Astronomy for Curious Kids

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Discovering the Solar System

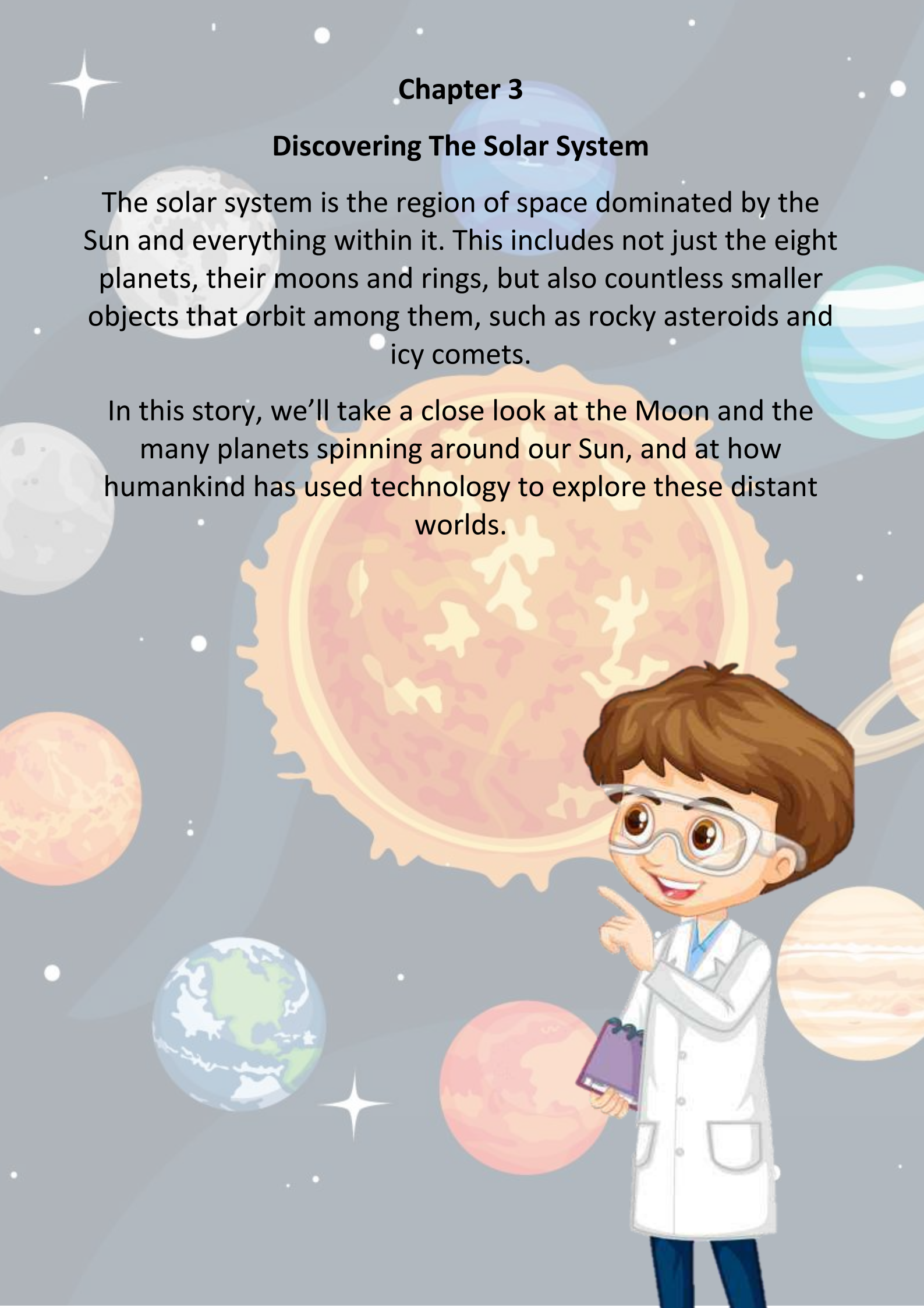
THINK DIGITAL ACADEMY

Chapter 3

Discovering The Solar System

The solar system is the region of space dominated by the Sun and everything within it. This includes not just the eight planets, their moons and rings, but also countless smaller objects that orbit among them, such as rocky asteroids and icy comets.

In this story, we'll take a close look at the Moon and the many planets spinning around our Sun, and at how humankind has used technology to explore these distant worlds.



Moon Map

The Moon has two main types of terrain – dark plains called “seas”, where there few craters and bright “highlands” covered in craters. The surface has been bombarded with space rocks throughout its history, which have carved out craters of all sizes. This bombardment was at its heaviest up to 3.8 billion years ago. Three billion years ago, changes inside the Moon caused molten lava to erupt through cracks in the surface, flooding the largest craters. The lava set into solid rock to create dark lunar seas.

