St Aiden's Homeschool

Our Solar System

Earth's Final Frontier

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Introduction

For I dipped into the Future, far as human eye could see; saw the vision of the world, and all the wonder that would be. -Alfred Lord Tennyson, 1842

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Outer space is perhaps the final frontier for man. Even though the rest of the solar system objects may seem like tiny dots from Earth, our celestial neighbours are still important to learn about.

In a Nutshell:

What is the solar system? It is our Sun and everything that travels around it. Our solar system is elliptical in shape. That means it is shaped like an egg. The Sun is in the centre of the solar system. Our solar system is always in motion. Eight known planets and their moons, along with comets, asteroids, and other space objects orbit the Sun. The Sun is the biggest object in our solar system. It contains more than 99% of the solar system's mass. Astronomers think the solar system is more than 4 billion years old.

Astronomers are now finding new objects far, far from the Sun which they call dwarf planets. Pluto, which was once called a planet, is now called a dwarf planet.

What is in the night sky?

What is up there in the sky? During the day, you can often see puffy clouds floating high in the air, and a huge ball of gas called the Sun. But when you look up on a cloudless night, you can see other things up there: the Moon and many, many stars. What are they? How many are there? How large are they? Can I touch them? These are only some of the questions human beings have pondered in the past and continue to ponder.

People have invented telescopes to see these planets and stars better. Stars are very hot balls of gas. Planets look like stars to the naked eye, but if you look at them every night for a month or so, you will notice how they move across the sky. That is because they are moving in their orbit around the sun, just like Earth! There are eight major planets in our solar system: Mercury, Venus, Earth, and Mars are the inner planets; Jupiter, Saturn, Uranus, and Neptune are the outer planets. There are also smaller objects in the outer regions call "dwarf planets". These include Pluto.

How is the Solar System measured?

When we look at things in the Solar System, we try to measure what we see. This allows us to compare the many objects and to know how and where they will move. To make it easy to share what we know with each other, a common method is used. Most of the world now measures the Solar System using the metric system. This system is a set of values that can be used to measure everything.

In this book, all of the measured values are in the metric system. This was first used in Europe during the eighteenth century. It was meant to replace all of the older systems of measuring things, such as the English system that used units such as feet, inches, pounds, and degrees Fahrenheit. The use of the metric system has made it much easier for people to agree on common sizes for things that are sold and to share information.

The types of values that are shown in this book are length, mass, temperature, and time. Length is used for values such as the size of a planet or the distance of a moon from a planet. Mass can be thought of as the weight of something if it was on the surface of the Earth. So if you weigh 30 kilograms on Earth, your mass is 30 kilograms. If you went somewhere where there was no gravity you would weigh nothing at all, but you would still have a mass of 30 kg. So the weight measures the pull of gravity on something with a given mass.

In the metric system, the length of something is measured in metres. A typical adult is about 1.7 metres high. One metre, in the old English system, is a little longer than 3 feet, 3 inches. The metre is sometimes shortened to an *m*. 'Metre' is spelled 'meter' in the United States.

For longer distances, the kilometre is used ('kilometre' is spelled 'kilometre' in the United States). A kilometre is a thousand metres. In the old English system, a kilometre is equal to about five-eighths of a mile. It is often shortened to *km*.

Mass is usually measured in grams. A thousand grams is called a kilogram. The kilogram is often shortened to *kg*. In the old English system, a kilogram is equal to about 2.2 pounds.

Finally, the temperature of something is measured in degrees Celsius. A degree is sometimes written as a little circle to the right of a temperature value. So 25° means twenty five degrees. The Celsius scale is based upon the temperatures at which water freezes and boils. At 0° Celsius, water at the surface of the Earth will freeze. When the temperature reaches 100° Celsius, water will begin to boil. Celsius is often shortened to C.

Space exploration — A long dream

Going in to space was always one of the biggest dreams people had, even thousands of years ago. Many science fiction authors had written about travelling in space even before the first airplane flight (in 1903). One of the most famous science fiction books is "From the Earth to the Moon" by Jules Verne — it was written in 1865, more then one hundred years before the first person walked on the moon.

