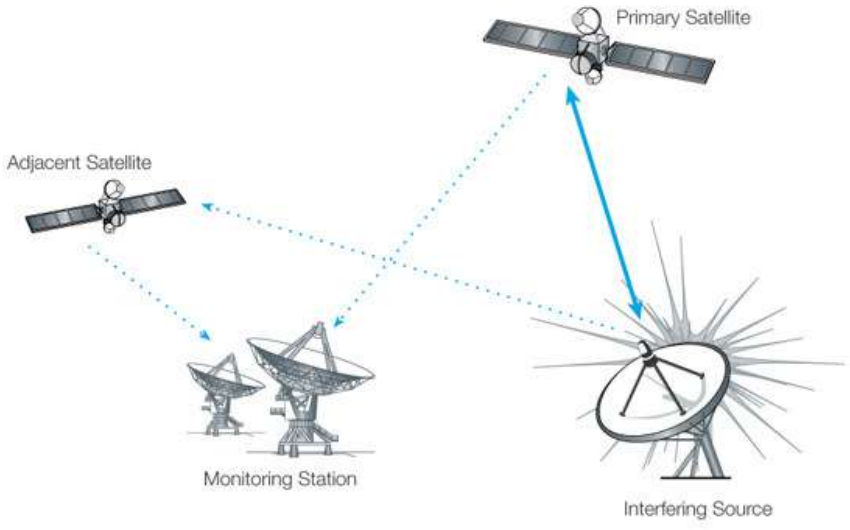
Vic: La Trobe University Space Physics Field Station; **WA:** Perth Observatory; **SA:** Cangaroo International Astrophysical Observatory

- **Why can't we see stars during the day?** *Penny, age 9*
- **Who do you think has been the greatest astronomer so far, and why?** *Meredith, age 11*
- **With more and more people being born on Earth and more and more trees being grown it adds weight to our planet. Yes people and trees do die but there is still weight after burial or cremation. As for trees they rot and grow foliage every year still adding weight. Do you think all the extra weight could affect how our planet orbits the sun? Will we be in danger in generations to come? What will happen if Earth slows down, or the gravity increases?** *Alison, age 13*
- **There is no up or down in space so what keeps the sun and all the planets suspended?** *Reggie, age 12*
- **In millions of years from now is there a chance that Mars might look like Earth and Earth look like Venus? Venus = very thick atmosphere and typical green house effect; Earth= Green House effect is taking place right now; Mars = frozen.... can it get warmer and sustain life?** *Jonno, age 13*
- **What are Solar Eclipses and how often do they occur? What is a Partial Eclipse and a Total Eclipse?** *Joy, age 9*
- **How many stars are in the universe and how many can we see with the naked eye?** *Walter, age 10*
- **What are some of the jobs that Earth-orbiting satellites do?** *Mary-anne, age 13*
- **What would it feel like to be in a spaceship that is constantly accelerating at 1-G?** *Basil, age 13*
- **How can we detect a planet orbiting a distant star in a different galaxy? We can't see it through a space telescope because of the nearby intense star. Then how do we detect it?** *Wendy, age 14*
- **Has there been a planet found in any other galaxy? If so please name it/them. If not, why?** *Jase, age 12*
- **How do we humans make use of energy from the Sun?** *Amanda, age 11*
- **Some say that the future of mankind depends on leaving Earth. It will cost quite a bit of money to get to outer space. An average Joe like me couldn't afford it. Do you think politicians will pass laws privatizing space colonization before it's even the kind of thing that common people can think about? Will space travel be possible for common people in the near future, and will it be cheap?** *Albert, age 14*
- **If I am inside my spacecraft in deep space and I sounded a horn would I be able to hear it? How about if I were outside my spacecraft?** *Wesley, age 13*





Space Detectives

One-page answer

Write a one-page response to any question. Include a small sketch.

These Space questions were found on the World Wide Web and were asked by kids.
Can you find an answer or maybe suggest one of your own? ➚

