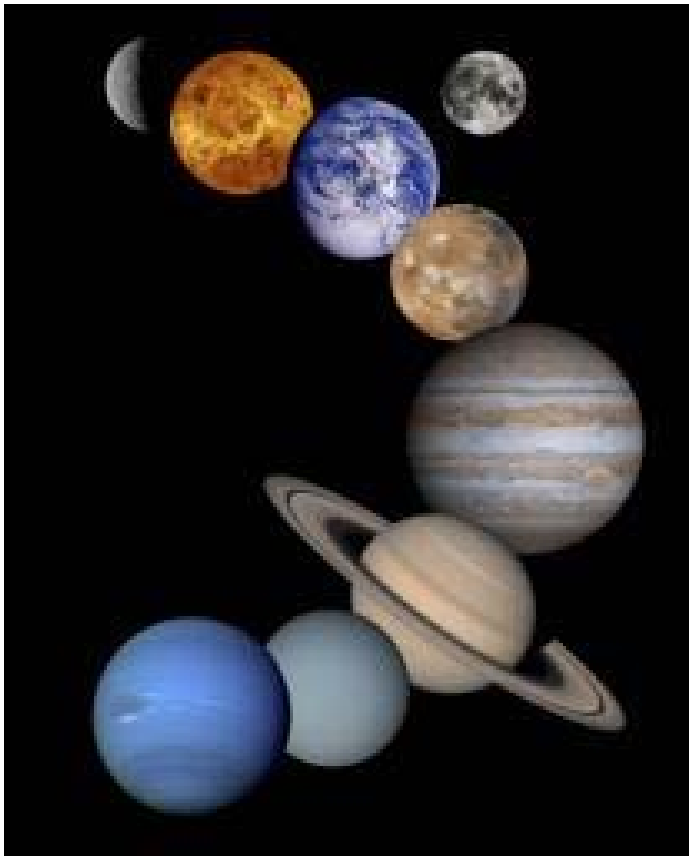
The Solar System

Planetarium education kit



Acknowledgements

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Visiting the Melbourne Planetarium

Planetarium shows consist of a 25 minute presentation in a domed theatre. They are followed by a 10 minute practical guide to 'What's in the sky tonight?'

If the planetarium show is your first programmed activity at Scienceworks, it is important that you arrive about 30 minutes before the show's starting time. This allows time to process payment and store lunches, and for our staff to address your students before proceeding to the planetarium.

Information about Planetarium shows

1. *The Search for Life: Are We Alone?*

Information about this show is available on the Melbourne Planetarium website:
http://museumvictoria.com.au/planetarium/WhatsOn/Search-Life/

2. *The Problem with Pluto*

The Problem with Pluto is a fully immersive production that is enjoyable for all ages, but is especially suited to students in Years 5-8.

Synopsis

Through the experiences of the intrepid character Lucy Leavitt, we are taken on a journey to examine the question, 'When is a planet not a planet?' This question is posed by Lucy who, along with her scientist mother Lillian, is on board a research craft heading to the outer limits of the Solar System. This trip (taken around the time of Lucy's birthday) is to gain data to silence recent debate questioning Pluto's status as a planet. We examine some of the new information about our Solar System and discuss how Pluto is different from the other planets in the Solar System. We investigate where Pluto belongs in the overall structure of the Solar System and highlight the difficulties of defining what makes a planet.

Features of the show

- A fun comparison of the planets in the Solar System, including major characteristics and orbits of each.
- A voyage through Saturn's rings, where chunks of rock and ice as large as houses whiz by, then to Neptune, where diamonds rain from the sky.
- A look into the unique and amazing history of the discovery of Pluto.
- An update of our traditional view of the Solar System to include the Kuiper Belt and Oort Cloud.
- Spectacular journeys through the Asteroid Belt and the Kuiper Belt, including a comparison of these amazing regions.
- A subtle reminder of the scientific method, including a respect for evidence and the importance of an open mind, together with information regarding how we know what we do about the universe.

http://museumvictoria.com.au/planetarium/WhatsOn/Problem-Pluto/

Frequently Asked Questions (FAQ)

These Frequently Asked Questions are listed under VELS and CSF Levels

Level 4 • The Planets

4.1 What is a planet?
According to the IAU (International Astronomical Union's) 2006 definition, a planet is an object that meets each of the following 3 criteria:
1. It orbits the sun, but is not a moon
2. Its mass is large enough to have pulled it into a spherical shape
3. It has cleared its orbit of other objects.