The first exploration of space

Space begins about 100 km or 62 miles above the earth. In 1942, the German rocket *A-4* became the first to reach that height, but it wasn't meant to do anything but fall straight down again and so wasn't terribly useful.

The Soviets were the first to put anything in space that would stay up: they launched the *Sputnik 1* satellite on October 4, 1957. This event started the Space Race, a competition between the United States and the Soviet Union. Within a month, the Soviets launched *Sputnik 2*, and in that spacecraft was the first space traveller: a dog called Laika.

The Americans were very surprised that the Soviets could have launched 'Sputnik', and began to design rockets and satellites of their own. The two countries would compete for the next few decades .This was called 'Space Race'.

A man in Space

On April 12, 1961, the first person was sent into space: Yuri Gagarin, a Soviet, riding in the spacecraft *Vostok 1*. The Soviets would send more people into space over the next few decades, and so would the Americans, but it wouldn't be until 2003 that another country would launch a spacecraft with a person in it: China, with the *Shenzhou 5*.

The race to the moon

At the beginning of the 1960s, American president John F. Kennedy made a famous speech in which he said that the U.S. was going to send people to the moon within the next 10 years. And that's what happened: in 1969, Neil Armstrong became the first person to walk on the moon.

The Space Shuttle

After the Apollo program that sent people to the Moon, the U.S. built the Space Shuttle, that is like a jet-plane that can go to space and return! (With the help of

rockets of course). The Space Shuttle helped construct the ISS (International Space Station) among another things.

The space shuttle will be retired in 2010, but it will be replaced with new vehicles that will take mankind to the Moon, Mars, and beyond!

Exploration beyond the Solar System

Many people dream of the day when humans can travel to another star and explore other worlds, some perhaps very similar to our own Earth. This, if it ever does happen probably won't happen for a very long time. The stars are so spread out that there are trillions of miles between stars that are "neighbours". Maybe one day, your great grandchildren will be standing atop an alien world wondering about their ancient ancestors?

Our Solar System

Do you ever wonder about the things in the sky—the Sun, the Moon, the stars? People have been watching the sky for a long time, trying to figure out what is out there. We keep coming up with new ways to learn more about outer space.

Planets are big balls of rock or gas that move around stars. We live on one we call the Earth, which moves around a star we call the Sun. There are at least seven other planets moving around the Sun and a lot of other smaller things as well. All these things together are called a *system*. The Latin word for the Sun is *Sol*, so we call this system the *Solar System*.

The planets, most of the satellites of the planets and the asteroids revolve around the Sun in the same direction, in nearly circular orbits. When looking down from above the Sun's North Pole, the planets orbit in a counter-clockwise direction. The planets orbit the Sun in or near the same plane, called the *ecliptic*. Pluto is a special case in that its orbit is the most highly inclined (18 degrees) and the most highly elliptical of all the planets. Because of this, for part of its orbit, Pluto is closer to the Sun than is Neptune. The axis of rotation for most of the planets is nearly perpendicular to the ecliptic. The exceptions are Uranus and Pluto, which are tipped on their sides.

Composition Of The Solar System

The Sun contains 99.85% of all the matter in the Solar System. The planets, which condensed out of the same disk of material that formed the Sun, contain only 0.135% of the mass of the solar system. Jupiter contains more than twice the matter of all the other planets combined.

The Hubble Space Telescope. This telescope is in space. It takes pictures of things that are too far away to be seen with a regular telescope.

A long time ago, people didn't realize that all these things in the Solar System move around the Sun. They thought everything moved around the Earth,

including the Sun. This seems sensible, because the Earth doesn't feel as if it's moving, does it?

About 500 years ago, however, a man named Copernicus suggested that all the planets moved around the Sun. Then, about 100 years later, a man called Galileo began looking at the sky with a new invention: the telescope. He showed that it was very likely that all the planets moved around the Sun. Soon, more and more people started using telescopes to study the sky. They began to learn how the planets and the other things in the Solar System moved.

