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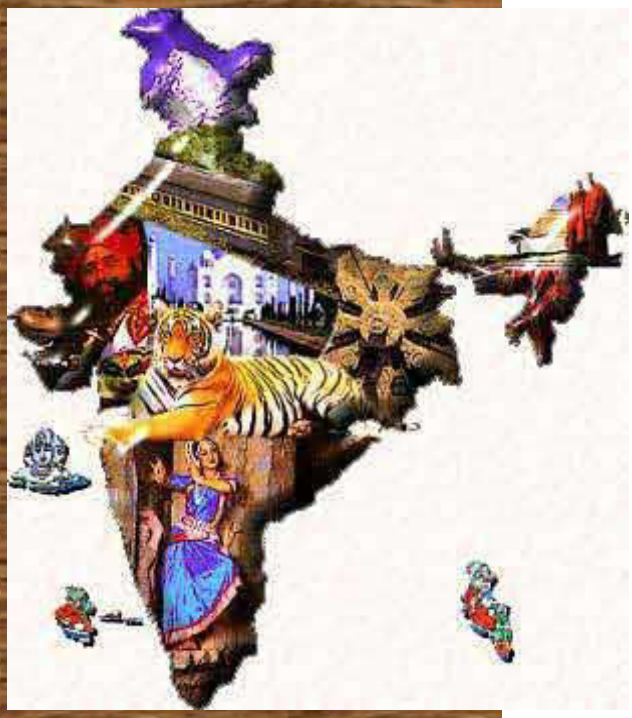

FREE

SOLAR SYSTEM

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Solar System

INTRODUCTION

The **SOLAR SYSTEM** comprises the Sun and its planetary system of eight planets, as well as a number of dwarf planets, satellites(moons), and other objects that orbit the Sun. It formed 4.6 billion years ago from the gravitational collapse of a giant molecular cloud. The vast majority of the system's mass is in the Sun, with most of the remaining mass contained in Jupiter. The four smaller inner planets, Mercury, Venus, Earth and Mars, also called the terrestrial planets, are primarily composed of rock and metal. The four outer planets, called the gas giants, are substantially more massive than the terrestrials. The two largest, Jupiter and Saturn, are composed mainly of hydrogen and helium; the two outermost planets, Uranus and Neptune, are composed largely of substances with relatively high melting points (compared with hydrogen and helium), called ices, such as water, ammonia and methane, and are often referred to separately as "ice giants". All planets have almost circular orbits that lie within a nearly flat disc called the ecliptic plane.

The Solar System also contains a number of regions populated by smaller objects. The asteroid belt, which lies between Mars and Jupiter, is similar to the terrestrial planets as it mostly contains objects composed of rock and metal. Beyond Neptune's orbit lie the Kuiper belt and scattered disc, linked populations of trans-Neptunian objects composed mostly of ices. Within these populations are several dozen to more than ten thousand objects that may be large enough to have been rounded by their own gravity. Such objects are referred to as dwarf planets. Identified dwarf planets include the asteroid Ceres and the trans-Neptunian objects Pluto, Eris, Haumea, and Makemake. In addition to these two regions, various other small-body populations including comets, centaurs and interplanetary dust freely travel between regions. Six of the planets, at least three of the dwarf planets, and many of the smaller bodies are orbited by natural satellites usually termed "moons" after Earth's Moon. Each of the outer planets is encircled by planetary rings of dust and other small objects.

The solar wind, a flow of plasma from the Sun, creates a bubble in the interstellar medium known as the heliosphere, which extends out to the edge of the scattered disc. The Oort cloud, which is believed to be the source for long-period comets, may also exist at a distance roughly a thousand times further than the heliosphere. The heliopause is the point at which pressure from the solar wind is equal to the opposing pressure of interstellar wind. The Solar System is located within one of the outer arms of the Milky Way galaxy, which contains about 200 billion stars.

OUR SUN

The **SUN** is the star at the center of the Solar System. It is almost perfectly spherical and consists of hot plasma interwoven with magnetic fields. It has a diameter of about 1,392,684 km (865,374 mi), around 109 times that of Earth, and its mass (1.989×10^{30} kilograms, approximately 330,000 times the mass of Earth) accounts for about 99.86% of the total mass of the Solar System. Chemically, about three quarters of the Sun's mass consists of hydrogen, while the rest is mostly helium. The remainder (1.69%, which nonetheless equals 5,600 times the mass of Earth) consists of heavier elements including oxygen, carbon, neon and iron, among others.

