Our SOLAR SYSTEM

This set contains the following lithographs:

- Our Solar System
- Our Star – The Sun
- Mercury
- Venus
- Earth
- Earth’s Moon
- Mars
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- Meteors and Meteorites
- Moons of the Solar System
- Jupiter
- Galilean Moons of Jupiter
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- Moons of Saturn
- Uranus
- Neptune
- Pluto and Charon
- Comets
- Kuiper Belt and Oort Cloud
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Home Page: www.nasa.gov/education/core

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NTV Weekday Programming Schedules (Eastern Times):
Video File — 6–7 a.m., 10–11 a.m., 12–1 p.m., 3–4 p.m., 6–7 p.m.,
10–11 p.m., 12–1 a.m.
NASA Gallery — 1–6 a.m., 1–3 p.m.
Education File — 8–10 a.m., 4–6 p.m., 8–10 p.m.
ISS Mission Coverage — 7–8 a.m., 11 a.m.–12 p.m., 7–8 p.m.,
11 p.m.–12 a.m.

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EDUCATORS
Please take a moment to evaluate this product at ehb2.gsfc.nasa.gov/edcats/lithograph_set/
your evaluation and suggestions are vital to continually improving NASA educational materials. Thank you.

LS-2005-12-003-HQ — JPL 400-1253A 12/05
Our Solar System

WHAT TO SEE

The Sun
The Sun is a star that lives at the centre of the Solar System. Its huge gravity holds the planets in place.

The planets
The planets all revolve around the Sun. There are eight in total - Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus and Neptune.

Moons
Moons rotate around their parent planet. Earth has one moon, but some planets have over 50. Only Mercury and Venus do not have any moons.

Asteroids
Asteroids are rocky bits of debris up to 1,000km (620 miles) across. Most live in the asteroid belt between Mars and Jupiter. They are the remnants from early planets that collided and were torn apart.

Comets
Comets are dirty snowballs of ice and dust that revolve around the Sun in long orbits. When they approach the Sun they heat up, leaving a trail of gas behind them, which looks like a tail.

LOCAL HISTORY
Our Solar System began forming about 4.6 billion years ago from a swirling gas cloud. Over time, the gas cooled and clumped together to form large bodies called ‘protoplanets’. The ‘left over’ material became comets, roaming silently through the Solar System.

Eventually after 100 million years, the enormous ball of gas at the centre of the cloud overheated and exploded in a huge nuclear reaction. The Sun was born.

People of the ancient world observed the movements of the planets and thought they were wandering stars. This is why the Greeks gave them the name planetes or ‘wanderers’.

TRAVEL INFORMATION

From the Earth
You can sometimes spot the planets in the night sky from Earth. Unlike the Sun and the other stars, they don’t produce their own light. They shine because they are reflecting the Sun’s light.

Before you leave
Be prepared to physically change during your journey through the Solar System. As you visit each planet, your age and weight will be different! This is due to the different atmospheric pressure, gravity and orbits of the planets around the Sun.

THE PLANETS

The rocky planets

The four planets closest to the Sun are:

* Mercury
* Venus
* Earth
* Mars

These are called the ‘rocky’ or ‘terrestrial’ planets. They are small by planetary standards and made of similar materials to the Earth.

The gas giants

The next four planets are:

* Jupiter
* Saturn
* Uranus
* Neptune

They are known as the ‘gas giants’. They all have rings and lots of moons. The gas giants are made up mostly of hydrogen, helium, frozen water, ammonia, methane, and carbon monoxide.

The Dwarf Planets

The International Astronomical Union redefined the term planet in August 2006, so Pluto is now classified as a dwarf planet. There are two other dwarf planets in the solar system, Ceres and Eris.

FAST FACTS

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*Mean Earth = 8,090 miles
**Mean Earth = 13,800 miles
***Mean Earth = 20,800 miles

ABOUT THE ILLUSTRATION

The planets are shown in the correct order of distance from the Sun, the correct relative sizes, and the correct relative orbital distances. The sizes of the bodies are greatly exaggerated relative to the orbital distances. The faint rings of Jupiter, Uranus, and Neptune are not shown.

FOR MORE INFORMATION

solarsystem.nasa.gov/planets/profiles/object/SolarSystem
The Sun

What To See:
The Sun is a 1 million km wide ball of burning gas. So be prepared for the best firework show you have ever seen!

Solar flares
Variations in the Sun’s magnetic field cause huge jets or loops of stellar material to shoot out into space.

Solar wind
Solar flares can be accompanied by dense clouds of electrically charged particles, travelling at around 450km per second. When they reach Earth, they can affect communications satellites.

But make sure you wear your protective sun filters over your eyes otherwise you could damage your eyesight.