Moon phases

The Moon orbits Earth every 27.3 days and turns on its axis at the exact same time, so that the same side is always facing Earth. As different amounts of the Earth-facing surface are lit by the Sun, it goes through a series of phases, from new Moon to full Moon and back.

Because the Sun's direction from Earth is also changing, it actually takes 29.5 days for the Moon to return to the same phase as the previous month.

Out of Curiosity

Rock samples brought back by astronauts show that the Moon's rocks are similar – but not identical – to Earth's. The Moon is also very large compared to the size of Earth itself; most moons are much smaller than their parent planets. Most astronomers now think that the Moon formed when a Mars-sized rogue planet struck Earth about 4.5 billion years ago. It threw a huge fountain of molten rock into orbit, where it came together into a new satellite

The Far Side

Space probe photos show that the far side of the Moon has far fewer dark seas – this is because most of the volcanic eruptions happened on the Earth-facing side.

Investigating the Sun

The Sun is the star at the centre of our solar system – a huge ball of gas generating energy that provides light and heat to the planets and other objects in its orbit.

The Sun's interior is made up of gas that gets denser (more tightly packed) and hotter toward a core where temperature can reach 15 million °C (27 million °F). energy pushing out from the core creates two more distinct internal layers, before finally escaping into space at the photosphere, the Sun's upper layer where its gas becomes mostly transparent.

Did you know?

Prominences are loops of cool gas running high above the surface, created by the Sun’s tangled magnetic field.

Solar flares are bursts of energy released when prominences collapse.

Sunspots are dark markings on the surface where the photosphere is cooler.

Gamma rays escaping from the core bounce back and forth in the foggy radiative layer, taking tens of thousands of years to move outward.

At the photosphere, the hot gas releases energy again in the form of light and heat that escape into space.
At the base of the convective later, the Sun's gas changes. It absorbs energy from below as heat, which sends it rising up like hot air.
In the Sun's core, hydrogen gas is forced together to make helium and release energy as gamma rays.

Solar Eclipses

Solar eclipses happen on rare occasions when the Moon passes across the face of the Sun as seen from Earth.

Partial Eclipse:

The Moon partially blocks the Sun – look for strange-shaped shadows on the ground.

Annular Eclipse:

The Moon passes right in front of the Sun, but because it's at its farthest Earth, a ring of sunlight shines around it.

Total Eclipse:

The Moon blocks light from the photosphere completely. For a few minutes, much fainter light from the Sun's outer atmosphere, or corona, becomes visible.

Solar Projection

The Sun’s light is so bright that it can easily damager your eyes, so you should never look at it directly. The best way to see features on the Sun is by using a telescope or binoculars (with one o the two large lenses covered by its cap), to project the Sun’s image onto a cord or paper screen. You can see the Sun’s shape during a partial eclipse and also track changing patterns of sunspots.

Professional astronomers use special telescopes that block nearly all of the Sun’s light and only allow a very small amount through to reveal surface details. Safety-graded “eclipse glasses” do a similar job, so you can look at the Sun during a partial eclipse.

Out of Curiosity

Astronomers can measure the Sun’s rotation by tracking how sunspots change their location on its disk. Their results show that the Sun isn’t solid – at the equator, it spins in about 25 days, but near the poles it takes around 35.

Studying the Planets

The five closest planets to Earth are all visible with the naked eye if you know where to look. Track them from week to week to study their movements, or use binoculars or a small telescope to see some of their most interesting features.

Inferior Planets

Mercury and Venus both orbit closer to the Sun and Earth – they are called inferior planets, and their movements are confined to loops around the Sun. Mercury, the smallest and innermost planet, is usually lost in its glare. It can only be spotted for a few days at dawn and spend months in dark evening or early morning skies, when it often outshines everything except the Moon.

Venus goes through phases like the moon and looks different in its various positions as it orbits the sun.

Planets with Phases

The distance from Earth to Mercury and Venus varies, depending on how the planets are arranged. At superior conjunction, they are on the opposite side of the Sun and Earth, while at inferior conjunction, they are on the near side and closest to Earth. Both planets go through a cycle of phases like the Moon, depending on how much of the sunlit side we can see. Mercury is so small that its phases are hard to spot, but Venus' are easily seen through binoculars or a small telescope – especially when it is a thin crescent.

Superior planets

Mars, Jupiter and Saturn, are the three naked-eye “superior” planets, orbiting the Sun farther out than Earth. This means they can make circles all the way around the sky, appearing at their biggest and brightest at “opposition”, when they are directly opposite the Sun and rise as it sets.

Features on Mars

Mars can go from big and bright to small and faint, but it's easy to find thanks to its orange-red colour. As its brightest, a telescope can show dark plains on its surface and gleaming white ice caps at the poles, which change in size depending on the Martian seasons.