The Sun formed about 4.6 billion years ago from the gravitational collapse of a region within a large molecular cloud. Most of the matter gathered in the center, while the rest flattened into an orbiting disk that would become the Solar System. The central mass became increasingly hot and dense, eventually initiating thermonuclear fusion in its core. It is thought that almost all stars form by this process. The Sun is classified as a G-type main-sequence star (G2V) based on spectral class and it is informally designated as a *yellow dwarf* because its visible radiation is most intense in the yellow-green portion of the spectrum, and although it is actually white in color, from the surface of the Earth it may appear yellow because of atmospheric scattering of blue light. In the spectral class label, *G2* indicates its surface temperature, of approximately 5778 K (5505 °C), and *V* indicates that the Sun, like most stars, is a main-sequence star, and thus generates its energy by nuclear fusion of hydrogen nuclei into helium. In its core, the Sun fuses 620 million metric tons of hydrogen each second.

Once regarded by astronomers as a small and relatively insignificant star, the Sun is now thought to be brighter than about 85% of the stars in the Milky Way galaxy, most of which are red dwarfs. The absolute magnitude of the Sun is +4.83; however, as the star closest to Earth, the Sun is the brightest object in the sky with an apparent magnitude of −26.74. The Sun's hot corona continuously expands in space creating the solar wind, a stream of charged particles that extends to the heliopause at roughly 100 astronomical units. The

bubble in the interstellar medium formed by the solar wind, the heliosphere, is the largest continuous structure in the Solar System.

STRUCTURE OF THE SUN

THE CORE: The Sun's core has a tremendously high temperature and pressure. The temperature is roughly 15 million °C.

At this temperature, nuclear fusion occurs, turning four hydrogen nuclei into a single helium nucleus plus a LOT of energy. This "hydrogen burning" releases gamma rays (high-energy photons) and neutrinos (particles with no charge and almost no mass).

THE RADIATIVE ZONE (or radiation zone): The next layer out from the core is this zone which emits radiation. This radiation diffuses outwards. The temperature ranges from 15 million °C to one million °C. It may take photons of radiation millions of years to pass through the radiative zone, as they gradually make their way outwards.

THE CONVECTIVE ZONE: In this next layer, photons continue to make their way outwards via convection (towards lower temperature and pressure). The temperature ranges from one million °C to 6,000 °C.

THE PHOTOSPHERE: This is the lower atmosphere of Sun and the part that we see (since it emits light at visible wavelengths). This layer is about 300 miles (500km) thick. The temperature is about 5,500 °C.

THE CHROMOSPHERE: This reddish layer is an area of rising temperatures. The temperature ranges from 6,000 °C (at lower altitudes) to 50,000 °C (at higher altitudes). This layer is a few thousand miles (or kilometers) thick. It appears red because hydrogen atoms are in an excite state and emit radiation near the red part of the visible spectrum. The Chromosphere is visible during solar eclipses (when the moon blocks the Photosphere).

THE CORONA: This is the outer layer of the Sun's atmosphere. The corona extends for millions of miles and the temperatures are tremendous, reaching one million °C.

OVERVIEW OF SUN

- The sun is a star. A star does not have a solid surface, but is a ball of gas (92.1 percent hydrogen (H_2) and 7.8 percent helium (He)) held together by its own gravity.
- Layers of sun are Photosphere, Chromospheres, corona

- The sun is the centre of our solar system and makes up 99.8% of the mass of the entire solar system.
- If the sun were as tall as a typical front door, Earth would be about the size of a nickel.
- Since the sun is not a solid body, different parts of the sun rotate at different rates. At the equator, the sun spins once about every 25 days, but at its poles the sun rotates once on its axis every 36 Earth days.
- The solar atmosphere (a thin layer of gases) is where we see features such as sunspots and solar flares on the sun.
- The sun is orbited by eight planets, at least five dwarf planets, tens of thousands of asteroids, and hundreds of thousands to three trillion comets and icy bodies.
- The sun does not have any rings.
- Spacecraft are constantly increasing our understanding of the sun -- from Genesis (which collected samples of the solar wind and returned the particles to Earth) to SOHO, STEREO, THEMIS, and many more, which are examining the sun's features, its interior and how it interacts with our planet. .
- Without the sun's intense energy there would be no life on Earth.
- The temperature at the sun's core is about 15 million degrees Celsius (27 million degrees Fahrenheit).