4.2 What is a dwarf planet?
A dwarf planet is an object that meets the first 2 criteria, but not the third. The first three dwarf planets to be classified were Pluto, Eris and Ceres (in August 2006).

4.3 Name the eight planets, in order away from the Sun.
Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus and Neptune

4.4 Which planets are terrestrial (solid)?
Mercury, Venus, Earth, Mars.

4.5 Which planets are gaseous?
Jupiter, Saturn, Uranus and Neptune.
The dwarf planet, Pluto is made of rock and ice.

4.6 Which is the hottest planet?
Venus has an average temperature of 482˚C.

4.7 Which is the coldest planet?
Neptune at -201˚C.

4.8 Which planet has the most moons?
Jupiter has 63 moons at last count.

4.9 Which planets don't have any moons?
Mercury and Venus.

4.10 Which planet has a red spot, and what is it?
Jupiter has a red spot, which is a huge raging storm.

4.11 Which planet takes the shortest time to revolve around the Sun?
Mercury's year takes only 88 (Earth) days.

4.12 Which planet has the shortest day?
A day on Jupiter lasts only 9.9 (Earth) hours.

4.13 Which planets have rings?
Jupiter, Saturn, Uranus and Neptune.

4.14 Which planets can we easily see in the night sky?
Mercury, Venus, Mars, Jupiter and Saturn.

4.15 Do the planets orbit in a circle around the Sun?
No, their orbits are slightly oval in shape (elliptical orbits).

4.16 How are the planet Mercury and our Moon similar?
They look similar with their grey cratered surface and neither have an atmosphere.

Level 4 • Miscellaneous

4.17 What is an asteroid?
A rocky object smaller than a planet orbiting the Sun.

4.18 What is the Asteroid Belt?
It is a ring or belt of asteroids orbiting the Sun. Although there are several of these, the main one is between Mars and Jupiter. It is here that the dwarf planet, Ceres can be found.

4.19 What is a satellite?
Any object that is in orbit around another. Natural satellites are called moons.

4.20 What is a galaxy?
A collection of billions of stars, planets, gas and dust, held together by their mutual gravity.

4.21 What is the name of our galaxy?
Our Solar System is a tiny part of the Milky Way Galaxy, which is a spiral galaxy.

Level 5 • Stars and Constellations

5.1 What is a constellation?
At one time, it was a pattern of stars that formed the shape of a familiar object, like a scorpion or a cross. These days, for astronomers, it is a designated area of the sky with fixed boundaries. All stars within those boundaries are considered part of the constellation.

5.2 How many constellations are there?
There are 88 constellations.

5.3 What is the ecliptic?
It is an imaginary line drawn through the stars that traces the apparent path of the Sun through the sky.

5.4 What is the Zodiac?
The constellations through which the Sun passes during a year. The ecliptic passes through the 12 constellations of the zodiac, as well as the constellation Ophiuchus.

5.5 What is an eclipse?
The 'blotting out' of part or all of the light from one celestial body by another, as viewed from a fixed point on Earth.

5.6 What is a solar eclipse?
It is when the Moon passes between the Sun and the Earth and blocks out part or all of the Sun.

Level 5 • The Moon

5.7 What is a lunar eclipse?
It is when the Full Moon passes into the Earth's shadow and temporarily gets much darker because the Earth blocks the Sun's light.

5.8 What is a New Moon?
It is the phase of the Moon that we cannot see. None of the Moon's surface that is lit up by the Sun is visible from the Earth. We are looking at the half of the Moon that is in shadow.