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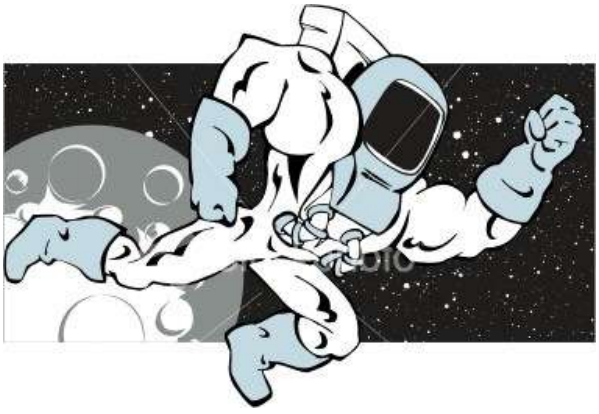
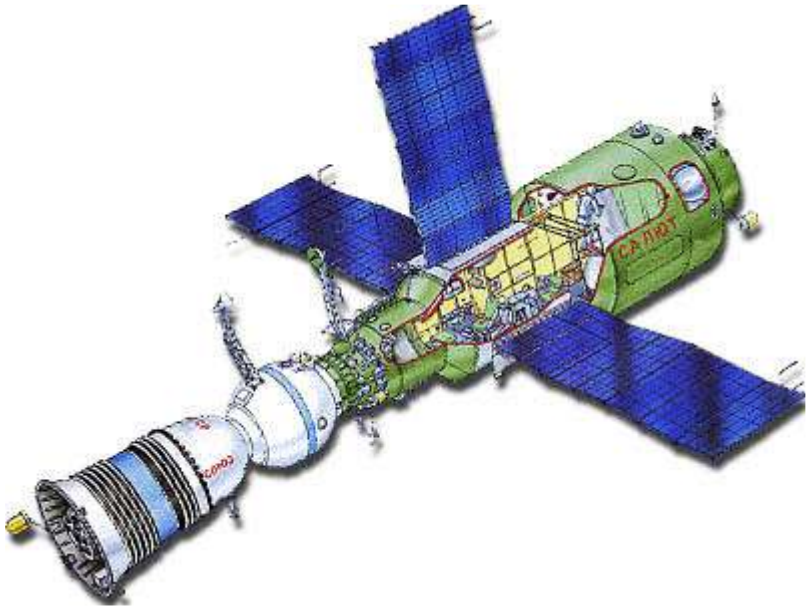
Vic: La Trobe University Space Physics Field Station; **WA:** Perth Observatory; **SA:** Cangaroo International Astrophysical Observatory

- **What is sky?** *Joey, age 9*
- **Let's say you had the chance to be one of the first settlers on Mars, would you jump at the chance to go?** *Katia, age 13*
- **What are quarks?** *Michael, age 13*
- **What if an Alien race wanted to make contact with Earth….what is the way they would most likely do it?** *Davinia, age 11*
- **Why can't sounds be heard in Space?** *Simone, age 10*
- **What is space junk?** *Edmund, age 9*
- **Which types of space radiations are harmful to us?** *Edwina, age 13*
- **What makes the universe so mysterious and fascinating?** *Cameron, age 9*
- **Is it possible that in the past Earth's atmosphere was so thick that life was impossible to form?** *Tim, age 12*
- **What might be the next great invention in astronomy?** *Emmanuel, age 12*
- **What are pulsars?** *Meredith, age 12*
- **What do you think might be the next great discovery in astronomy?** *Santana, age 12*
- **I've heard about the North Star. What is special about this star?** *Alison, age 12*
- **What are quasars?** *Billy, age 13*
- **If the moon got within 1 000 km of Earth what gravitational effects would we notice?** *Josie, age 12*
- **How long would it take to walk the distance to the moon?** *Kev, age 11*
- **What will happen to a person if they left a spaceship to walk on the moon without a space suit?** *Ollie, age 12*
- **Is our sun in a solid or a gaseous state?** *Tracey, age 13*
- **What caused the craters on the Moon?** *Venita, age 10*
- **If it is true that a gas fills all the space available, why doesn't the atmosphere move off into outer space?** *Kath, age 12*
- **When you're in space, which way is up?** *Wanda, age 10*





Name ..... Date .....

Incredible Journey

A 2040 Space story

The year is 2040. You are a fully trained astronaut and experienced Space pilot. You accept an offer to trial a sophisticated new spacecraft, powered by a breakthrough technology. This is a top-secret mission and you need to travel solo.
Write a short but gripping account of your trip, telling of something amazing that happens.
Was it something you saw? Was it something you encountered? Did you discover something new?

Your story should be set out in three paragraphs: a short introduction, the body, and a brief conclusion.
It will be greatly enhanced if you include well-chosen verbs, adverbs and adjectives.
Have some excellent sentence beginnings and don't forget the all-important element of surprise.

Name ..... Date .....

Space Haikus

A haiku is a non rhyming poem of 3 lines and consisting of 17 syllables. The first line has 5 syllables, the second has 7 and the last line has 5 syllables.
Each line tells something about the poem's subject (its title).
At the right is an example of a haiku.

Rain

Tip-tap goes the rain
As it hits the window pane
I can hear the rain

Write haikus for each of the subjects below. When you've finished, decorate them with attractive illustrations.

The Sun

Space Journey

Stars in the Sky

The Moon

Name ..... Date .....

Space Acrostic

An acrostic is a non rhyming poem where the first letters of each line form the title; all lines are about the subject.
Write an 'Astronomy' acrostic *(it's not as difficult as you think!)*

When you've finished your acrostic poem decorate it with an attractive illustration.