FACTS AND FIGURES ABOUT SUN

Discovered By	Known by the Ancients
Date of Discovery	Unknown
Equatorial Inclination to Orbit	7.25 with respect to the ecliptic
Mean Radius	**Metric:** 695,508 km **English:** 432,168.6 miles **Scientific Notation:** 6.9551 x 10^5 km ***By Comparison:*** *109.2 x that of Earth*
Equatorial Circumference	**Metric:** 4,370,005.6 km **English:** 2,715,395.6 miles

	Scientific Notation: 4.37001 x 10^6 km ***By Comparison:*** *109.2 x that of Earth*
Volume	**Metric:** 1,409,272,569,059,860,000 km^3 **English:** 338,102,469,632,763,000 mi^3 **Scientific Notation:** 1.40927 x 10^{18} km^3 ***By Comparison:*** *1,301,018.805 Earths*
Mass	**Metric:** 1,989,100,000,000,000,000,000,000,000,000 kg **English:** 4,385,214,857,119,400,000,000,000,000,000 lbs **Scientific Notation:** 1.989 x 10^{30} kg ***By Comparison:*** *333,060.402 x Earth's*
Density	**Metric:** 1.409 g/cm^3 ***By Comparison:*** *0.256 that of Earth*
Surface Area	**Metric:** 6,078,747,774,547 km^2 **English:** 2,347,017,636,988 square miles **Scientific Notation:** 6.07877 x 10^{12} km^2 ***By Comparison:*** *11,917.607 Earths*
Surface Gravity	**Metric:** 274.0 m/s^2 **English:** 899.0 ft/s^2 **Scientific Notation:** 2.740 x 10^2 m/s^2 ***By Comparison:*** *27.96 x Earth's surface gravity*
Escape Velocity	**Metric:** 2,223,720 km/h **English:** 1,381,756 mph **Scientific Notation:** 6.177 x 10^5 m/s ***By Comparison:*** *55.20 x Earth*

PLANETS OF SOLAR SYSTEM

We have nine planets in our Solar System. These planets circle around the sun, this is called orbits. A lot of astronomy people like to think of the Solar System been made up in two parts We have the Inner Solar System which has Mercury, Venus, Earth and not forgetting Mars. These are closest to the sun and are called the terrestrial planets simply because they have very solid rocky surfaces. The Outer Solar System has Jupiter ,Saturn, Uranus, Neptune these are sometimes called the gas giants Out past Neptune you'll find the small planet of Pluto which has a solid but icier surface.

MERCURY

PLANET PROFILE

Mass: 330,104,000,000,000 billion kg (0.055 x Earth)
Equatorial Diameter: 4,879
Polar Diameter: 4,879
Equatorial Circumference: 15,329 km
Known Satellites: none
Notable Satellites: none
Orbit Distance: 57,909,227 km (0.39 AU)
Orbit Period: 87.97 Earth days
Surface Temperature: -173 to 427°C
First Record: 14th century BC
Recorded By: Assyrian astronomers

MERCURY is the smallest and closest to the Sun of the eight planets in the Solar System, with an orbital period of about 88 Earth days. Seen from the Earth, it appears to move around its orbit in about 116 days, which is much faster than any other planet. This rapid motion may have led to it being named after the Roman deity Mercury, the fast-flying messenger to the gods. Because it has almost no atmosphere to retain heat, Mercury's surface experiences the greatest temperature variation of all the planets, ranging from 100 K (−173 °C; −280 °F) at night to700 K (427 °C; 800 °F) during the day at some equatorial regions. The poles are constantly below 180 K (−93 °C; −136 °F). Mercury's axis has the smallest tilt of any of the Solar System's planets (about $\frac{1}{30}$ of a degree), but it has the largest orbital eccentricity. At aphelion, Mercury is about 1.5 times as far from the Sun as it is

at perihelion. Mercury's surface is heavily cratered and similar in appearance to the Moon, indicating that it has been geologically inactive for billions of years.

