OUR SOLAR SYSTEM | LESSON 1

The Grand Tour

A tour of the Sun, all eight planets, the Moon and Pluto, drawn where they really are today.

Grades 4-8 | About 15 minutes of narrated flight, plus discussion stops | 11 stops | Start: learn.allseeing.space/grand-tour

What students will see and do

Students fly to each world in turn and hear what it is made of, how hot or cold it is, and what missions have found there. Four discussion stops ask them to compare worlds and explain why Earth is livable.

Learning objectives

- Name the planets in order from the Sun and sort them into rocky planets, gas giants and ice giants
- Explain why an atmosphere matters more than distance for a planet's temperature
- Describe evidence that Mars once had liquid water
- Explain why Pluto was reclassified as a dwarf planet

NGSS connections

MS-ESS1-3	Students compare sizes, distances, temperatures and orbits of solar system objects (scale properties).
MS-ESS1-2	The Sun's gravity holds every orbit together; the Moon's gravity raises Earth's tides.
MS-ESS1-1	Earth's tilt, not its distance from the Sun, causes the seasons.
DCI ESS1.B	Earth and the Solar System.

40-minute class plan

1. 5 min: pre-lesson prompt. Before we fly: list the planets you can name in order from the Sun. Which one do you think is the hottest, and why?
2. 18-20 min: run the lesson. Keep discussion stops short (1-2 minutes each) or turn them off in the Lessons menu.
3. 8 min: whole-class discussion using two of the questions below.
4. 5 min: Exit ticket: Name one way Venus and Earth are alike and one way they are very different. Which world would you send a robot to next, and why?

Full exploration (about 60 minutes)

1. 5 min: pre-lesson prompt, recorded so students can revisit it.
2. 25-30 min: run the lesson with every discussion stop at full length.
3. 15 min: follow-up activity. Make a toilet-paper-roll scale model of planet distances (1 sheet = 9.3 million miles).
4. 10 min: revisit the pre-lesson ideas, then the exit ticket.

Before the lesson

Before we fly: list the planets you can name in order from the Sun. Which one do you think is the hottest, and why?

Discussion stops: timing and key points

At Earth (3-5 min): Venus is closer to the Sun than Earth, and Mercury is closer still. Why is Venus hotter than Mercury? What does that tell you about how important an atmosphere is?

- Venus's thick carbon dioxide atmosphere traps heat (a runaway greenhouse effect).
- Mercury has almost no atmosphere, so its heat escapes at night.
- Distance from the Sun is not the only factor; Earth's moderate atmosphere keeps it livable.

At Mars (4-6 min): Mars once had rivers and lakes. What do you think happened to its water? What would astronauts need to bring to live on Mars?

- Mars lost much of its atmosphere over billions of years, likely stripped by the solar wind after its magnetic field faded.
- Some water froze into the polar caps and underground ice.
- Astronauts would need air, water, food, power, a pressurized home and shielding from radiation.

At Saturn (3-5 min): Saturn's rings are mostly ice. Where do you think all that ice came from? How could scientists test your idea?

- Ideas: a moon or icy comet torn apart by Saturn's gravity, or material left over from Saturn's formation.
- Tests: measure how clean or dusty the ice is (clues to age), compare the ice to Saturn's moons, study spacecraft data.

At Pluto (3-5 min): In two thousand six, Pluto was reclassified as a dwarf planet. Do you think scientists should change the names of things when they learn more? Why?

- Look for reasoning, not one right answer.
- Science updates names and categories when evidence changes. Ceres was once called a planet too.
- The 2006 definition requires a planet to clear its orbit; Pluto shares its zone with many Kuiper Belt objects.

More questions for after the lesson

1. On Mercury, one sunrise to the next takes longer than a whole year. What does that tell you about how slowly it spins?
2. Why does Earth have seasons? Use the word tilt in your answer.
3. Which moon would be the best place to search for life, and why?