Jupiter’s Moons and Clouds

Jupiter is the largest planet in the solar system and is much farther away than Mars, so the arrangement of planets doesn’t affect its brightness as much. Binoculars will show Jupiter’s four giant moons shifting from side to side of the bright disk from one night to the next. Even a small telescope will show some of the dark cloud bands that wrap around the planet.

Rings of Saturn

Saturn is small than Jupiter and almost twice as far away. It looks like a yellowish “star” that takes nearly 30 years to circle through the zodiac constellations. Binoculars will show something strange about its shape, but it takes a telescope to really see the shape of its rings.

The angle of Saturn’s rings to Earth changes through each orbit. Sometime they are side-on, but every 15 years they lie edge-on to Earth and nearly disappear from sight

Fragments of The Solar System

The space between the planets is mostly empty, but there are plenty of small objects following their own paths around the Sun. these vary from durst to clouds to space rocks that pass through Earth’s atmosphere.

Shooting Stars

Most of the small objects that cross Earth's path through space are tiny specks of dust. As they plunge into the thin gas of the outer atmosphere, they heat them up due top friction from the air and they burn away in short-lived trails of light known as shooting stars or meteors.

Meteor Streams

Meteors enter the atmosphere from different directions all the time, but sometimes Earth meets a large cloud of dust on its own path through space, such as that left behind the orbit of these “meteor streams”, the result is a shower of shooting stars coming from one direction. They appear to radiate from a point in the sky.

Annual Showers

Because Earth crosses some meteor streams at the same time each year, they can be predicted. Here are some of the brightest and best known.

Most of these showers take place over several nights on either side of their peak.

Name	Constellation	Peak around	Peak meteors per hour
Quadrantids	Bootes	January 4	110
Lyrids	Lyra	April 23	18
Eta Aquariids	Aquarius	May 6	50
Delta Aquariids	Aquarius	July 30	25
Perseids	Perseus	August 12	100
Orionids	Orion	October 21	25
Leonids	Leo	November 17	10 (but storms of thousands happen about every 33 years)
Geminids	Gemini	December 15	150