Now, we send rockets into space to learn more. Astronauts travel around the Earth. Some of them have landed on the Moon. Robots can fly to other planets to take pictures. We can see things that people like Copernicus and Galileo could only dream about.

We can use very large telescopes to see what has happened to other stars. We compare pictures of distant stars with pictures of the Sun. We can use thousands of pictures of the planets to learn more about Earth. We use what we learn about all the things in the Solar System to figure out how it was formed. We can also guess what might happen to it in the future.

What is in the solar system?

At the centre of the Solar System is the Sun. It is a star, like the billions of other stars in the sky. The other stars are very, very far away, so they look tiny. The Sun is important to us because it gives us heat and energy that allows life. None of the life on Earth could exist without the Sun.

The rest of the things in the Solar System *orbit* (travel around) the Sun. The planets are the largest of these. Each planet is a little like the Earth. But the planets are also very different from each other.

Many of the planets have *moons*. A moon orbits a planet. Mercury has no moons. Earth has one. Jupiter has 63!

The planets closest to the Sun are called the *inner planets*. These are Mercury, Venus, Earth, and Mars. Then comes a big ring of *asteroids*, chunks of rock much smaller than planets. This ring is called the *asteroid belt*. Within the asteroid belt, there is a dwarf planet named Ceres. Then come the *outer planets*: Jupiter, Saturn, Uranus, and Neptune. Farther out there are two dwarf planets, Pluto and Eris.

Beyond the orbit of Neptune is another big ring of things like the asteroids, called the *Kuiper belt*. Kuiper (said "KYE-per") was the last name of the person who first wrote about it. Most of the things in the Kuiper belt are hard to see through telescopes.

After the Kuiper belt comes the *Oort cloud*. Scientists think this is where *comets* come from. It is very far away, many times farther away than Pluto is from the Sun (over a thousand times). It is near the edge of the Solar System. (Yes, "Oort" was the last name of the person who first wrote about it.)

In between all the other things is dust. The pieces of dust are very far apart, but they shine in the light of the Sun. Before dawn, in September or October, they glow in the East. We call this the *zodiacal glow*.

When pieces of space dust hit the Earth's atmosphere, they burn brightly. We call them shooting stars or meteors.

The Sun creates *solar wind*—a kind of gas that blows away from the Sun into space. This gas travels out past the planets into outer space. The edge, where the solar wind meets the wind from other stars, is called the *heliopause*. That is about 100 times as far from us as the Earth is from the Sun. Beyond that is a lot of empty space. The nearest star to our Sun is thousands of times farther away than the size of the entire solar system. The Universe is a really huge place!

What holds it together?

Why do all of the planets orbit the Sun? Why do moons orbit planets? Why doesn't the Sun move off and leave the planets behind? The answer to all of these questions has to do with *gravity*. Gravity is a force that is a property of *mass*. It pulls things together.

We don't notice the pull from the Sun because it also pulls on the Earth by the same amount. But the Sun's gravity is strong enough to keep the Earth from shooting away. Even though the Earth is going fast, it keeps turning to go around the Sun. It is like they were tied together with an invisible string. In the same way, moons orbit many of the planets. They are kept there by gravity. The Sun itself does not sit still in space. The entire Solar System is orbiting the centre of our galaxy. The whole thing stays together because of the force of gravity.

About mass

Everything is made out of matter. The amount of matter is called mass. Two bananas have twice the mass of one banana. The more mass a thing has, the more gravity pulls it and the more its gravity pulls other objects. We don't notice the pull from a banana because it is so much less than the pull from the Earth. If you stand on the ground and let go of a banana, gravity will pull it down towards the centre of the Earth. It will hit the ground. If you could throw the banana hard enough at the right angle, it would go into orbit around the Earth. That is how rockets put astronauts into orbit. If you threw the banana really, REALLY hard in the right direction, it would fly away from Earth and never come back; but our arms are not that strong.

The force of gravity from anything is strongest very close to that thing, and weaker further from it. Scientists use *weight* to mean how hard gravity pulls us. Astronauts weigh less on the moon because it has less mass. It does not pull as hard. We actually weigh a tiny bit less on top of a tall mountain than we do in a lower place. This is because we are farther from most of the Earth.