From The Earth:
The Sun is by far the brightest object in the sky. It’s so bright that during the day its light drowns out virtually everything else in space.

The Sun is so powerful that even from the Earth, its light can damage your eyesight. So never look at the Sun directly or through a telescope.

The best time to appreciate the majesty of the Sun from the Earth is during a solar eclipse. Then the Moon passes in front of the Sun and so it temporarily disappears from the sky.

Inside The Sun:
Life on Earth is totally dependent on the energy it receives from the Sun. This energy is produced when hydrogen atoms inside the Sun fuse to form helium.

The Sun consumes four million tons of hydrogen every second. Even so, it’s so vast that our star has enough fuel to keep it shining for another five billion years.

The Sun’s energy output is estimated to be 386 billion, billion megawatts. So in 15 minutes our Sun radiates as much energy as mankind consumes in all forms, during an entire year.

Before you leave
Make sure you obtain a timetable of sunspot activity. Sunspots are caused when the Sun’s gasses are disrupted as they spin around.

Why sunspots happen
Just like the Earth and all the planets, the Sun spins around a central axis. But this rotation is not smooth like the Earth because the Sun is not solid. So the gas at the Sun’s poles revolves at a different speed to the gas at the equator.

This causes the Sun’s magnetic field to warp. Magnetic eruptions manifest themselves as dark ‘sunspots’ on the surface. Eventually the field becomes so complex that it collapses, causing the north and south poles to swap.

Then the process begins again. This is known as the ‘solar cycle’.

A complete cycle takes 22 years, after which the original north pole is restored. Maximum sunspot activity occurs during the period when the poles are in the process of switching. The last time this happened was in 2001.

When you arrive
A journey to the Sun itself would be impossible even for the best protected of ships due to the scorching temperatures.

Anyone attempting to fly close to the Sun will have to be aware of the solar wind. It will have a significant effect on the path of any craft approaching the Sun.

Local History:
The Sun has been given many names over the course of history. The Greeks named it 'helios', the origin of the adjective 'heliocentric' (meaning centred around the Sun). The Romans referred to the Sun as 'solar'.

Until the Middle Ages it was generally assumed that the Sun orbited the Earth. In the 16th century, Nicholas Copernicus argued that it was the Earth that travelled around the Sun. However, he was not the first person to suggest this - the Greek Philosopher Aristarchus beat him to it by nearly 2000 years.
Mercury

What To See:

Caloris Basin- The most conspicuous feature on the planet is the Caloris Basin, a crater larger than the British Isles. A staggering 1300km (800 miles) across, it is one of the largest impact craters in the Solar System. It was formed by a collision between Mercury and another rocky body. This explosive event must have happened early in the history of the planet, as the floor of the basin has been scarred by many more recent impacts. To fully appreciate the scale of this incident you should also fly over the opposite side of the planet. Here you can still see the large rocky ridges caused by shock waves from this event.

Spotting Mercury From The Earth:
It is difficult to see Mercury from Earth. Being the closest planet to the Sun, it is often masked by the Sun's light. The best time to spot it is near sunrise or sunset, when it is out of the light. Mercury is not visible at night because it's near the Sun. So when the Sun sets, so does Mercury. On rare occasions, Mercury passes directly between the Sun and the Earth. When this happens it can be seen as a small spot on the Sun's surface.

Travel Information:
Journey time · 5.5 Earth months
1 Mercurian year · 88 Earth days
Contacting home · Time lag = 920 seconds
Before you leave- Make sure that you are ready for all conditions. Mercury has the widest temperature range of any planet in the Solar System, from a chilly -173°C at night to a sizzling 350°C during the day.

When you arrive- The descent to Mercury is smooth. The planet has very little atmosphere so there is no chance of your ship burning up as you approach. But this means the planet has little protection against asteroids. So the surface is littered with craters of all sizes. What little atmosphere there is consists of atoms blasted from the planet's surface by the solar wind. Mercury's tiny gravitational field is not large enough to hold these atoms in place. So the atmosphere is being continually regenerated as impacting asteroids kick up dust, which then gradually leaks out into space.

Local History:
The Romans named Mercury after their 'messenger of the gods' because the planet crossed the night sky so quickly. The Greeks referred to Mercury as 'Apollo' when it appeared in the morning sky and 'Hermes' when they spotted it in the evening.

ABOUT THE IMAGES
1 | Mercury's southern hemisphere imaged by Mariner 10.
2 | Terraces and a central peak mark this as a complex impact crater.
3 | A Mariner 10 photomosaic of a portion of the Caloris Basin.
4 | A scarp (cliff) more than 300 kilometers (185 miles) long extends from upper left to lower right in this image.
5 | A close-up of Mercury's south pole taken by Mariner 10 in 1974.