5.9 Is the Moon visible in the daytime?
Yes. The Moon is always visible at some time during the day, unless it's within a few days of New Moon. At this time, we cannot see the illuminated section of the Moon, even though the Moon is in the daytime sky.

5.10 What are the phases of the Moon?
The parts of the Moon lit by the Sun that we see in the sky over one month (from Earth).

5.11 What causes the Moon's phases?
As we view the Moon from Earth over a month, the phases we observe at any time depend on where in the sky the Moon is relative to the Sun. This varies as the Moon slowly orbits the Earth (once ever 27.32 days).

General FAQ's

The Stars

1. **What is the solar wind?**
   A flow of electrically charged particles (plasma—protons and electrons) which streams from the Sun's atmosphere. Typical solar winds can be 400 kilometres per second.

2. **What is the photosphere of the Sun?**
   The visible surface of the Sun.

3. **What is a sunspot?**
   An area seen as a dark spot on the photosphere of the Sun. Sunspots are typically 2000 degrees cooler than the surrounding area.

4. **What is a red giant star?**
   It has low surface temperature and a diameter that is at least eight times as large as the Sun.

5. **What does magnitude mean?**
   A measure of the brightness of a celestial body. For historical reasons, bright stars have lower magnitudes. The brightest star in our night sky (Sirius) has a magnitude of -1.46 and the faintest star visible to the unaided eye has a magnitude of 6.

The Planets

6. **Are all planets round?**
   No. The planets that are round are Mercury and Venus. The other planets have an oblate shape. Uranus, Saturn and Jupiter are more oblate than Neptune, Mars and Earth.

7. **Given that the orbits of Neptune and Pluto intersect, will they ever collide?**
   Probably not. Even though the orbits of Pluto and Neptune intersect, a collision is virtually impossible because of the high inclination of Pluto's orbit.

8. **What is the 'morning star' or the 'evening star'?**
   It is not a star at all but the planet Venus, often seen just after sunset or just before sunrise.

9. **Will other planets ever collide with the Earth?**
   The positions of the planets in our Solar System have been predicted for about the next one billion years and there is no sign that they will ever stray from their current elliptical orbits.

10. Could life start on another planet in our Solar System?
We don't know. Several environments look promising. The surface of Titan (Saturn's largest Moon) has an atmosphere that we think resembles what Earth's atmosphere was like before life started. Examination of an asteroid from Mars suggested that life may have once been present just below the Martian surface, but this has not been proven. Liquid water and an internal heat source were recently discovered beneath the icy surface of Jupiter's moon Europa, giving scientists another world that might support life.

The Moon

11. What is the terminator on the Moon?
The dividing line between the illuminated and the non-illuminated part of the Moon.

12. What is a Mare?
The direct translation from Latin means 'sea'. The large circular plains on our Moon are named Mares because centuries ago they were thought to be seas.

13. Does any Moon in our Solar System also have a Moon?
No, although the asteroid Ida has been found to have an orbiting 'moon' -- a very diminutive asteroid called Dactyl.

14. Would you see stars in the daytime on the Moon and Mars?
You would be able to see stars from the Moon because there is no atmosphere to scatter sunlight. On Mars, the atmosphere is much thinner than Earth's atmosphere, but carries a lot of dust. The sky would be about as bright as Earth's twilight, and you would be able to see some of the very bright stars all the time.