Vocabulary

orbit, mass, atmosphere, greenhouse effect, gas giant, ice giant, dwarf planet, Kuiper Belt

Exit ticket

Exit ticket: Name one way Venus and Earth are alike and one way they are very different. Which world would you send a robot to next, and why?

Follow-up activities

- Make a toilet-paper-roll scale model of planet distances (1 sheet = 9.3 million miles).
- Planet trading cards: each student researches one world and adds three facts heard in the lesson.
- Compare two planets in a Venn diagram using the transcript.

Full transcript

Introduction

Welcome to the Grand Tour. I am Aetherion, and for the next fifteen minutes I will fly you across your whole solar system, from the Sun at its center to the frozen worlds at its edge. Every planet you see is drawn where it truly is today, calculated from its real orbit.

As we travel, listen for three things. How big is each world? What is it made of? And could anything live there? Hold on to those questions. At a few stops your teacher may pause me so you can talk about them.

1. The Sun

This is your star, the Sun. It is so large that about one hundred and nine Earths could line up across its face, and more than a million Earths could fit inside it. It holds about ninety nine point eight percent of all the mass in the solar system. Everything else, every planet, moon, and comet, is the leftover crumbs.

The Sun is a giant ball of hot gas, mostly hydrogen and helium. Deep in its core, where the temperature is about twenty seven million degrees Fahrenheit, hydrogen atoms are squeezed together so hard that they fuse into helium. That fusion releases the energy that becomes sunlight. Every second, the Sun turns about four point four million tons of its own mass into pure energy.

Sunlight is fast, but space is big. Light leaving the Sun right now will take about eight minutes and twenty seconds to reach Earth. So when you look at the Sun, and you should never look straight at it, you are always seeing it as it was eight minutes ago.

The Sun is about four and a half billion years old, which is roughly halfway through its life. Its gravity is what holds the whole system together. Without it, every planet would drift off in a straight line into the dark. Let us follow that gravity outward, to the closest planet.

2. Mercury

Mercury is the smallest planet and the closest to the Sun. It is only a little larger than Earth's Moon, and it looks a lot like the Moon too: gray, rocky, and covered in craters. One crater, called the Caloris Basin, is about nine hundred thirty miles across, big enough to hold most of Texas.

Mercury races around the Sun faster than any other planet. Its year, one trip around the Sun, takes only eighty eight Earth days. But it spins very slowly. From one sunrise to the next on Mercury takes about one hundred and seventy six Earth days. That means a single day on Mercury lasts two of its years.

Mercury has almost no air to hold heat. In daylight the ground reaches about eight hundred ten degrees Fahrenheit, hot enough to melt lead. At night it drops to about minus two hundred ninety degrees Fahrenheit. And yet, in deep craters near its poles where sunlight never reaches, NASA's MESSENGER spacecraft found ice.

3. Venus

Venus is almost the same size as Earth, and it is your closest planetary neighbor. For a long time people imagined it might be a warm, swampy twin of Earth. It is not. Venus is the hottest planet in the solar system, even though Mercury is closer to the Sun.

The reason is its air. Venus is wrapped in a thick blanket of carbon dioxide, with clouds of sulfuric acid on top. Sunlight gets in and warms the ground, but the heat cannot escape. This is called a runaway greenhouse effect. The surface stays around eight hundred sixty nine degrees Fahrenheit, day and night, at the poles and at the equator.

Standing on Venus would feel like being about three thousand feet deep in the ocean, because the air pressure is more than ninety times stronger than on Earth. The Soviet Union landed several Venera probes there. The longest-lasting one sent pictures for about two hours before the heat and pressure destroyed it.

Venus is strange in one more way. It spins backwards compared to most planets, and it spins so slowly that one rotation takes two hundred and forty three Earth days, longer than its year of two hundred and twenty five days. From Venus, the Sun would rise in the west.

4. Earth

And here is Earth, the third planet, and the only place in the universe where we know life exists. About seventy one percent of its surface is covered by liquid water. It sits at just the right distance from the Sun for water to stay liquid, not boiled away like on Venus and not frozen solid like on Mars.