FOR MORE INFORMATION
solarsystem.nasa.gov/planets/profile.cfm?Object=Mercury
**Venus**

**What To See:**
If you can stand the hostile conditions on this planet's surface then there's lots to see, including volcanoes, craters and spectacular landscapes.

**Mead Crater:** The Mead Crater is big, even by Venusian standards - a breathtaking 280km across. This is one of the best, preserved large craters in the Solar System. At first glance, the Mead Crater looks similar to the many volcanoes on Venus. But we can tell that it's a meteor crater by the rings of debris surrounding it. Like all craters on Venus, Mead is relatively young. Unlike other nearby planets, the surface of Venus shows no evidence of heavy bombardment in its early history. So the entire planet's surface must have reformed within the last 500 million years.

**Spotting Venus From Earth:**
Besides the Sun and the Moon, Venus is the brightest object in the sky. It cannot be seen in the middle of the night. But you can try and spot it near the horizon at sunrise or sunset. Because it is closer to the Sun than the Earth, Venus shows phases, like the Moon. Sometimes these can be seen with the naked eye. But even through a telescope, Venus reveals few secrets. The whole planet is surrounded by a thick blanket of clouds. So the only way to discover what lies beneath is to go there.

**Travel Information:**
Journey time · 3.5 Earth months
1 Venusian year · 225 Earth days
Contacting home · Time lag = 1000 seconds

**Before you leave**
Make sure that your spaceship has full thermal insulation, otherwise Venus' dense atmosphere will cause the hull to overheat as it enters the atmosphere. Your spaceship will also need to withstand enormous pressure changes. Not only will it have to deal with the vacuum of space, but the craft will also need to cope with high pressures once it lands. The pressure of the air on the surface of Venus is equal to that one km below the oceans on Earth.

**When you arrive**
The approach to Venus may be a little rocky, as the winds in the upper atmosphere can reach 350km per hour. However, there is little breeze at ground level and temperatures soar. Venus' thick atmosphere creates a strong greenhouse effect, causing temperatures to rise to a sweltering 464ºC.

**A word of warning:** Venus has no magnetic field, so it's easy to get lost among the thick clouds of sulphuric acid as you fly in.

**Local History:**
Venus was named after the Roman goddess of beauty. In keeping with this theme, virtually all the features on the planet are given female names.
Earth

What To See:
Thousands of man-made attractions are well worth a visit.
**Great Wall of China** - It's often said that the Great Wall of China is the only artificial object visible from space. This is not the case but at nearly 6400km long, The Great Wall remains the largest artificial structure on the planet.
In low Earth orbits, many other constructions can be spotted, including the Egyptian pyramids and some modern buildings too. In higher orbits even the Great Wall is impossible to spot.

Local History:
The Earth is the only planet whose name doesn't derive from Greek or Roman mythology. 'Earth' is derived from Old English. The Romans however, referred to the planet as Terra.
**Tectonic plates** - The surface of the planet is relatively young. Unlike other planets, the Earth's crust is made of plates which gradually slide across the globe at about the same speed as your fingernails grow.
So the map of Earth is continually changing. We know that, 120 million years ago, most of the land on the planet was joined to form a super-continent known as Pangea.

Travel Information:
One Earth year · 365.26 Earth days
Population · 6.4 billion humans

Before you leave
Earth is the only planet in the Solar System on which conditions are right for intelligent life to evolve. The planet is the correct distance from the Sun for water to exist as a liquid, a vital ingredient for life. What is the recipe for life?
Earth's oceans also help to regulate the planet's temperature. So it remains fairly constant even when solar conditions change.

The Earth also has a powerful magnetic field. This, combined with the atmosphere, shields the planet from the majority of the harmful solar radiation.
The Earth is therefore the only planet you can walk on without the aid of protective clothing. One word of warning though, local fashions can change remarkably quickly.

When you arrive
Two thirds of Earth are covered by oceans. So unless your craft is equipped for a watery touchdown, you will have to choose your landing site with care.
Earth's terrain is the most varied of any planet of the Solar System. The poles are covered in vast glaciers of ice. Arid deserts are found near the equator. And large areas of land are dominated by vegetation.
There are so many different types of creatures on Earth that they haven't all been catalogued yet. However, human actions have also caused the extinction of many species.
Earth’s Moon
Earth’s Moon

What To See:
Maria - The landscape is divided into two main areas. The dark patches are called maria, meaning ‘seas’. It was named at a time when people thought that liquid water flowed over these regions. Since then, it was discovered that the maria are areas of solidified lava. They were formed over four thousand million years ago, when the Moon was volcanically active. The largest of these regions is called ‘Oceanus Procellarum’.
Terrae - The other main regions are called ‘terrae’, or ‘land’. These lightly coloured highlands are the most ancient regions on the Moon. They are covered in countless craters - the scars from millions of years worth of impacts.
Crater Tycho - This eye-catchy crater in the south can be even seen from the Earth. Its giant walls are 4.5km (miles) high and 85km (53 miles) apart. Tycho is surrounded by bright rays that stretch half way across the globe. These are the splashes of molten rock that splattered across the Moon when the crater was formed by a massive asteroid impact.
Mare Tranquillitatis - Mare Tranquillitatis is the site of the first ever lunar landing. See if you can spot the plaque left behind by the astronauts. It shouldn't be too tricky - there is no wind on the Moon, so you should still be able to follow the footprints.