A

S

T

R

O

N

O

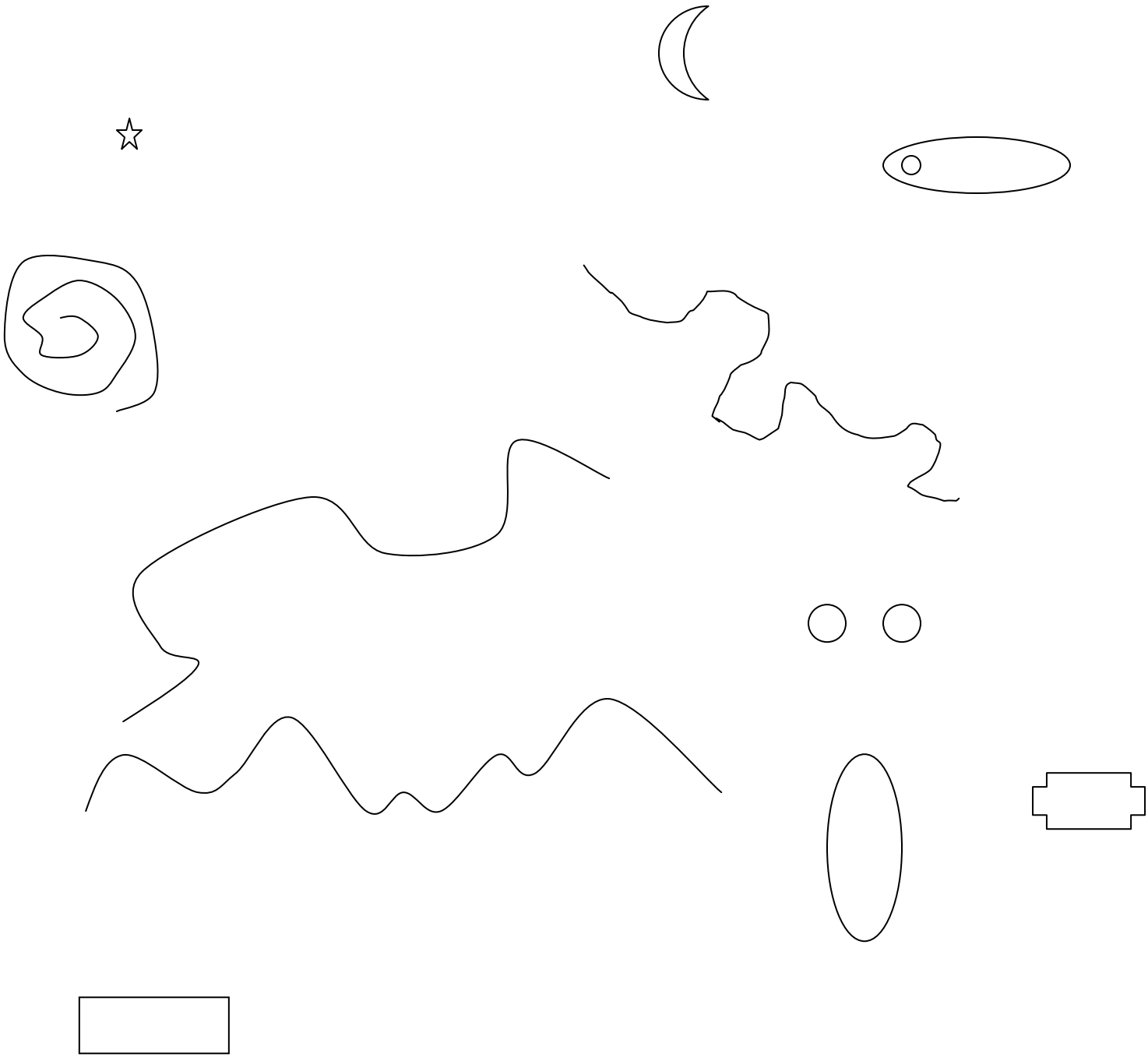
M

Y

Name ..... Date .....

Space Art

Use these shapes and squiggles to create an original Space picture.
(add your own lines and shapes to make characters and objects; let your imagination run free)



Name ..... Date .....

Space Dilemma

Curriculum areas covered: Science; Health; Society & Environment; Technology & Enterprise

Exploration of Space should be abandoned.
The money saved would be better used here on Earth.

You may or may not agree with the above statement. Here are some notes to support it:
The space industry costs billions of dollars per year. But for what return?
OK, we learn more about our solar system and the universe itself, but, apart from filling textbooks and magazines, of what use is this knowledge? Who cares if the Milky Way is spiral shaped? How does it matter if Mars once supported life? Of what use is it knowing that Neptune and Uranus are made of gas? Of what importance to us are black holes? So what if distant galaxies emit regular pulses.

All this is to say nothing of the huge losses associated with the space industry. Spacecraft have been known to disintegrate soon after launch, only to plummet back to Earth in a billion dollar catastrophe. Other craft, whose malfunctioning computers cause them to lose touch with ground control, hurtle onwards into black oblivion, never to be seen, or heard from, again.
Last but not least, there is the human side: the space industry is responsible for many brave astronauts and cosmonauts meeting untimely deaths, all in the name of 'progress'.

It's hard to believe that the leaders of nations can't see that exploring other worlds is immoral.
If only they would pour these billions and billions of wasted dollars into helping to feed, clothe and educate the poor of our own world.

Your task now is to present reasons in support of the <u>other</u> side of the 'argument'...that the exploration of Space – despite costing billions of dollars each year- should continue.