Earth's air is about seventy eight percent nitrogen and twenty one percent oxygen. That oxygen was made by living things, tiny ocean microbes and plants, over billions of years. Earth also has a magnetic field, created by molten iron moving deep inside the planet, that shields the surface from harmful particles streaming out of the Sun.

Earth is tilted on its axis by about twenty three and a half degrees. That tilt, not your distance from the Sun, is what gives you seasons. When your half of the planet leans toward the Sun, you get summer. In fact, Earth is closest to the Sun in early January, during winter in the northern hemisphere.

Earth travels about ninety three million miles from the Sun, a distance astronomers call one astronomical unit. You are riding around the Sun at roughly sixty two thousand miles per hour right now, even though it feels like you are sitting still.

Discussion stop: Venus is closer to the Sun than Earth, and Mercury is closer still. Why is Venus hotter than Mercury? What does that tell you about how important an atmosphere is?

5. The Moon

This is the Moon, Earth's only natural satellite, about two hundred thirty nine thousand miles away. Most scientists think it formed when a body about the size of Mars crashed into the young Earth. Debris from that collision gathered in orbit and pulled itself together into the Moon.

The Moon always shows the same face to Earth. It spins exactly once for every trip around Earth, so the far side is always turned away from you. The dark patches you can see from home are ancient lava plains, and the bright areas are older, heavily cratered highlands.

Twelve astronauts walked on the Moon between nineteen sixty nine and nineteen seventy two, during NASA's Apollo missions. With no wind or rain to wear them away, their footprints are almost certainly still there. The Moon's gravity also pulls on Earth's oceans, creating the tides. And it is slowly drifting away from Earth, about one point five inches every year.

6. Mars

Mars, the red planet. Its color comes from iron oxide, which is rust, in its dusty soil. Mars is about half the width of Earth, and a day there is almost the same as yours, twenty four hours and thirty seven minutes. But its year lasts six hundred and eighty seven Earth days.

Mars has the tallest volcano known in the solar system, Olympus Mons, about fourteen miles high, roughly two and a half times the height of Mount Everest. It also has Valles Marineris, a canyon system about two thousand five hundred miles long. Stretched across the United States, it would reach from coast to coast.

Long ago, Mars had rivers, lakes, and maybe even a shallow sea. You can still see dried-up riverbeds and deltas. Today its air is very thin, less than one percent as thick as Earth's, and mostly carbon dioxide. Liquid water cannot last on the surface, but there is plenty of ice at the poles and underground.

Robots are exploring Mars right now. NASA's Curiosity rover has been driving across Gale Crater since twenty twelve. The Perseverance rover landed in Jezero Crater, an ancient lake bed, in twenty twenty one. It is collecting rock samples that scientists hope to bring back to Earth one day, to search for signs of ancient life.

Discussion stop: Mars once had rivers and lakes. What do you think happened to its water? What would astronauts need to bring to live on Mars?

7. Jupiter

We have crossed the asteroid belt, and here is Jupiter, the largest planet. More than thirteen hundred Earths could fit inside it, and it has about two and a half times the mass of all the other planets put together. Jupiter has no solid surface to stand on. It is a gas giant, made mostly of hydrogen and helium.

Jupiter spins faster than any other planet. A day there lasts less than ten hours. That fast spin stretches its clouds into the colorful bands you see. The Great Red Spot is a storm wider than Earth that has been raging for at least one hundred and fifty years, and probably much longer.

Jupiter has nearly a hundred known moons. The four largest were discovered by Galileo Galilei in sixteen ten. Io is the most volcanic place in the solar system. Ganymede is the largest moon of all, bigger than the planet Mercury. And Europa hides a salty ocean beneath its icy shell, one of the best places to search for life beyond Earth.

8. Saturn

Saturn, the ringed planet. It is the second largest planet, and another gas giant. Saturn is so light for its size that, if you could find a bathtub big enough, it would float in water.