Travel Information:
Before you leave
Check out reports from previous visitors to the Moon. The first manned expedition was made by Neil Armstrong and Edwin ‘Buzz’ Aldrin on the Apollo 11 mission of 1969. Since then there have been a further five manned missions.

When you arrive
Though the Moon is the closest body to the Earth, we can't walk on the surface unaided. There’s no atmosphere, so it’s impossible to breathe. The lack of atmosphere also means there’s no protection from harmful radiation in the solar wind. But it’s not all bad news. One day we could use hydrogen stored in the Moon’s surface as a source of fuel.

Local History:
The Moon has had a place in many world mythologies. To the Romans, the Moon was the goddess Luna. The Greeks referred to the Moon goddess as Selene, and the Egyptians worshiped the Moon as Isis.

Moon madness

The phases of the Moon have often been associated with madness, giving rise to the English word ‘lunatic’.

How the Moon was made
How the Moon formed is still unconfirmed. The latest thinking suggests it was created after a collision between the Earth and a Mars-sized planet early in the Earth’s history.

Spotting The Moon From The Earth:
The Moon is the easiest thing to spot in the night sky. Even with the naked eye, you can see quite a lot of detail on its surface. Through a telescope it is a stunning sight, with craters, rays and dark regions clearly visible.

The far side of the Moon - Only half the Moon is visible from the Earth. This is because the time the Moon takes to spin on its axis is exactly the same as the time it takes to orbit the Earth. This is no coincidence. Because the Moon is not completely round and bulges slightly, unbalancing its gravitational force. This forced the Moon’s rotation to slow down, until its bulge was aligned with the Earth. The force exerted by the Moon on the Earth is having a similar effect on the Earth’s rotation. Gradually the Earth is slowing down. One day, the length of time the Earth takes to spin round its axis will be the same as the Moon takes to orbit us. When that happens, we will only be able to see the Moon from one side of the Earth.

Phases of the Moon - Over the course of a month, the Moon appears to grow ('wax') and shrink ('wane'). In fact, ever since prehistoric times, the phases of the Moon have been used as a basis for calendars and time measurement. This is how we get the length of our month – the time that passes from one full Moon to the next. The phases occur because half of the Moon is illuminated by the Sun. But this is not always the same half that is visible from the Earth.
Mars

What To See:
Mars has some of the most spectacular scenery in the Solar System.

*Valles Marineris*- A giant canyon system stretching over 5,000km (3,100 miles) along the equator with an average depth of 6km. See if you can spot the erosion channels that could reveal the planet's watery past.

*Olympus Mons*- The largest volcano in the Solar System. Reaching 27km (17 miles) high and 700km (435 miles) across. But don't be afraid - this monstrous volcano is now extinct, so your visit will be a safe one.

*The face*- In 1976, Viking Orbiter 1 sent pictures of a very unusual rock formation. When the Sun strikes Mars at a certain angle, the shadow looks like a human face. Is this proof of alien intelligence at work? Or is it just chance that the rugged surface of Mars conjures up this image? Until there is more evidence, you will have to decide for yourself.

Local History:
It's usually claimed that Mars was named after the Roman god of war because of its angry red color. But early on in the Roman empire, Mars was worshipped as a god of growth and fertility.

Spotting Mars From Earth:
Mars' red color, though more pronounced when seen through a telescope, is still noticeable with the naked eye. Mars can often be spotted from Earth. Usually it travels across the sky from east to west. However, for 70 days of its two-year orbit, it reverses direction across the sky. This is the best times to observe Mars, because it's at the closest point to Earth.

Travel Information:
Journey time - 5.25 Earth months
1 Martian year - 2.11 Earth years
Contacting home - Time lag = 25.4 minutes

Before you leave- Mars is closer in temperature to Earth than any of the other planet in the Solar System. But don't let this catch you off your guard. Mars' weather is even more unpredictable than our own. We recommend a summer visit, when the temperature can reach a pleasant 20ºC. But keep an eye on the weather forecasts! Storms can sweep across the whole planet. Within days, the temperature can plummet by 20 degrees.

Travelers in the winter months should note that Mars can reach a bitter -140ºC.