Exploration of Space should be continued.
Humanity will benefit in many ways.

Here are my arguments in support of the Space Programme:

1).....

.....

.....

2).....

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3).....

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4).....

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5).....

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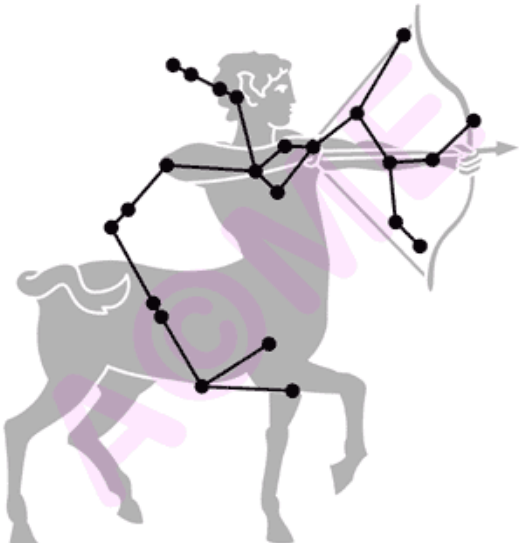
Name ..... Date .....

Constellations



You may go outside some night and see all kinds of stars, and maybe you have even spotted the Southern Cross, but what about Leo the Lion or Pisces the Fish? What are they?
Where did the constellations come from?
We know the constellations are helpful for remembering the stars, but why would people want to do that (besides astronomers, that is)?
Perhaps there is something about the mystery of the night sky that makes people want to tell stories about the constellations. The picture at the right is an ornate star chart showing the great hunter Orion. He is holding his traditional bow and arrow.

The constellations have changed over time. In our modern world, many of the constellations have been redefined so now every star in the sky is in exactly one constellation. In 1929, the International Astronomical Union (IAU) adopted official constellation boundaries that defined the 88 official constellations that exist today.

Since different constellations are visible at different times of the year, you can use them to tell what month it is. Around the world, farmers know that for most crops, you plant in the spring and harvest in autumn. But in some regions, there is not much difference between the seasons. Some historians suspect that many of the myths associated with the constellations were invented to help the farmers remember them. When they saw certain constellations, they would know it was time to begin the planting or the reaping.

The constellations are totally imaginary things that poets, farmers and astronomers have made up over the past 6 000 years (and probably even more). The real purpose for the constellations is to help us tell which stars are which, nothing more.
On a really dark night, you can see about 1 000 to 1 500 stars. Trying to tell which is which is hard. The constellations help by breaking up the sky into more manageable bits. They are used as memory aids.

Questions:

1) In the first paragraph what is the meaning of 'ornate'?

.....

2) How many official constellations are there?

.....

3) Are the same constellations visible throughout the year?

.....

4) In which season do farmers harvest most of their crops?

.....

5) Why were the constellations important to farmers?

.....

6) Which people made up constellations?

.....

7) What is the real purpose for the constellations?

.....

The Galaxy Song

Composer & © Eric Idle

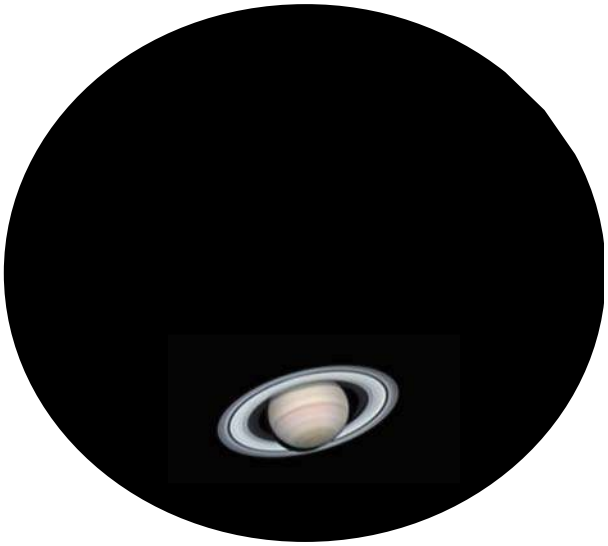
* A fun song to sing or chant, especially with creative finger, hand, arm, head, leg and whole-body animations *

Just remember that you're standing on a planet that's evolving
And revolving at nine hundred miles an hour,
That's orbiting at nineteen miles a second, so it's reckoned,
A sun that is the source of all our power.
The sun and you and me and all the stars that we can see
Are moving at a million miles a day
In an outer spiral arm, at forty thousand miles an hour,
Of the galaxy we call the "Milky Way".

Our galaxy itself contains a hundred billion stars.
It's a hundred thousand light years side to side.
It bulges in the middle, sixteen thousand light years thick,
But out by us, it's just three thousand light years wide.
We're thirty thousand light years from galactic central point.
We go 'round every two hundred million years,
And our galaxy is only one of millions of billions
In this amazing and expanding universe.