Mercury does not experience seasons in the same way as most other planets, such as the Earth. It is locked so it rotates in a way that is unique in the Solar System. As seen relative to the fixed stars, it rotates exactly three times for every two revolutions it makes around its orbit. As seen from the Sun, in a frame of reference that rotates with the orbital motion, it appears to rotate only once every two Mercurian years. An observer on Mercury would therefore see only one day every two years.

OVERVIEW

- Mercury is the smallest planet in our solar system – only slightly larger than the Earth's moon.
- It is the closest planet to the sun at a distance of about 58 million km (36 million miles) or 0.39 AU.
- One day on Mercury (the time it takes for Mercury to rotate or spin once) takes 59 Earth days. Mercury makes a complete orbit around the sun (a year in Mercury time) in just 88 Earth days.
- Mercury is a rocky planet, also known as a terrestrial planet. Mercury has a solid, cratered surface, much like Earth's moon.
- Mercury's thin atmosphere, or *exosphere,* is composed mostly of oxygen (O_2), sodium (Na), hydrogen (H_2), helium (He), and potassium (K). Atoms that are blasted off the surface by the solar wind and micrometeoroid impacts create Mercury's exosphere.
- Mercury has no moons.
- There are no rings around Mercury.
- Only two spacecraft have visited this rocky planet: Mariner 10 in 1974–5 and MESSENGER, which flew past Mercury three times before going into orbit around Mercury in 2011.
- No evidence for life has been found on Mercury. Daytime Temperatures can reach 430 degrees Celsius (800 degrees Fahrenheit) and drop to -180 degrees Celsius (-290 degrees Fahrenheit) at night. It is unlikely life (as we know it) could survive on this planet.
- Standing on on Mercury's surface at its closest point to the sun, the sun would appear more than three times larger than it does on Earth.

FACTS AND FIGURES ABOUT MERCURY

Discovered By	Known by the Ancients
Date of Discovery	Unknown
Orbit Size Around Sun (semi-major axis)	**Metric:** 57,909,227 km **English:** 35,983,125 miles **Scientific Notation:** 5.7909227 x 10^7 km (0.38709927 A.U.) ***By Comparison:*** *Earth is 1 A.U. (Astronomical Unit) from the sun.*
Perihelion (closest)	**Metric:** 46,001,009 km **English:** 28,583,702 miles **Scientific Notation:** 4.600 x 10^7 km (3.075 x 10^{-1} A.U.) ***By Comparison:*** *0.313 x Earth*
Aphelion (farthest)	**Metric:** 69,817,445 km **English:** 43,382,549 miles **Scientific Notation:** 6.982 x 10^7 km (0.4667 A.U.) ***By Comparison:*** *0.459 x Earth*
Orbit Circumference	**Metric:** 359,976,856 km **English:** 223,679,248 miles **Scientific Notation:** 3.600 x 10^8 km ***By Comparison:*** *0.383 x Earth*
Average Orbit Velocity	**Metric:** 170,503 km/h **English:** 105,946 mph **Scientific Notation:** 4.7362 x 10^4 m/s ***By Comparison:*** *1.590 x Earth*
Orbit Eccentricity	0.20563593 ***By Comparison:*** *12.305 x Earth*
Orbit Inclination	7.0 degrees

Equatorial Inclination to Orbit	0 degrees ***By Comparison:*** *Earth's equatorial inclination to orbit is 23.45 degrees.*
Mean Radius	**Metric:** 2,439.7 km **English:** 1,516.0 miles **Scientific Notation:** 2.4397 x 10^3 km ***By Comparison:*** *0.3829 x Earth*
Equatorial Circumference	**Metric:** 15,329.1 km **English:** 9,525.1 miles **Scientific Notation:** 1.53291 x 10^4 km
Volume	**Metric:** 60,827,208,742 km^3 **English:** 14,593,223,446 mi^3 **Scientific Notation:** 6.08272 x 10^{10} km^3 ***By Comparison:*** *0.056 x Earth's*
Mass	**Metric:** 330,104,000,000,000,000,000,000 kg **Scientific Notation:** 3.3010 x 10^{23} kg ***By Comparison:*** *0.055 x Earth's*
Density	**Metric:** 5.427 g/cm^3 ***By Comparison:*** *0.984 x Earth*
Surface Area	**Metric:** 74,797,000 km^2 **English:** 28,879,000 square miles **Scientific Notation:** 7.4797 x 10^7 km^2 ***By Comparison:*** *0.147 x Earth*
Surface Gravity	**Metric:** 3.7 m/s^2 **English:** 12.1 ft/s^2 ***By Comparison:*** *If you weigh 100 pounds on Earth, you would weigh 38 pounds on Mercury.*
Escape Velocity	**Metric:** 15,300 km/h **English:** 9,507 mph