Its rings stretch about one hundred seventy thousand miles across, but in most places they are only about thirty three feet thick. They are made of billions of chunks of water ice, from tiny grains to pieces as big as a house, all orbiting Saturn like countless tiny moons. Some scientists think the rings are fairly young, perhaps only a few hundred million years old.

Saturn has more known moons than any other planet. Titan, the largest, is bigger than Mercury and has a thick nitrogen atmosphere. It has rain, rivers, and lakes, but they are made of liquid methane and ethane, not water. In two thousand five, the Huygens probe parachuted down and landed on Titan's surface.

Another moon, Enceladus, sprays jets of water from cracks near its south pole. The Cassini spacecraft flew through those jets and found salt and organic molecules. Cassini studied Saturn for thirteen years. In twenty seventeen it ended its mission by diving into Saturn's atmosphere, so it could never crash into and contaminate those moons.

Discussion stop: Saturn's rings are mostly ice. Where do you think all that ice came from? How could scientists test your idea?

9. Uranus

Uranus is an ice giant. Beneath its clouds it is made largely of water, ammonia, and methane in hot, dense forms. Methane gas in its upper atmosphere absorbs red light, which is why Uranus looks pale blue-green.

Uranus is tipped over on its side, tilted about ninety eight degrees, probably knocked over by a giant collision long ago. It takes eighty four years to orbit the Sun, so each pole gets about forty two years of continuous sunlight, followed by forty two years of darkness.

Uranus was the first planet discovered with a telescope, by William Herschel in seventeen eighty one. Only one spacecraft has ever visited it: Voyager two, which flew past in nineteen eighty six. It also has thin, dark rings and more than two dozen moons.

10. Neptune

Neptune is the most distant planet, about thirty times farther from the Sun than Earth. Sunlight takes around four hours to get here. Neptune is deep blue and stormy, with the fastest winds measured anywhere in the solar system, more than one thousand two hundred miles per hour.

Neptune was the first planet found using mathematics. Astronomers noticed that Uranus was being tugged slightly off course. In eighteen forty six, Urbain Le Verrier calculated where an unseen planet should be, and Johann Galle found Neptune almost exactly there.

One year on Neptune lasts about one hundred and sixty five Earth years. It finished its first full orbit since its discovery in twenty eleven. Its largest moon, Triton, orbits backwards and has geysers of nitrogen. Triton was probably a small world from farther out that Neptune's gravity captured.

11. Pluto

And finally, Pluto. It was discovered in nineteen thirty by Clyde Tombaugh and called the ninth planet for seventy six years. In two thousand six, astronomers decided that a planet must clear its orbit of other large objects. Pluto shares its region with many other icy bodies, so it was reclassified as a dwarf planet.

In twenty fifteen, NASA's New Horizons spacecraft flew past Pluto and showed it to be surprisingly active. It has mountains of water ice as tall as the Rockies and a huge heart-shaped plain of frozen nitrogen. Its moon Charon is about half Pluto's size. One trip around the Sun takes Pluto two hundred and forty eight years.

Pluto lives in the Kuiper Belt, a vast ring of icy leftovers from the birth of the solar system. Beyond that, a giant shell of comets called the Oort Cloud may stretch more than a light-year from the Sun.

Discussion stop: In two thousand six, Pluto was reclassified as a dwarf planet. Do you think scientists should change the names of things when they learn more? Why?

Wrap-up

That is your solar system: one star, four rocky planets, two gas giants, two ice giants, and countless smaller worlds. Each one tells part of the story of how planets form and why Earth turned out the way it did.

Think back to the three questions. Which world surprised you the most? Which one would you most like to explore? Press L to choose another lesson, or ask me about any world we visited.

Positions are computed live from real orbits. Narration is checked against public scientific sources; full credits at learn.allseeing.space/credits.html. Standards are listed as connections to NGSS, not formal alignments. Report an issue: info@allseeing.space