One final word of warning - make sure you are prepared for dust storms. Tornadoes as large as eight kilometers high have been seen causing havoc across the Martian landscape.

When you arrive-
Your first decision when you arrive will be which hemisphere to head for. The southern hemisphere is higher, and has a more rugged landscape.

The northern hemisphere lies an average of five kilometers lower. We know that the surface there is younger, as there are fewer impact craters. There is no evidence of plate tectonics on Mars. This means that growing volcanoes aren't disrupted by surface movements. This means they can grow 100 times larger than on Earth, like Olympus Mons. But don't worry, the volcanoes on Mars aren't active.
What To See:
Asteroids range in size from tiny dust particles to huge worlds nearly 1,000 km (600 miles) across.
Most asteroids are oddly shaped. They aren’t spherical like planets, because their gravity is too low to pull them into a round form. (This only happens when asteroids are over 250 km in size.) Smaller ones are angular and shaped like potatoes and peanuts. The oddest looking asteroid so far is called ‘Kleopatra’, which looks like a 220km long dog bone.
Asteroid belt-Thousands of asteroids swarm across the 20 million miles of space between the planets Mars and Jupiter. This ‘asteroid belt’ marks the junction between the inner and outer Solar System and houses 90 - 95% of all asteroids. Others orbit close to the Sun and some have been captured by the gravity of planets like Jupiter, Mars and the Earth.
Asteroids with moons- Some asteroids have others revolving around them, just as the Moon revolves around the Earth. Ida, an asteroid about 56km in diameter has its own moon - a tiny body only 1km in size. Other asteroids may well have moons of their own waiting to be discovered.
Binary asteroids- Some asteroids travel in pairs, spinning around a common centre of gravity. These are called ‘binaries’. Astronomers were surprised by this, because they thought their gravity would be too weak to bind them together. This discovery solved the age-old mystery of why impact craters often appear in pairs on the Earth, such as the Clearwater Lakes in Canada.

Travel Information:
Before you leave
There’s no way you will be able to visit all the asteroids, so you’ll have to decide which ones you want to see. Groups are usually named after the largest body they contain. For example, the Amor group that live near the Sun or the Trojans next to Jupiter.
When you arrive-
Be careful if you try and land on an asteroid. Most of them spin around as they travel through space, so touchdown may be a little tricky.

Asteroids From The Earth:
Although you can’t see asteroids with the naked eye, a good pair of binoculars or a small telescope will help you to spot them.

Most asteroids are in stable solar orbits. However, Jupiter’s gravitational field can sometimes pull bodies out of orbit, and send them off at random paths through the Solar System. Could one of these bodies strike the Earth one day?

Missions-
Many mission have been launched from Earth to investigate these rocky remnants: NASA’s Galileo mission flew past two main belt asteroids, Ida and Gaspra, in the early 1990s en route to Jupiter. In 2000, the NEAR-Shoemaker satellite flew past asteroid Mathilde before it went into orbit around near-Earth asteroid Eros. A year later it made a soft landing on the asteroid’s surface. The Deep Space 1 mission whizzed past an asteroid called Braille before reaching its main target, Comet Borrelly, in 2001.

Local History:
The first asteroid was discovered by Giuseppe Piazzi in 1801. The Italian astronomer named it ‘Ceres’, after the Sicilian goddess of grain. Its size relative to the other asteroids has led its inclusion in a new category - the dwarf planets. There are two other dwarf planets, Pluto and Eris. Since then, over 100,000 asteroids have been classified. There may be up to a million 1km-sized bodies in the Solar System. Increasing numbers are being discovered by dedicated searches such as the Near Earth Asteroid Tracking system (NEAT), from Hawaii and the Space Guard program.

Fast Facts:

<table>
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<th>Fast Facts</th>
<th>Eros</th>
<th>Gaspra</th>
<th>Vesta</th>
<th>Ceres</th>
<th>Ida</th>
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<td>Mean Distance</td>
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<td>(AU*)</td>
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<td>7.15</td>
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<td>9 hr, 4 min</td>
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<tr>
<td>(min)</td>
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<tr>
<td>Dimensions (km)</td>
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<tr>
<td>(mn)</td>
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<td>12 x 7 x 7</td>
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<td>(mi)</td>
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*AU = astronomical unit, the mean distance from Earth to the Sun; 149.60 million km or 92.96 million mi.
WHAT TO SEE
Jupiter is one of the four ‘gas giant’ planets. Unlike rocky worlds like the Earth, Jupiter is composed almost entirely of gas. Inside this swirling ball of gas lies a small core of solid rock. The bright colours in Jupiter’s clouds are caused by complex interactions of various simple gases. Hydrogen, helium, carbon dioxide, water and methane are all present, along with clouds of ammonia ice and ammonium hydrosulphide. The distinct bands are created by high-speed winds, with adjacent rings blowing in opposite directions. Between the bands are vortices where wind speeds reach 600 km per hour.