	Scientific Notation: 4.25 x 10^3 m/s ***By Comparison:*** *Escape Velocity of Earth is 25,030 mph*
Sidereal Rotation Period (Length of Day)	58.646 Earth days 1407.5 hours ***By Comparison:*** *58.81 x Earth*
Minimum/Maximum Surface Temperature	**Metric:** -173/427 °C **English:** -279/801 °F **Scientific Notation:** 100/700 K

VENUS

PLANET PROFILE

Mass: 4,867,320,000,000,000 billion kg (0.815 x Earth)
Equatorial Diameter: 12,104 km
Polar Diameter: 12,104 km
Equatorial Circumference: 38,025 km
Known Satellites: none
Notable Satellites: none
Orbit Distance: 108,209,475 km (0.73 AU)
Orbit Period: 224.70 Earth days
Surface Temperature: 462 °C
First Record: 17th century BC
Recorded By: Babylonian astronomers

VENUS is the second planet from the Sun, orbiting it every 224.7 Earth days. The planet is named after the Roman goddess of love and beauty. After the Moon, it is the brightest natural object in the night sky, reaching an apparent magnitude of −4.6, bright enough to cast shadows. Because Venus is an inferior planet from Earth, it never appears to venture far from the Sun: its elongation reaches a maximum of 47.8°. Venus reaches its maximum brightness shortly before sunrise or shortly after sunset, for which reason it has been referred to by ancient cultures as the Morning Star or Evening Star.

Venus is a terrestrial planet and is sometimes called Earth's "sister planet" because of their similar size, gravity, and bulk composition (Venus is both the closest planet to Earth and the

planet closest in size to Earth). However, it has also been shown to be very different from Earth in other respects. It has the densest atmosphere of the four terrestrial planets, consisting of more than 96% carbon dioxide. The atmospheric pressure at the planet's surface is 92 times that of Earth's. With a mean surface temperature of 735 K (462 °C; 863 °F), Venus is by far the hottest planet in the Solar System.

OVERVIEW

- Venus is only a little smaller than Earth.
- Venus is the second closest planet to the sun at a distance of about 108 million km (67 million miles) or 0.72 AU.
- One day on Venus lasts as long as 243 Earth days (the time it takes for Venus to rotate or spin once). Venus makes a complete orbit around the sun (a year in Venusian time) in 225 Earth days.
- Venus is a rocky planet, also known as a terrestrial planet. Venus' solid surface is a cratered and volcanic landscape.
- Venus' thick and toxic atmosphere is made up mostly of carbon dioxide (CO_2) and nitrogen (N_2), with clouds of sulphuric acid (H_2SO_4) droplets.
- Venus has no moons.
- There are no rings around Venus.
- More than 40 spacecraft have explored Venus. The Magellan mission in the early 1990s mapped 98 percent of the planet's surface.
- No evidence for life has been found on Venus. The planet's extreme high temperatures of almost 480 degrees Celsius (900 degrees Fahrenheit) make it seem an unlikely place for life as we know it.
- Venus spins backwards (retrograde rotation) when compared to the other planets. This means that the sun rises in the west and sets in the east on Venus.