The universe itself keeps on expanding and expanding
In all of the directions it can whizz
As fast as it can go, at the speed of light, you know,
Twelve million miles a minute, and that's the fastest speed there is.
So remember, when you're feeling very small and insecure,
How amazingly unlikely is your birth,
And pray that there's intelligent life somewhere up in space,
'Cause there's really not much down here on Earth.

Name ..... Date .....



About 170 planets have been found outside the Solar System. Some astronomers think there may be planets around up to half the stars in our galaxy alone - that's 50 billion possible planetary systems.

Until the 1990s, the only planets that we knew of were the ones that orbited the Sun in our Solar System. Then in 1995, two astronomers, Michel Mayor and Didier Queloz, made a momentous discovery. They detected a new planet orbiting a distant star called 51 Pegasi. Our Solar System was no longer alone. New worlds were out there waiting to be discovered.

The Sun supports a family of planets around it. So it makes sense to look for new planets around stars that are similar to the Sun. There are over a quarter of a billion stars similar in weight and composition to the Sun in our galaxy alone. The problem is how to detect planets around these stars. Unfortunately, you can't spot them by looking through a telescope as they're too far away. The only way to identify extra-solar planets is to look for the effect they have on their parent star.

An orbiting planet will affect its parent star in two ways:
1) **The movement of the star**. Stars revolve slowly around the centre of their galaxy in a smooth, elliptical orbit.
But if a star has planets around it, their combined gravity will yank the star out of its smooth orbit, making it wobble slightly.
By measuring the wobble, astronomers can work out the size of its planets, and how far they are from their parent star.
2) **Light from the star**. Normally, stars shine with a constant brightness. But if a planet passes between you and a star, the star dims as it passes by. Measuring the changing brightness of a star can tell us if there are planets orbiting around it.

So far, all of the worlds that have been discovered are gas giants like the planet Jupiter. We have yet to find any smaller, rocky planets like Earth. But that doesn't mean there aren't any new planets like Earth out there. It's much easier to spot larger planets than smaller ones, so it's no surprise that we've found them first.
Over the next 20 years, a flotilla of new spacecraft will be launched to hunt for new Earth-like planets.
The discovery of habitable worlds could be just around the corner.

Source of origin: BBC *Reproduced with permission*

Questions:

1) There may be 50 billion planetary systems in our galaxy. Can you write 50 billion in digit form?

.....

2) What is meant by *a momentous discovery* ?

.....

3) What do you think an extra-solar planet is?

.....

4) What may cause a star to wobble in its orbit around its galaxy's centre?

.....

5) What may cause a star to dim?

.....

6) What does 'worlds' refer to in the first line of the final paragraph?

.....

7) What is meant by *a flotilla of new spacecraft* ?

.....

8) Would could it mean to humans if a new Earth-like planet is discovered?

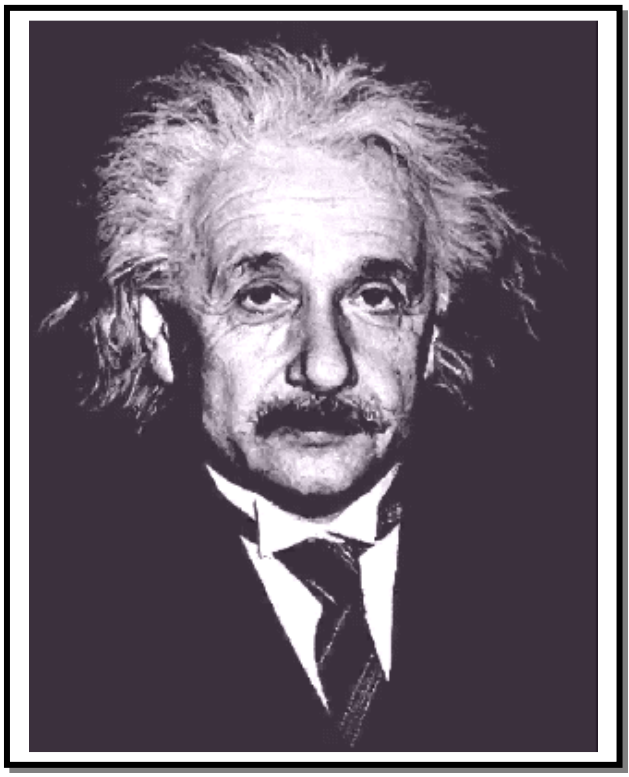
.....

.....

Name ..... Date .....

Albert Einstein

$E=mc^2$



Albert Einstein is perhaps the most famous scientist of modern times. One of his most well-known accomplishments is the formula $E=mc^2$. Despite its familiarity, many people don't really understand what it means. We hope this explanation will help!