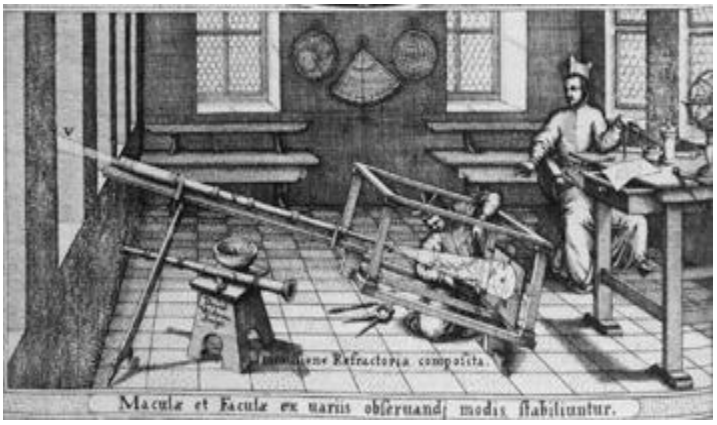
Who discovered the Solar System?

Anyone who looks up at the sky enough can see seven bright objects. These are the Sun, our Moon, Mercury, Venus, Mars, Jupiter, and Saturn. People have known about them for a very long time. Ancient people thought they were related to gods. In Babylon, they named the days of the week after them. Almost everyone was sure that all these things were orbiting the Earth. They did not know we lived in a **Solar** System.

In 1543, Nicholaus Copernicus figured out that the planets orbit the Sun. Only the Moon orbits the Earth. But he was afraid to say so for most of his life. Then Galileo Galilei pointed a telescope at the sky. He found moons orbiting Jupiter. He was certain Copernicus was right, and he got in trouble for saying so. It took seventy years to convince scientists that the planets orbit the Sun· Now, almost everyone on Earth understands that we live in a Solar System.

People made better telescopes and found more things in the sky – moons, new planets, and asteroids. More things, like the dwarf planet Eris, are being found today.

How have we explored the Solar System?



The Sun's image shines on a sheet of paper in 1625. Never let the Sun shine in your eyes

The Voyager 2 space craft.

Before the telescope, people explored the sky with their eyes. They saw how the planets seemed to "wander" through the sky. They learned to predict where the Sun, the moon, and planets would be in the sky. They built some *observatories* --

places for watching the sky. They watched the Sun and stars to tell the time of year. In China, they even knew when the moon would block the Sun. Most people thought that *celestial bodies* could cause war or peace on Earth.

After telescopes were first made, people kept making them better. Astronomers saw that planets are not like stars. They are worlds, like the Earth. They could see that some planets have moons. They began to think about what these worlds were like. At first, some thought that the other planets and moons had people or animals living on them. They thought about how it would be to live on these other worlds. Then they made telescopes better and saw that there are no plants or animals on the Moon or on Mars.

Buzz Aldrin on the Moon

Now, we can explore by going to some of the other worlds. Twelve Astronauts walked on the Moon about 35 years ago. They brought rocks and dirt back to Earth. Spacecraft flew by Venus, Mars, and the outer planets. The pictures they took showed us a lot of what we know about these worlds. Robots landed on Mars in 1971, 1976, and 1997. They took thousands of pictures of the planets. Two robots, "Spirit" and "Opportunity", are working on Mars right now. They send photos and movies back to Earth. They also check rocks to find out what the rocks are made of.

So far, we have not found any life except on Earth. Maybe tiny one-celled life once lived on Mars. Maybe there is life under the ice on Jupiter's moon Europa. New spacecraft are being planned to look for life on these worlds.

How was our Solar System formed?