FACTS AND FIGURES ABOUT VENUS

Discovered By	Known by the Ancients
Date of Discovery	Unknown
Orbit Size Around Sun (semi-major axis)	**Metric:** 108,209,475 km **English:** 67,238,251 miles **Scientific Notation:** 1.0820948 x 10^8 km (7.2333566 x 10^{-1} A.U.) ***By Comparison:*** *0.723 x Earth*

Perihelion (closest)	**Metric:** 107,476,170 km **English:** 66,782,596 miles **Scientific Notation:** 1.07476 x 10^8 km (7.184 x 10^{-1} A.U.) ***By Comparison:*** *0.731 x Earth*
Aphelion (farthest)	**Metric:** 108,942,780 km **English:** 67,693,905 miles **Scientific Notation:** 1.08943 x 10^8 km (0.7282 A.U.) ***By Comparison:*** *0.716 x Earth*
Orbit Circumference	**Metric:** 679,892,378 km **English:** 422,465,538 miles **Scientific Notation:** 6.799 x 10^8 km ***By Comparison:*** *0.723 x Earth*
Average Orbit Velocity	**Metric:** 126,074 km/h **English:** 78,339 mph **Scientific Notation:** 3.5020 x 10^4 m/s ***By Comparison:*** *1.176 x Earth*
Orbit Eccentricity	0.00677672 ***By Comparison:*** *0.406 x Earth*
Orbit Inclination	3.39 degrees
Equatorial Inclination to Orbit	177.3 degrees (retrograde rotation) ***By Comparison:*** *7.56 x Earth*
Mean Radius	**Metric:** 6,051.8 km **English:** 3,760.4 miles **Scientific Notation:** 6.0518 x 10^3 km ***By Comparison:*** *0.9499 x Earth*
Equatorial Circumference	**Metric:** 38,024.6 km **English:** 23,627.4 miles **Scientific Notation:** 3.80246 x 10^4 km

	By Comparison: *0.9499 x Earth's*
Volume	**Metric:** 928,415,345,893 km^3 **English:** 222,738,686,740 mi^3 **Scientific Notation:** 9.28415 x 10^{11} km^3 ***By Comparison:*** *0.857 x Earth's*
Mass	**Metric:** 4,867,320,000,000,000,000,000,000 kg **Scientific Notation:** 4.8673 x 10^{24} kg ***By Comparison:*** *0.815 x Earth*
Density	**Metric:** 5.243 g/cm^3 ***By Comparison:*** *Comparable to the average density of the Earth.*
Surface Area	**Metric:** 460,234,317 km^2 **English:** 177,697,463 square miles **Scientific Notation:** 4.6023 x 10^8 km^2 ***By Comparison:*** *0.902 x Earth*
Surface Gravity	**Metric:** 8.87 m/s^2 **English:** 29.1 ft/s^2 ***By Comparison:*** *If you weigh 100 pounds on Earth, you would weigh 91 pounds on Venus.*
Escape Velocity	**Metric:** 37,296 km/h **English:** 23,175 mph **Scientific Notation:** 1.036 x 10^4 m/s ***By Comparison:*** *0.926 x Earth*
Sidereal Rotation Period (Length of Day)	-243.018 Earth days (retrograde) -5832.4 hours (retrograde) ***By Comparison:*** *243.68 x Earth*
Minimum/Maximum Surface Temperature	**Metric:** 462 °C **English:** 864 °F **Scientific Notation:** 735 K

Atmospheric Constituents	Carbon Dioxide, Nitrogen **Scientific Notation:** CO_2, N_2 ***By Comparison:*** *Earth's atmosphere consists mostly of N_2 and O_2. CO_2 is largely responsible for the Greenhouse Effect and is used for carbonation in beverages. N_2 is 80% of Earth's air and is a crucial element in DNA.*

EARTH

Planet Profile

Mass: 5,972,190,000,000,000 billion kg

Equatorial Diameter: 12,756 km

Polar Diameter: 12,714 km

Equatorial Circumference: 40,030 km

Known Satellites: 1

Notable Satellites: The Moon

Orbit Distance: 149,598,262 km (1 AU)

Orbit Period: 365.26 Earth days

Surface Temperature: -88 to 58°C

EARTH is the third planet from the Sun, and the densest and fifth-largest of the eight planets in the Solar System. It is also the largest of the Solar System's four terrestrial planets. It is sometimes referred to as the world or *the Blue Planet*.