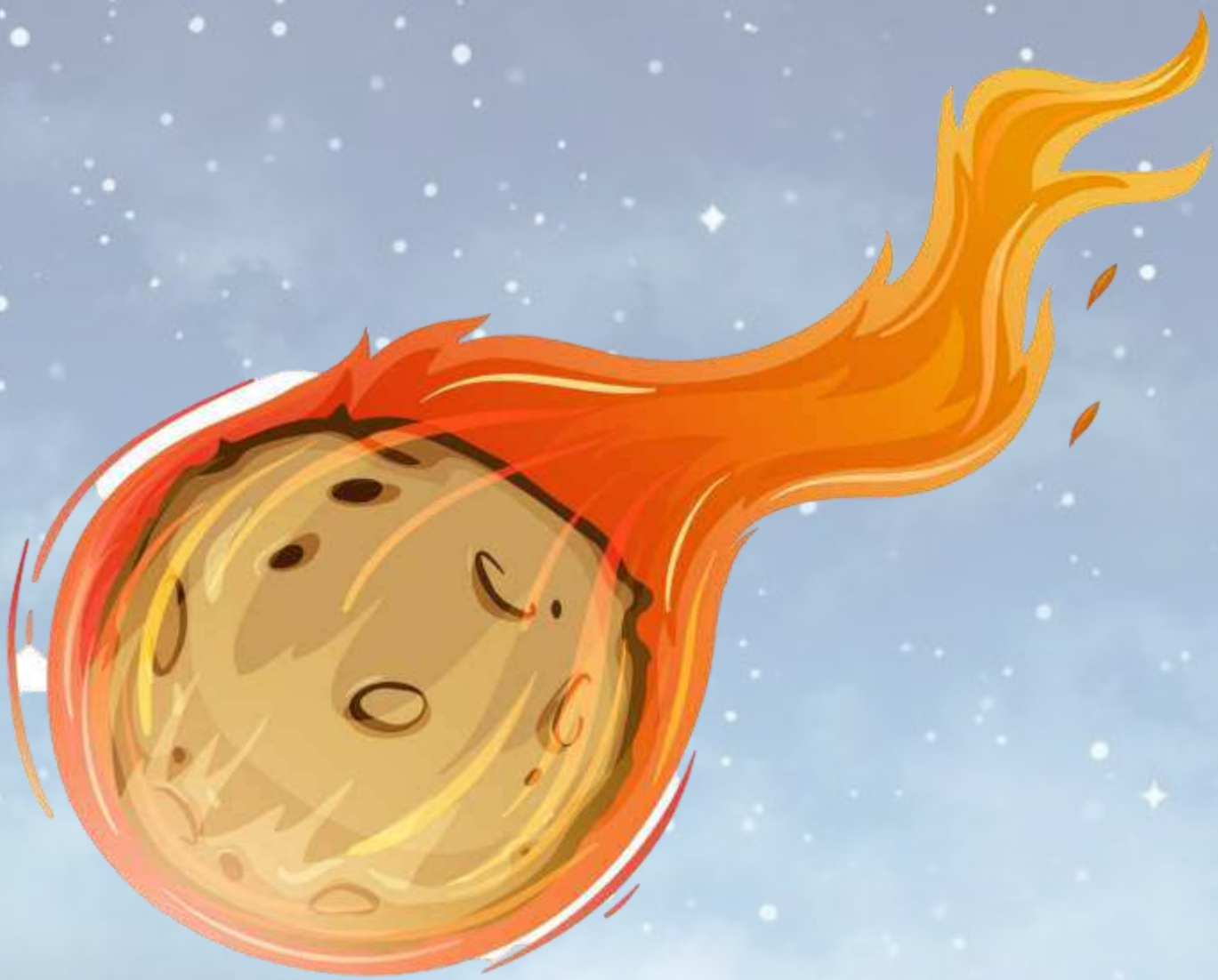
Meteorites

On rare occasions, chunks of solid rock fall into Earth's atmosphere. These objects can create spectacular fireballs called bolides, as they fall. Friction with the air can slow them down, and sometimes they can even survive to hit the ground. They are then known as meteorites.

Meteorites allow scientists to study fragments of other worlds in laboratories on Earth. Soe come from the Moon and some from Mars, but most are chunks of asteroids that may have changed little since the early days of the solar system.

Out of Curiosity

While some meteorites stand out from their surroundings, others blend in and are hard to tell from Earth rocks. One way to track down meteorites is to look in places with no natural rocks, such as ice sheets or deserts; any rocks found there must have fallen out of the sky.



Impact Craters

When large meteorites hit the ground, the results can be spectacular – a shock wave melts both the meteorite and the rock below, spraying it over the nearby landscape and forming a bowl-shaped impact crater. On Earth, these craters are rapidly worn down and disguised, but many other worlds in the solar system preserve countless impact craters from their ancient history.

Dino Extinction

Around 66 million years ago, a 10-km (6 mile) chunk of space rock struck what is now Mexico. The aftermath of the impact, including huge tidal waves, wildfires and years of dark, cold skies around the world, brought an end to the age of the dinosaurs.

Explorers on the Moon

The Moon may be the closest world to Earth, but visiting still requires crossing 400,00 km (250,000 miles) of space, then surviving hostile conditions on the lunar surface.

Robot Pioneers

When humans set the goal of reaching the Moon in the 1960s, we'd only ever seen it from a distance. Space probes (unmanned devices sent to explore space), were launched to learn more about conditions before a landing could be planned.

Robot probes included the Lunar Orbiter which mapped the surface from a distance, the Ranger (right), which sent back close-up pictures before smashing into the surface, and the Surveyors which sent back data about surface conditions. Until the first Surveyor landings, many scientists worried that the Moon's surface was a sea of dust that would swallow up anything that landed on it.

To The Moon and Back

In order to reach the Moon, engineers at US space agency NASA came up with an ingenious plan. A giant rocket launched a three-part spacecraft named Apollo toward the Moon. One part (the Lunar Module), was designed to land on the surface, while another (the linked Command and Service Modules), kept a third astronaut in orbit around the Moon. All three astronauts travelled home to Earth in the third part, the Command Module.

Walking on The Moon

The Apollo Luna Module carried two astronauts to the lunar surface, while a third remained in the orbiting Command Module. Astronauts wore spacesuits to shield from the airless conditions and extreme temperatures, with thick boots and multiple layers to protect them from sharp moon rocks. The Apollo II mission was the first to land people on the moon, but five successful Apollo missions followed. The last three missions also carried an electric car called the Lunar Roving Vehicle.

Lunar Module

The Lunar Module had a crew cabin mounted on a spiderlike landing section. Rockets in the landing section fired to steer the module's descent. When the surface expedition ended, a separate rocket underneath the crew cabin fired to blast it free of the landing section and return it to lunar orbit.

The Apollo Landings

Name	Lunar module	Landing date	Landing site	Expedition length
Apollo II	Eagle	July 1969	Sea of Tranquillity	21 hours
Apollo 12	Intrepid	November 1969	Ocean of Storms	32 hours
Apollo 14	Antares	February 1971	Fra Mauro region	33 hours
Apollo 15	Falcon	July 1971	Apennine mountains	67 hours
Apollo 16	Orion	April 1971	Descartes highlands	71 hours
Apollo 17	Challenger	December 1972	Taurus-Littrow valley	75 hours

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