Miscellaneous

15. What is a meteorite?
A fragment of rock that survives the journey through Earth's atmosphere and lands on Earth.

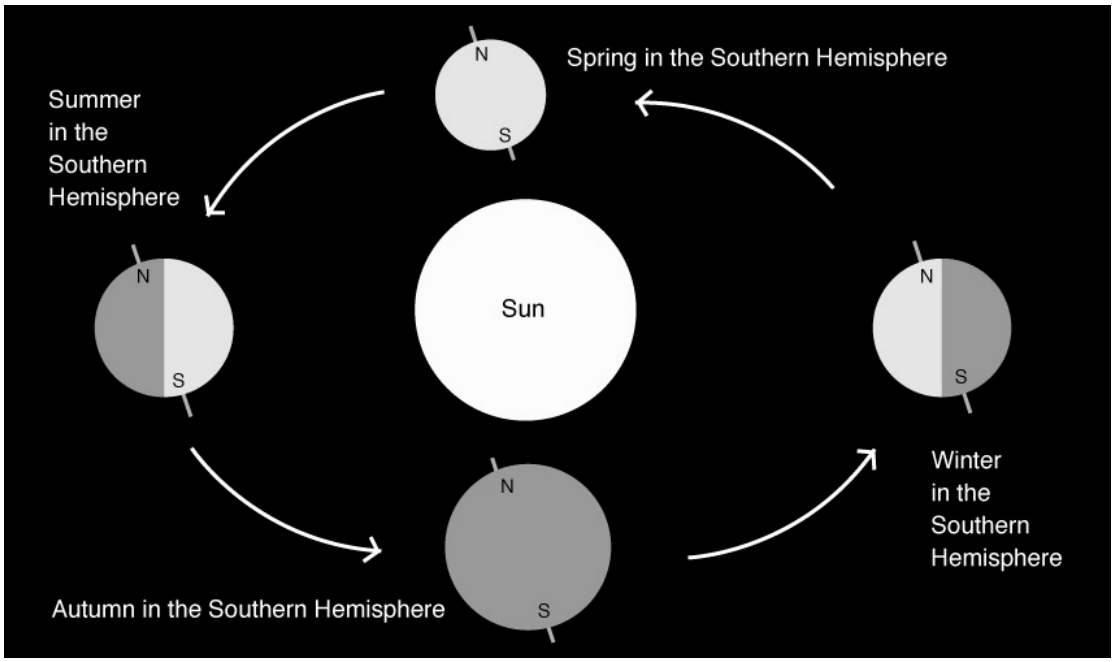
16. Where is the biggest meteorite crater in Australia?
'Spider' crater in Western Australia. It measures 13 kilometres across.

17. What is a meteor (also called 'shooting star' or 'falling star')?
It's a bright streak of light in the sky caused by a meteoroid – a small chunk of dust or rock entering the Earth's atmosphere. They are travelling very fast and burn up because of the heat generated as they travel through the atmosphere. Very large, bright ones are called fire-balls and bolides.

18. What is a comet?
Comets are small solid objects, often likened to 'dirty snowballs'. They consist mainly of ice with some grains of rock or dust mixed in. This icy object is called the nucleus of the comet. It has an irregular shape and is typically only a few kilometres (~5-50km) across. The famous tail of a comet is formed when the frozen nucleus approaches the Sun. As the ice melts, dust and gas is released, often in sudden jet-like spurts. This material forms an atmosphere (or coma) around the comet that increases the size of the comet enormously.

19. What is the zenith?
The zenith is the highest point in the sky at your location. To find the zenith look straight up.

20. What is the equinox?
The equinox occurs when the Sun crosses the equator, meaning that the Sun is directly above the equator at noon. On this day, the number of hours of daylight equals the number of hours of darkness. There are two equinoxes each year: in the Southern Hemisphere the Autumn Equinox occurs around March 21 and the Spring Equinox occurs around September 21.



21. How do astronomers weigh the planets?
By using a simple equation in physics called Kepler's Third Law. It states that the mass of a planet is related to the orbital period (the time taken for the planet to orbit the Sun) and distance from the Sun. If a planet has a moon, we can use this law to find the mass of the planet by using the period of the moon and distance the moon is from the planet. All planets have moons, except for Mercury and Venus. For these two planets, visits by probes in the 1960s enabled us to calculate their masses.