Earth formed approximately 4.54 billion years ago, and life appeared on its surface within its first billion years. Earth's biosphere then significantly altered the atmospheric and other basic physical conditions, which enabled the proliferation of organisms as well as the formation of the ozone layer, which together with Earth's magnetic field blocked harmful solar radiation, and permitted formerly ocean-confined life to move safely to land. The physical properties of the Earth, as well as its geological history and orbit, have allowed life to persist. Estimates on how much longer the planet will be able to continue to support life range from 500 million years (myr), to as long as 2.3 billion years (byr).

Earth's lithosphere is divided into several rigid segments, or tectonic plates, that migrate across the surface over periods of many millions of years. About 71% of the surface is

covered by salt water oceans, with the remainder consisting of continents and islands which together have many lakes and other sources of water that contribute to the hydrosphere. Earth's poles are mostly covered with ice that is the solid ice of the Antarctic ice sheet and the sea ice that is the polar ice packs. The planet's interior remains active, with a solid iron inner core, a liquid outer core that generates the magnetic field, and a thick layer of relatively solid mantle.

Earth gravitationally interacts with other objects in space, especially the Sun and the Moon. During one orbit around the Sun, the Earth rotates about its own axis 366.26 times, creating 365.26 solar days, or one sidereal year. The Earth's axis of rotation is tilted 23.4° away from the perpendicular of its orbital plane, producing seasonal variations on the planet's surface with a period of one tropical year (365.24 solar days). The Moon is Earth's only natural satellite. It began orbiting the Earth about 4.53 billion years ago (bya). The Moon's gravitational interaction with Earth stimulates ocean tides, stabilizes the axial tilt, and gradually slows the planet's rotation.

The planet is home to millions of species of life, including humans. Both the mineral resources of the planet and the products of the biosphere contribute resources that are used to support a global human population. These inhabitants are grouped into about 200 independent sovereign states, which interact through diplomacy, travel, trade, and military action. Human cultures have developed many views of the planet, including its personification as a planetary deity, its shape as flat, its position as the center of the universe, and in the modern Gaia Principle, as a single, self-regulating organism in its own right.

OVERVIEW

- If the sun were as tall as a typical front door, Earth would be the size of a nickel.
- Earth is the third planet from the sun at a distance of about 150 million km (93 million miles) or one AU.
- One day on Earth takes 24 hours (this is the time it takes the Earth to rotate or spin once). Earth makes a complete orbit around the sun (a year in Earth time) in about 365 days.
- Earth is a rocky planet, also known as a terrestrial planet, with a solid and dynamic surface of mountains, valleys, canyons, plains and so much more. What makes Earth different from the other terrestrial planets is that it is also an ocean planet: 70 percent of the Earth's surface is covered in oceans.

- The Earth's atmosphere is made up of 78 percent nitrogen (N_2), 21 percent oxygen (O_2) and 1 percent other ingredients -- the perfect balance for us to breathe and live. Many planets have atmospheres, but only Earth's is breathable.
- Earth has one moon. Another name for a moon is *satellite.*
- Earth has no rings.
- Many orbiting spacecraft study the Earth from above as a whole system and together aid in understanding our home planet.
- Earth is the perfect place for life.
- Earth's atmosphere protects us from incoming meteoroids, most of which break up in our atmosphere before they can strike the surface as meteorites

FACTS AND FIGURES ABOUT EARTH

Discovered By	Known by the Ancients
Date of Discovery	Unknown
Orbit Size Around Sun (semi-major axis)	**Metric:** 149,598,262 km **English:** 92,956,050 miles **Scientific Notation:** 1.4959826 x 10^8 km (1.000 A.U.)
Perihelion (closest)	**Metric:** 147,098,291 km **English:** 91,402,640 miles **Scientific Notation:** 1.47098 x 10^8 km (9.833 x 10^{-1} A.U.)
Aphelion (farthest)	**Metric:** 152,098,233 km **English:** 94,509,460 miles **Scientific Notation:** 1.52098 x 10^8 km (1.017 A.U.)
Orbit Circumference	**Metric:** 939,887,974 km **English:** 584,019,311 miles **Scientific Notation:** 9.399 x 10^8 km
Average Orbit Velocity	**Metric:** 107,218 km/h **English:** 66,622 mph **Scientific Notation:** 2.9783 x 10^4 m/s
Orbit Eccentricity	0.01671123