The Great Red Spot
This circular knot of gases marks a vast thunderstorm that has raged on the planet’s surface for over 300 years. The spot is over twice the size of Earth and is the largest thunderstorm in the Solar System. Jupiter’s most prominent feature is even visible from the Earth. How such a huge storm has survived for so long remains a mystery.

Jupiter’s rings
An infrared imager is a must-have gadget for any trip to Jupiter. Like Saturn, Jupiter also has a system of rings. They’re very faint when viewed with the naked eye. But scanned in the infrared spectrum, Jupiter’s rings are a colourful sight. Unlike Saturn’s rings, Jupiter’s do not contain ice crystals. They are probably composed of debris from meteor collisions on Jupiter’s moons.

LOCAL HISTORY
The Romans named the planet Jupiter after their king of the gods - a fortunate coincidence since they couldn’t possibly have known that Jupiter is the largest planet in the Solar System. The Greeks referred to the planet as Zeus, who was the king in their mythology.

TRAVEL INFORMATION
Journey time: 18 months
1 Jovian year: 11.9 Earth years
Contacting home: Time lag = 76.5 minutes

Before you leave
Jupiter has a gigantic magnetic field, so finding your way there won’t be a problem. But make sure that your ship is properly insulated. Radiation from high energy particles trapped inside the field is strong enough to kill you.

When you arrive
The approach to Jupiter has to be one of the most spectacular journeys in the Solar System. Jupiter has a multitude of large moons. And there is evidence that there may be many more smaller satellites, so keep your eyes peeled.

The origins of these smaller moons remains a mystery. Many are in ‘retrograde orbit’, meaning that they circle in the opposite direction to the major moons. So these odd moons may be asteroids that have been captured from the asteroid belt by Jupiter’s immense gravity.

Exploring Jupiter
Jupiter is a ‘gas giant’, so it’s not possible to land a ship on its surface. Travelling far below the clouds of this planet is not advised. Temperatures and pressures soon begin to rise. So far, no probes have survived over 150 metres below the surface of Jupiter.

SPOTTING JUPITER FROM THE EARTH
Jupiter is one of the easiest planets to spot from the Earth. Though Venus is brighter, Jupiter is further from the Sun, so it’s visible long after the Sun and Venus have set. Other than the Moon, it’s the brightest object you can see in the middle of the night.

Four of Jupiter’s moons - Io, Europa, Ganymede and Callisto - are easily visible with binoculars. When Galileo discovered these moons in 1610, they provided the first evidence that not all heavenly bodies revolved around the Earth.
WHAT TO SEE
Saturn is a ‘gas giant’ planet, like its larger neighbour Jupiter. Although it's not as brightly coloured as Jupiter, the planets have a very similar composition. The atmosphere, mostly hydrogen and helium, with traces of simple compounds, spins around the planet.

Saturn’s rings
Saturn has the most spectacular ring system in the Solar System. These rings aren’t solid, but made up of billions of separate chunks. They range from microscopic particles to rocks that are a few metres in diameter.

When Galileo Galilei first spotted the rings, he was convinced that he was seeing three separate planets moving together.

It’s thought that the rings are made mainly of water ice, though some chunks may have rocky centres. No one is sure how they formed. But we do know that they change over time. Some particles are lost into space and these are replaced by debris released by Saturn’s moons.

The Cassini Gap
On closer inspection, Saturn’s rings are composed of many hundreds of smaller bands, with gaps in between. The largest break - the Cassini Gap - is visible from Earth.

Saturn’s moons may create some of these gaps as they sail through, clearing debris from their paths.

SPOTTING SATURN FROM THE EARTH
Saturn is the furthest planet that can be seen with the naked eye. But without the aid of a telescope, it can be tricky to spot against the background of stars. The give-away sign of any planet is that it doesn’t 'twinkle' like stars do.

If you catch the planet at the right time, you can see its rings. But every few years they seem to disappear. This is due to a change in the orientation of Saturn compared to Earth. When the rings are edge on, they are very hard to spot being only one kilometre thick.

TRAVEL INFORMATION

Journey time · 29.4 Earth months
1 Saturnian year · 29.5 Earth years
Contacting home · Time lag = 159.4 minutes

Before you leave
You’d be well advised to get hold of a satellite timetable before travelling. With many known moons and more still to be confirmed, Saturn’s skies can be a nightmare to navigate.

A pair of ultraviolet imaging goggles is also a must. Saturn has an impressive aurora display which changes hourly. It’s formed when electrically charged particles from the solar wind hit Saturn’s atmosphere.