One of Einstein's great insights was to realize that matter and energy are really different forms of the same thing. Matter can be turned into energy, and energy into matter. For example, consider a simple hydrogen atom, basically composed of a single proton. This sub-atomic particle has a mass of 0.000 000 000 000 000 000 000 001 672 kg.
This is a tiny mass indeed. But in everyday quantities of matter there are *a lot* of atoms! For instance, in one kilogram of pure water, the mass of hydrogen atoms amounts to slightly more than 111 grams, or 0.111 kg. Einstein's formula tells us the amount of *energy* this mass would be equal to, if it were all suddenly *turned* into energy. It says that to find the energy, you multiply the mass by the square of the speed of light, this number being 300 000 000 metres per second (a *very* large number):

$E=mc^2$ = 0.111 x 300 000 000 x 300 000 000
= 10 000 000 000 000 000 Joules

This is an incredible amount of energy! One Joule is about the energy released when you drop a book to the floor. But the amount of energy in 111 grams of hydrogen atoms is equal to burning hundreds of thousands of litres of petrol. If you consider all the energy in the full kilogram of water, which also contains oxygen atoms, the total energy equivalent is close to that released if 40 million litres of petrol were burned! It has been calculated that a single drop of water -if its mass were converted to energy- could power an ocean liner around the world!

Conversions from *mass ⇨ energy* and *energy ⇨ mass* are occurring all the time in the universe, for example in stars (not just exploding ones) and black holes. Many scientists believe it all started with the Big Bang and has continued ever since.

After reading this passage you probably have several questions. Write them here.

1. .....

.....

2. .....

.....

3. .....

.....

4. .....

.....

Now, time for a class discussion!

Something extra to do: *Find out what you can about this remarkable scientist's childhood.*

Name ..... Date .....

Pioneer Female Astronomers

Dorothea Klumpke Roberts & Annie Jump Cannon

Dorothea Klumpke Roberts (1861-1942) devoted her life to photographing stars (astro-photography). Much of her work was at the Paris Observatory, on a new 34 cm refracting telescope. Her job was to measure and record star positions and to study their light.

In 1899 Dorothea was selected by the French to be lofted in a balloon to observe a meteor shower, becoming the first woman to make astronomical observations from a balloon.

In her long career Dorothea published two photographic star atlases as well as catalogues of other deep sky objects.

In her later years, she set up a number of financial awards to benefit young astronomers.
Asteroids MP 339 Dorothea and MP 1040 Klumpkea were named after Dorothea Klumpke Roberts, pioneer woman astronomer.

As a young woman **Annie Jump Cannon** (1863-1941) studied physics and astronomy. She went on to undertake major work in star classification at Harvard College Observatory in the USA.

Annie charted more than a quarter of a million stars and along the way discovered 300 new ones. The unique method of starlight classification that she devised remains in place to this day.

Annie was the first woman elected as an officer of the American Astronomical Society and in 1923 she was voted one of the 12 greatest living Americans.
In her honour the American Astronomical Society and the American Association of University Women present the annual Annie J. Cannon Award to women studying astronomy.

Dorothea Klumpke Roberts, Annie Jump Cannon and other women of their era did almost all of the work in cataloguing the sky, laying the foundations for the future progress of modern astronomy.

Questions

1. What is an astrophotographer?

.....

2. Dorothea Klumpke Roberts observed the skies from a balloon. Why not from a plane? *(think about it!)*

.....

3. What might *other deep sky objects* include?

.....

4. *Annie charted more than a quarter of a million stars.* Rewrite this sentence using digits for the underlined words.

.....

5. How do you know that Annie's method of classifying starlight was successful?

.....

6. What qualities of character would be required of someone to photograph, classify, measure and records stars?

.....

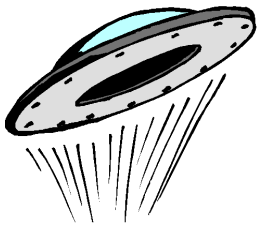
7. Classifying stars has taken much longer than classifying planets. Why would you say this is?

.....

Name ..... Date .....

Is there Life out there?

...and if there is, is it intelligent?



We live on planet Earth, one of 8 major planets in the solar system which is centred on the Sun.
The Sun is just one of billions of stars in the Milky Way galaxy.
It is probable that many of these stars also have planets revolving around them
The Milky Way is but one of billions of galaxies in the universe.
So it is quite likely that there are billions of planets 'out there'.

In 200 words or less say whether you think there may be other life in the universe.
If not, why not?
If so, might some of this life be intelligent and what physical form might it have?

Solutions

page 6 Space Quiz

1. Jupiter **2**. distance **3**. Sun **4**. Space **5**. more than 20 **6**. gravity **7**. small **8**. Galilei
9. the Moon **10**. Neil Armstrong **11**. revolutions **12**. stars **13**. galaxy **14**. galaxy
15. Jupiter **16**. Proxima Centauri **17**. elliptical **18**. rotation **19**. core **20**. gravity
21. 8 minutes **22**. the Sun **23**. the Sun **24**. 10-20 billion **25**. Sun **26**. Russia **27**. meteors
28. 24 hours **29**. Moon **30**. star