22. What is a light year?
It is the distance light travels in one year, about 10 million million kilometres.

An additional source of FAQ's (Frequently Asked Questions) is the 'Ask the Astronomer' web site. It has a list of over 3,000 FAQ's and also provides the opportunity to ask your own questions.
http://image.gsfc.nasa.gov/poetry/ask/askmag.html

Solar System statistics at a glance

	Mercury	Venus	Earth	Earth's Moon	Mars	Jupiter	Saturn	Uranus	Neptune	Sun
Average Distance from Sun (millions of km)	57.9	108.2	149.6	0.384 from Earth	227.9	779	1,434	2,873	4,495	~40 trillion km to nearest star
Average Distance from Sun (compared to Earth; also called the Astronomical Unit – AU)	0.39	0.72	1	0.0026 from Earth	1.52	5.21	9.59	19.22	30.05	
Approx. Distance from the Sun in Light Time (light travels at 299,790 km/s)	3 minutes	6 minutes	8 minutes	1 second from Earth	13 minutes	43 minutes	1 hour 20 minutes	2 hours 40 minutes	4 hours 10 minutes	4.3 light years to nearest star
Average Orbital Speed (km/s)	47.9	35.0	29.8	1.0	24.1	13.1	9.7	6.8	5.4	220
Time to Orbit the Sun (a planet's year)	88.0 days	224.7 days	365.2 days	27.3 days to orbit Earth	1.88 years	11.87 years	29.44 years	84 years	164 years	225 million years to orbit the galaxy
Time to Rotate (negative sign indicates rotation in opposite direction)	58.65 days	-243 days	23.9 hours	27.3 days	24.6 hours	9.9 hours	10.7 hours	-17.2 hours	16.1 hours	25 days
Length of Day (measured from sunrise to sunrise)	176 days	117 days	24 hours	29.5 days	24.7 hours	9.9 hours	10.7 hours	from 17.2 hrs to 21 years	16.1 hours	
Equatorial Diameter (km)	4,879	12,104	12,756	3,475	6,794	142,984	120,536	51,118	49,528	1,392,000
Equatorial Diameter (compared to Earth)	0.38	0.95	1	0.27	0.53	11.2	9.4	4.0	3.9	109
Mass (10^{24} kg)	0.330	4.87	5.97	0.073	0.642	1,899	568	86.8	102	2,000,000
Surface Gravity (compared to Earth at 9.8m/s^2)	0.38	0.91	1	0.16	0.38	2.36	0.92	0.89	1.12	27.9
Axial Tilt (degrees)	0.01	177.4	23.5	6.7	25.2	3.1	26.7	97.8	28.3	7.5
Maximum & Minimum Temperatures (degrees Celsius; S = surface, C = clouds)	+427 (S) day -173 (S) night	+482 (S) day and night	+58 (S) day -88 (S) night	+123 (S) day -233 (S) night	+20 (S) day -140 (S) night	-108 (C) mean	-139 (C) mean	-197 (C) mean	-201 (C) mean	5,800 (S) 15,000,000 (core)
Principle Gases in Atmosphere	None	Carbon Dioxide	Nitrogen & Oxygen	None	Carbon Dioxide	Hydrogen & Helium	Hydrogen & Helium	Hydrogen, Helium & Methane	Hydrogen, Helium & Methane	Hydrogen & Helium
Number of known Satellites (date of latest discovery)	0	0	1	0	2 (Aug 1877)	63 (Feb 2004)	60 (July 2007)	27 (Dec 2005)	13 (Sept 03)	8 planets + 3 dwarf planets (Aug 06)
Planet Discovery Date	known since ancient times	known since ancient times		known since ancient times	known since ancient times	known since ancient times	known since ancient times	31 March 1781 by William Herschel	23 Sept 1846 by Adams, Le Verrier, Galla and d'Arrest	