When you arrive
As with all the gaseous planets, Saturn does not have a surface to land on.

Watch out for the gale-force winds. At the equator, they can reach over 1500km per hour, and are mostly in the easterly direction. A trip to the poles is recommended, as here wind speeds decrease, as broad bands of gas travel in opposite directions.

No probes have ever penetrated the planet’s surface. The clouds are thought to hide a layer of metallic liquid hydrogen covering a rocky core. Even so, the planet has the smallest density of any in the Solar System. In fact, Saturn is so light that it’d float on water - if there were an ocean large enough!

LOCAL HISTORY
In Roman mythology, Saturn was the god of agriculture, and was the father of Jupiter. The Greeks referred to the planet as 'Cronus'.

ABOUT THE IMAGES
1. Casini captured this true-color image of Saturn and its magnificent rings.
2. A natural-color close-up view of Saturn’s rings.
3. This Cassini image shows a bright storm in a region of high atmospheric activity.
4. Saturn’s bright equatorial region displays swirls and eddies in this Cassini image.
5. An ultraviolet image of Saturn’s rings shows more ice (turquoise colors) near the outer edge of the rings.

FOR MORE INFORMATION
solarsystem.nasa.gov/planets/profile.cfm?Object=Saturn
Uranus

WHAT TO SEE
Like nearby Saturn, Jupiter and Neptune, Uranus is a planet made almost entirely of gas.

A blue hue
The atmosphere is mostly hydrogen and helium, with small quantities of methane. It’s the methane that absorbs the red light from the Sun’s ray, giving the planet its distinct blue colour.

The weather
To the naked eye, Uranus is a fairly featureless planet. However, enhanced telescope images show seasonal changes in the planet’s atmosphere during the year.

SPOTTING URANUS FROM THE EARTH
Uranus can occasionally be spotted with the naked eye, if you know where to look. But it’s hard as it looks very similar to the background of stars.

Even with a small telescope, Uranus can be hard to find. Through larger telescopes, it appears as a greenish disc, without any distinguishing marks.

LOCAL HISTORY
Uranus was not known in the ancient world. It was the first planet to be discovered with the aid of a telescope.

When Wilhelm Herschel spotted it in 1781, he named it "the Georgium Sidus" (the Georgian Planet). It was later given the name Uranus (the Greek god of the heavens), to continue the tradition of naming planets after Classical gods.

TRAVEL INFORMATION
Journey time · 8.5 Earth years
1 Uranian year · 84.0 Earth years
Contacting home · Time lag = 319.5 minutes

Before you leave
Make sure you time your trip well. Other planets spin around an axis that is perpendicular to their direction of travel. But Uranus is tipped on its side and spins in the same direction as it travels. So it rolls around its orbit.

No one knows for certain what happened to Uranus to make it like this.

This means that each of Uranus’ poles faces away from the Sun for half of the planet’s orbit. So each pole alternates between nights and days that last for 42 years.

When you arrive
Like the gaseous giants Jupiter and Saturn, Uranus has a system of rings. They are so dark however, that even visitors to the Uranian system will not be able to see them directly. The only way to spot them is by observing as they block the light of stars beyond.

Uranus has no distinct surface on which to land. But it’s thought that Uranus has a core of rock and ice.

About the images
1. A true-color composite image by Voyager 2.
2. A Voyager 2 composite-enhanced image emphasizing high-level haze in the atmosphere.
3. Voyager 2 imaged "lanes" of fine dust particles in the rings.
4. An infrared composite image taken by the Keck Observatory in November 2004 shows atmospheric details and turns the rings a reddish color.
5. As it departed Uranus for Neptune, Voyager 2 looked back and captured this crescent view of the planet.
6. Slant contrast is exaggerated in this false-color image, showing Uranus' dark "polar hood" — a veil of ice and dust.
7. Exaggerated contrast and false color reveal some details of Uranus' clouds.

For more information
solarsystem.nasa.gov/planets/profile.php?obj=Uranus
Neptune
Neptune

WHAT TO SEE
Neptune is one of the four 'gas giants' (along with Jupiter, Saturn and Uranus). They are planets composed almost entirely of gas.

Mystery colour
Neptune’s vivid blue colour is a mystery. No one knows the identity of the light-absorbing chemical that creates its deep blue skies.

'Scooters'
While flying past Neptune, Voyager 2 spotted a small white cloud shooting around the planet’s upper atmosphere every 16 hours. It was dubbed ‘The Scooter’ because of its strange shape. It may have been a plume rising from a larger cloud lower in the atmosphere. But what is was is still a mystery.

SPOTTING NEPTUNE FROM THE EARTH
Neptune cannot be seen from the Earth with the naked eye. Even through powerful telescopes, the planet can be hard to spot. When Galileo saw it, he thought it was just another star.