page 7 Space Research

1. 142 800 km **2**. 300 000 km/s **3**. 149 000 000 km **4**. every 76 years
5. Proxima Centauri (in the Alpha Centauri group) **6**. a spiral galaxy **7**. two
8. Titan, Rhea, Iapetus, Mimas, Enceladus, Tethys, Dione, Hyperion, Phoebe *and many others*
9. Yuri Gagarin **10**. gases (hydrogen, helium & methane)

page 8 Space Crossword

						R		M	O	O	N
A	N	D	R	O	M	E	D	A			
	A					D		R			
	S							S	U	N	
W	A	Y								E	
										P	
										T	
C										U	
O		E						S		N	
M		A	S	T	R	O	N	O	M	E	R
E		R				R		L			I
T	I	T	A	N		B		A			N
		H				I		R			G
			P	L	U	T	O				S

page 9 Solar System Myths

1. They didn't know that the Sun, other planets, and stars were so far away and much much bigger than they appeared.
2. Mercury is close to the Sun and is therefore very hot. If it had rings they would not be made of ice.
3. The core of every planet is very hot.

page 10 Comets

1. Add current year to 240.
2. It appears often (every 76 years), sightings have been recorded through the ages (by different peoples) and it is depicted on at least one famous tapestry.
3. They are not luminous and are only visible when reflecting light from the Sun.
4. Ice and gas is lost, resulting in a rocky asteroid-like object.

page 11 Our Moon

Moon Walkers Neil Armstrong (1969), Buzz Aldrin (1969), Pete Conrad (1969), Alan Bean (1969), Alan Shepard (1971), Edgar Mitchell (1971) , David Scott (1971), James Irwin (1971), John W. Young (1972), Charles Duke (1972), Eugene Cernan (1972), Harrison Schmitt (1972)
Moon Facts diameter = 3 476 km mass = 7.36×10^{22} kg distance from Earth = 384 000 km time to rotate = 29.5 days time to revolve around Earth = 29.5 days
Names of 6 US manned Moon missions (with landings)
Apollo 11 (1969) Apollo 12 (1969) Apollo 14 (1971) Apollo 15 (1971) Apollo 16 (1972) Apollo 17 (1972)
Something interesting about the Moon's mountains
The Moon has many great mountains and mountain ranges. Many rise more than 4 000 m above the surrounding plains. The highest of all soar about 7 000 m, nearly as high as Earth's tallest peaks.
Something interesting about the Moon's craters
The Moon has thousands and thousands of craters, some so small that they would fit inside your living room, while others are 160 km or more across. Some craters are very deep and ringed by tall mountains. Others are shallow. Scientists believe that most of the craters were formed by rocks that smashed into the Moon in its distant past.

page 12 Space Puzzle

meteor galaxy Jupiter star asteroid comet planet Saturn constellation

page 13 The Planets

Please Note: no. moons figures are correct at time of publication.

Mercury	*no. moons: 0*	*dist' from Sun: 57 million km*	*orbital period: 88 days*
Venus	*no. moons: 0*	*dist' from Sun: 107 million km*	*orbital period: 225 days*
Earth	*no. moons: 1*	*dist' from Sun: 150 million km*	*orbital period: 365.3 days*
Mars	*no. moons: 2*	*dist' from Sun: 229 million km*	*orbital period: 687 days*
Jupiter	*no. moons: 28*	*dist' from Sun: 777 million km*	*orbital period: 4 333 days*
Saturn	*no. moons: 70*	*dist' from Sun: 1 429 million km*	*orbital period: 10 759 days*
Uranus	*no. moons: 21*	*dist' from Sun: 2 871 million km*	*orbital period: 30 684 days*
Neptune	*no. moons: 8*	*dist' from Sun: 4 496 million km*	*orbital period: 60 190 days*

page 14 The Hubble Telescope

1. greatly advanced the methods of astronomy and what it is able to achieve
2. Earth-orbiting telescopes avoid the distorting effects of Earth's atmosphere
3. 'achieves heroically' means Hubble does a splendid job at what it was designed to do…photograph objects in Space, discover new galaxies, etc
4. Hubble is not as large as many Earth-based telescopes because it consists only of structural materials and instruments (it is not manned) and doesn't have auxiliary rooms and other features that large Earth-based telescopes –which are actually observatories-, have.
5. Edwin Hubble is *remembered in the best way possible* because the world famous instrument that bears his name is making amazing discoveries in Hubble's chosen profession, astronomy.

page 15 Galaxies

1. A starburst galaxy is a galaxy formed when two or more galaxies merge, causing new stars to form.
2. The observable universe is that part of the universe that we can see with the aid of telescopes.
3. Intergalactic Space (the space between galaxies) contains a tiny amount of gas, with an average density less than one atom per cubic metre.
4. Observational data are transmissions (light, other electromagnetic waves, etc) received from Space and processed here on Earth by astronomers.