Our Solar System is part of the Milky Way *galaxy*. Galaxies are big mixes of dust, gas, stars, and other things. Inside our Milky Way galaxy are clouds of dust and gas where stars are born. Our Solar System was created in this kind of cloud. A

part of the cloud began to get smaller and less spread out. It formed a big, spinning disk of gas and tiny pieces of dust. This disk was thickest at the middle. The middle slowly collapsed until it became the Sun. We are still trying to learn how the planets were formed. Most scientists think that they were formed from the left over gas and dust.

The Sun and planets start to form out of a disk of dust and gas.

This is how it could have happened. The rest of the disk continued to spin around the Sun. The tiny pieces of dust hit each other and some of them stuck together, next the bits of dust slowly collected to form grains, these in turn joined to form lumps the size of gravel, then pebbles, and then rocks. The rocks crashed together into mountains. The mountains crashed together to make bigger things. These big things swept up most of the rest of the disk to form the planets, moons, and asteroids.

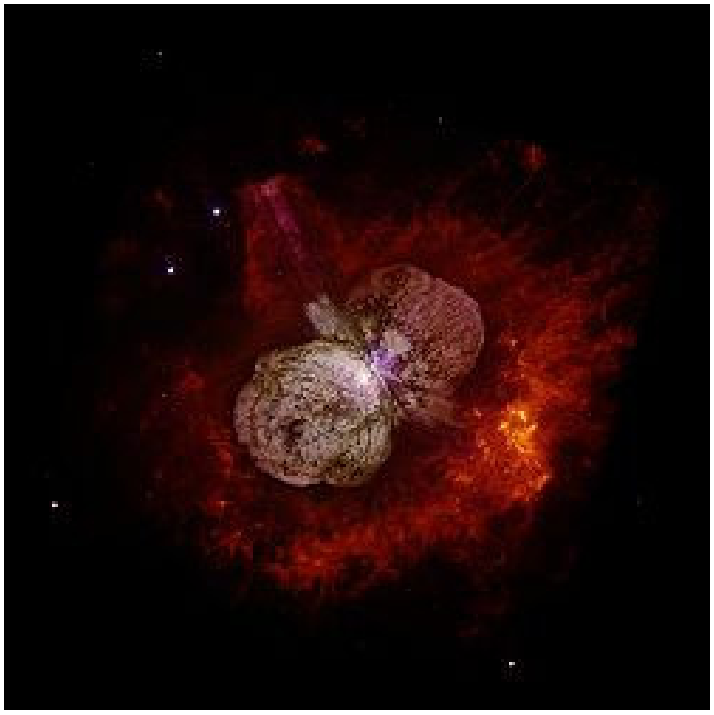
The Sun got hotter as it collapsed. It began to glow. The temperature at the centre reached a million degrees. The Sun started to make a lot of light and heat. This light and heat swept away most of the leftover dust and gas between the inner planets. This light and heat are the sunlight we see and feel every day on Earth.

What will happen to the Solar System?

In another five billion years, the Sun will use up most of its hydrogen fuel. It will enter the final stages of its life. The middle of the Sun will shrink down and become even hotter. The outer layer of the Sun will grow much bigger than it is now. It will form a *red giant*.

It will be so big that some of the nearest planets will be inside it. These planets will burn away. Which planets get destroyed will depend on how much mass the Sun has left. A strong solar wind will blow some of the outer layers of gas away from

the Sun. The Sun will have less mass. The Sun's gravity will be less. All of the planets will move further away from the Sun.



The massive, rapidly-aging star Eta Carinae throws off a giant cloud of gas, forming a planetary nebula.

After it has been a red giant for a while, the Sun will start to burn *helium*. It will shrink down and will not be a red giant any more. It will use the helium up in about a billion years. Then it will become a red giant once again. More gas will blow away for a few hundred thousand years.

A *planetary nebula* will form. The nebula could last for a few thousand to a few tens of thousands of years. It will glow in the light of the Sun.

At the centre, the Sun might shrink into a tiny star called a **white dwarf**. That kind of star is about the size of Earth. It would take about 100 of these white dwarfs, stacked end to end, to be as wide as the Sun is today. The Sun will not have any more fuel to burn. It will have lots of heat left over and will keep getting cooler and dimmer. Then its light will go out in a hundred billion years from now.