LOCAL HISTORY
Neptune was named after the Roman god of the sea. Neptune has the honour of being the first planet to be discovered on paper before it was actually seen. Neptune’s gravitational field affects the orbit of Uranus. So its existence was deduced using Newton's laws of motion. Then it was spotted by Johann Gottfried Galle in September 1846.

TRAVEL INFORMATION
Journey time • 12 Earth years
1 Neptunian year • 164.9 Earth years
Contacting home • Time lag = 8.26 hours

Before you leave
Make sure you check the weather forecast before you set off for Neptune. In 1989, astronomers spotted a giant dark storm in the planet’s atmosphere similar to the giant red spot on Jupiter. However, observations in 1994 failed to locate it. Either the spot was concealed beneath the clouds, or it had simply died.

When you arrive
Neptune has no solid surface to land on, although it may have a tiny core of rock. Its atmosphere is mostly hydrogen and helium with traces of methane. Neptune has the wildest weather of any planet in the Solar System, with winds of up to 2,000km per hour. Descending towards the planet, you get a fantastic view of the planet’s ring system. As with other planets, the rings of Neptune are separated into different bands. Their layout is determined by the gravitational fields of the planet and its moons.
Pluto and Charon

WHAT TO SEE
Before its reclassification, Pluto was the furthest planet from the Sun. From the surface of Pluto, the Sun is so tiny it looks like a bright star in the sky. Pluto is very small, only half the size of Earth’s moon.

This remote ball of ice remains a bit of a mystery. The first probe due to visit Pluto won’t arrive until July 2015.

Light and dark regions
Telescope images show light and dark regions. The lighter areas are probably ices of nitrogen, methane, ethane and carbon dioxide. The darker regions may be a result of photochemical reactions driven by cosmic rays, but their exact nature is unknown.
Further investigation will be one of the first tasks for any visitor to Pluto.

LOCAL HISTORY
Pluto was discovered by accident in 1930 by Clyde William Tombaugh. Astronomers had begun to search for a new planet beyond Neptune after calculations of this planet’s orbit predicted the existence of a large mass beyond it.

The sums later proved to be wrong, but not before astronomers had started their search for a new planet. And before the error in the calculations had been realised, Pluto had already been discovered.

Pluto was named after the Greek god of the underworld, possibly because it is so far from the Sun. The name was suggested by an 11 year old school girl from Oxfordshire.

Planet or dwarf?
Astronomers have disagreed about Pluto in the past, arguing that it should not be called a planet because of its small size and distant location. To resolve the issue, the IAU have confirmed a new scientific definition. To be called a planet, an object must be in orbit round the Sun, it must be large enough that it takes on a nearly round shape, and its orbit must be clear of other planets. For 20 out of every 248 years, Pluto’s orbit overlaps with Neptune’s orbit, so Pluto is no longer classifiable as a planet. It joins Ceres and Eris in the newly formed category ‘dwarf planets’.

TRAVEL INFORMATION
Journey time · 8 Earth years
1 Plutonian year · 248 Earth years
Time lag · 7.93 hours

Before you leave
Make sure that you wrap up warm. At a chilly -230ºC, Pluto is one of the coldest places in the Solar System.
You might want to make sure you time your trip for the summer months. During the winter, it is so cold that even the atmosphere freezes!

When you arrive
While approaching Pluto, keep an eye out for the unusual feature of its rotation. It rotates in the opposite direction to all the planets.

Pluto’s moons
Pluto has one large moon, Charon, and two tiny moons called Nix and Hydra.
There are many moons in the Solar System that spin around on their axis at the same rate as they orbit their planet. Our Moon is like this, which is why we always see the same side of the Moon when we look at it from Earth.

Pluto is the only celestial body that spins at the same rate as its moon orbits. So you can only see Charon from one side of Pluto.

SPOTTING PLUTO FROM THE EARTH
Pluto can’t be seen from Earth with the naked eye. It’s possible (though tricky) to spot it through a telescope, if you know exactly where to look.

Even powerful Earth-based telescopes aren’t strong enough to see Pluto’s dark surface in detail. The view from the Hubble telescope shows less detail than you can can see on the Moon from Earth.

ABOUT THE IMAGES

1 Pluto is mostly brown and is probably covered with methane frost.
2 Astronomers investigating the sometimes-elongated shape of Pluto in some images eventually determined that Pluto had a companion — a large moon nearly half Pluto’s size.
3 The Hubble Space Telescope resolved Pluto and Charon as separate disks, enabling better measurements of both bodies.
4 A surface map of Pluto created from four Hubble Space Telescope images, showing distinct areas of brightness.

FOR MORE INFORMATION
solarsystem.nasa.gov/planets/profile.cfm?Object=Pluto