Dwarf Planet statistics at a glance

	Ceres	Pluto	Eris
Average Distance from Sun (millions of km)	415	5,870	10,100
Average Distance from Sun (compared to Earth; also called the Astronomical Unit – AU)	2.8	39.2	67.5
Approx. Distance from the Sun in Light Time (light travels at 299,790 km/s)	23 minutes	5 hours 26 minutes	9 hours 22 minutes
Average Orbital Speed (km/s)	17.9	4.7	3.4
Time to Orbit the Sun (a planet's year)	4.6 years	248 years	560 years
Time to Rotate (negative sign indicates rotation in opposite direction)	9.1 hours	-6.4 days	less than 8 hours
Length of Day (measured from sunrise to sunrise)	9.1 hours	from 6.4 days to 62 years	less than 8 hours
Equatorial Diameter (km)	975	2,390	2,600
Equatorial Diameter (compared to Earth)	0.08	0.19	0.20
Mass (10^{24} kg)	0.001	0.0125	0.0166
Surface Gravity (compared to Earth at 9.8m/s^2)	0.03	0.06	~0.08
Axial Tilt (degrees)	4	122.5	44
Maximum & Minimum Temperatures (degrees Celsius; S = surface, C = clouds)	-34 (S) day -106 (S) night	-225 (S) mean	-218 (S) day -243 (S) night
Principle Gases in Atmosphere	None	Nitrogen, Carbon Monoxide & Methane	Methane
Number of known Satellites (latest discovery)	0	3 (Oct 2005)	1 (Sept 2005)
Planet Discovery Date	1 Jan 1801 by Giuseppe Piazzi	18 Feb 1930 by Clyde Toumbaugh	21 Oct 2003 by Brown, Trujillo and Rabinowitz

Curriculum links

This table shows the links between the school-based activities in this kit and the domains of the Victorian Essential Learning Standards.

VELS	**Physical, Personal & Social Learning**				**Discipline-based Learning**						**Interdisciplinary Learning**			
Victorian Essential Learning Standards / **School-based education activities**	Health & Physical Education	Interpersonal Development	Personal Learning	Civics & Citizenship	The Arts	English	Languages Other Than English	Humanities	Mathematics	Science	Communication	Design, Creativity & Technology	Information & Communications	Thinking
Brainstorming and graphic organising		■	■							■	■			■
Order of the planets			■							■				■
Time traveller		■							■	■				■
Calculate your age on other planets			■						■	■				■
How high can you jump on other planets?		■	■						■	■				■
Seasons on other planets						■			■	■			■	
Planets in a bottle		■							■	■				
Microgravity demonstration			■						■	■		■		■
Calculating day length									■	■			■	■
Making a polar sundial									■	■		■	■	
Using the Southern Cross to find south		■							■	■	■			
Plotting the movement of the Southern Cross										■		■		■
A model of the Earth and Moon		■								■		■		
Mapping features of our Moon									■	■		■	■	
The rotating Moon		■								■	■			■
Modelling Moon phases		■								■	■	■		■

Internet resources

Melbourne Planetarium
http://museumvictoria.com.au/planetarium/

The Eight Planets
http://www.nineplanets.org/

NASA Solar System Exploration
http://solarsystem.nasa.gov/index.cfm

NASA's Planetary Photo Journal
http://photojournal.jpl.nasa.gov/index.html

Great Images in NASA
http://grin.hq.nasa.gov/subject-science.html

Science@NASA
http://science.nasa.gov/

NASA education materials
http://education.nasa.gov/home/index.html

Hubble Heritage Project
http://heritage.stsci.edu/

General astronomy information (secondary school level):
http://imagine.gsfc.nasa.gov/docs/homepage.html

General information about astronomy and the Universe:
http://www.windows.ucar.edu/tour/link=/the_universe/the_universe.html

Galileo's autobiography:
http://www-gap.dcs.st-and.ac.uk/~history/Mathematicians/Galileo.html

Multimedia presentation about the Hubble Deep Field (you will need sound):
http://hubblesite.org/hubble_discoveries/hubble_deep_field/

All you need to know about spectra:
http://www.astro.uiuc.edu/~kaler/sow/spectra.html

Online Astrophysics Unit: (NSW curriculum but relevant information)
http://outreach.atnf.csiro.au/education/senior/astrophysics/index.html

Origin of the constellations:
http://www.stargazers.iinet.net.au/constellorigins.htm

Retrograde motion with animation:
http://www.scienceu.com/observatory/articles/retro/retro.html

The Universe within one billion years: Map of clusters and superclusters
http://www.atlasoftheuniverse.com/superc.html

Cosmic background radiation pictures and information:
http://map.gsfc.nasa.gov/news/index.html

European Space Agency – Space science news:
http://www.esa.int/esaSC/