page 16 Black Holes

1. Escape velocity is the velocity (speed) that must be travelled by an object if it is to escape the gravitational pull of a planet, moon or other such body.
2. Planet B has the lesser escape velocity because its mass is less than that of planet A.
3. Most stars are stable for most of their lives because the outward pressure exerted from within them balances their inward gravitational pull.
4. Answers will vary. *(…Light Trapper, Suction Pit, Black Magnet …)*

page 17 Space Questions

1. A meteor is the flash of light that we see in the night sky when a small chunk of interplanetary debris burns up as it passes through our atmosphere. 'Meteor' refers to the flash of light caused by the debris, not the debris itself.
A meteorite is any part of the debris that survives the fall through the atmosphere and lands on Earth.
2. 1997
3. Auroras are streamers or bands of light sometimes visible in the night sky. They are thought to be caused by charged particles from the sun entering the earth's magnetic field and stimulating molecules in the atmosphere.
4. Between the orbits of Mars and Jupiter.
5. 165 years (that is, Earth years)
6. Maria Mitchell
7. 508 cm (5.08 m)
8. In Space (orbiting Earth)

page 18

Early Astronomers *Nicolaus Copernicus*

1. The science that deals with the properties of light; in this case dealing with the way light changes direction when it is either refracted and dispersed by a lens or reflected from a mirror.
2. Probably so that he could focus his attention and concentrate better. Another reason is that his ideas were very controversial and he wanted to keep them to himself.
3. His observations were made without the aid of a telescope.
4. Rotation: The sun rose, and set, at 24 hour intervals (on average: taking into account the seasons) throughout the year.
Revolution: The stars appeared to move as the days went by -as the Earth moved around the Sun- and after 365 days they were in their original positions again.

page 19 Early Astronomers *Galileo Galilei*

1. Galileo's telescope magnified 20 times so the star would be 1 cm in diameter.
2. The surface of the Moon is covered with ground-up rock and also some big rocks. As well as this there are many mountains and craters.
3. Saturn may have appeared to have a band of fuzziness across it and at its edges (this being the rings).
4. We'll know much more about all the objects in our Solar System, especially the Moon, the other planets, asteroids and the Sun. We can also expect to have learnt more about comets and meteoroids. We'll probably have a good knowledge of at least some of the stars in our galaxy (and perhaps even in other galaxies). Our understanding of non physical phenomena such as electromagnetic radiation will have surely increased as will our knowledge of distant objects such as quasars, pulsars and black holes. It is a good bet that we will have discovered more fascinating, mysterious phenomena than those known to us already and we may even discover one or more natural laws (things like $E = mc^2$).

page 20 Early Astronomers *Tycho Brahe*

1. He set or corrected them in order to make accurate measurements.
2. They were probably not yet discovered.
3. Probably because they could only be seen with the naked eye at certain points in their orbits.
4. There wouldn't be interference from lights of large communities (even if these lights were from flickering flames). Astronomers, especially those involved in recording accurate observations, would work better when not surrounded by distractions, so isolation would be a distinct advantage.

page 21 Early Astronomers *Johannes Kepler*

1. When a planet transits the Sun it through an imaginary line between Earth and the Sun.
2. To overcome nearsightedness and farsightedness these days we use spectacles (glasses).
3. Viewing an object with two eyes enables us to see it from two slightly different angles and if it close enough we can see its depth dimension as well as its length and height.
4. *answers will vary*

page 23 Light Year

1. A light minute is the distance that light travels in one minute.
2. A light second is the distance that light travels in one second.
3. 300 000 km
4. 8
5. 16 minutes
6. your present age minus 4.2 years
7. A light century is the distance that light travels in one hundred years.
8. 300 000 x 60 x 60 x 24 x 365.25 kilometres.
9. 300 000 x 60 x 60 x 24 x 365.25 x 4.2 kilometres.
10. 300 000 x 60 x 60 x 24 x 365.25 x 1 000 000 000 kilometres.

Billy says to Bobby, "What's a million light years?" Bobby replies, "A very long time indeed!" Something is wrong here. What is it?
A million light years is not a long time, it's a long distance.

page 33 Constellations

1. having a pattern and lots of detail
2. 88
3. no
4. autumn
5. When farmers saw certain constellations they would know it was time to begin planting or reaping.
6. poets, farmers and astronomers
7. help us tell which stars are which

page 35 Finding Planets

1. 50 000 000 000
2. an extremely important discovery
3. a planet that does not belong to our solar system
4. the gravitational pull of any planets it may have
5. a planet traveling between you (the observer) and the star.
6. planets
7. a fleet of new spacecraft
8. a place that (i) may contain life (ii) may one day be habitable (iii) indicate the probable presence of yet more Earth-like planets elsewhere

page 37 Dorothea Klumpke Roberts & Annie Jump Cannon

1. a person who photographs stars
2. in 1899 there were no planes
3. planets, asteroids, comets
4. Annie charted more than 250 000 stars.
5. her method is still used today
6. patience, perseverance, intelligence, …
7. (i) there are millions and millions of stars and very few planets (ii) stars are much more distant than planets, making their details harder to make out (iii) new stars are being discovered all the time; this is not so with planets

page 38 Is there Life out there?

See Teachers Notes (page 5) and also 'Life in the Universe' in the Nature's Kids section on Intelligent Australia's website: http://www.intelligentaustralia.com

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