Orbit Inclination	0.00005 degrees
Equatorial Inclination to Orbit	23.4393 degrees
Mean Radius	**Metric:** 6,371.00 km **English:** 3,958.8 miles **Scientific Notation:** 6.3710 x 10^3 km
Equatorial Circumference	**Metric:** 40,030.2 km **English:** 24,873.6 miles **Scientific Notation:** 4.00302 x 10^4 km
Volume	**Metric:** 1,083,206,916,846 km^3 **English:** 259,875,159,532 mi^3 **Scientific Notation:** 1.08321 x 10^{12} km^3
Mass	**Metric:** 5,972,190,000,000,000,000,000,000 kg **Scientific Notation:** 5.9722 x 10^{24} kg
Density	**Metric:** 5.513 g/cm^3
Surface Area	**Metric:** 510,064,472 km^2 **English:** 196,936,994 square miles **Scientific Notation:** 5.1006 x 10^8 km^2
Surface Gravity	**Metric:** 9.80665 m/s^2 **English:** 32.041 ft/s^2
Escape Velocity	**Metric:** 40,284 km/h **English:** 25,031 mph **Scientific Notation:** 1.119 x 10^4 m/s
Sidereal Rotation Period (Length of Day)	0.99726968 Earth days 23.934 hours
Minimum/Maximum Surface Temperature	**Metric:** -88/58 (min/max) °C **English:** -126/136 (min/max) °F **Scientific Notation:** 185/331 (min/max) K
Atmospheric Constituents	Nitrogen, Oxygen

Scientific Notation: N_2, O_2

By Comparison: *N_2 is 80% of Earth's air and is a crucial element in DNA.*

MOON

Moon Profile

Circumference at Equator: 10,917.0 km

Diameter: 3,475 km

Mass: 73,476,730,924,573,500 million kg (0.0123 x Earth)

Average Distance from Earth: 384,400 km

Length of Orbit: 27.3 Earth days

Surface Temperature: -233 to 123 °C

THE **MOON** is the only natural satellite of the Earth and the fifth largest moon in the Solar System. It is the largest natural satellite of a planet in the Solar System relative to the size of its primary, having 27% the diameter and 60% the density of Earth, resulting in $^{1}/_{81}$ itsmass. Among satellites with known densities, the Moon is the second densest, after Io, a satellite of Jupiter.

The Moon is in synchronous rotation with Earth, always showing the same face with its near side marked by dark volcanic maria that fill between the bright ancient crustal highlands and the prominent impact craters. It is the brightest object in the sky after the Sun, although its surface is actually dark, with a reflectance just slightly higher than that of worn asphalt. Its prominence in the sky and its regular cycle of phases have, since ancient times, made the Moon an important cultural influence on language, calendars, art and mythology. The Moon's gravitational influence produces the ocean tides and the minute lengthening of the day. The Moon's current orbital distance, about thirty times the diameter of the Earth, causes it to appear almost the same size in the sky as the Sun, allowing it to cover the Sun nearly precisely in total solar eclipses. This matching of apparent visual size is a coincidence. The Moon's linear distance from the Earth is currently increasing at a rate of 3.82 ± 0.07 cm per year, but this rate is not constant.

The Moon is thought to have formed nearly 4.5 billion years ago, not long after the Earth. Although there have been several hypotheses for its origin in the past, the current most widely accepted explanation is that the Moon formed from the debris left over after a giant impact between Earth and a Mars-sized body.

The Moon is the only celestial body other than Earth on which humans have set foot. The Soviet Union's Luna programme was the first to reach the Moon with unmanned spacecraft in 1959; the United States' NASA Apollo program achieved the only manned missions to date, beginning with the first manned lunar orbiting mission by Apollo 8 in 1968, and six manned lunar landings between 1969 and 1972, with the first being Apollo 11. These missions returned over 380 kg of lunar rocks, which have been used to develop a geological understanding of the Moon's origins, the formation of its internal structure, and its subsequent history.

OVERVIEW OF MOON

- If the sun were as tall as a typical front door, Earth would be the size of a nickel and the moon would the size of a green pea.
- The moon is Earth's satellite and orbits the Earth at a distance of about 384 thousand km (239 thousand miles) or 0.00257 AU.
- The moon makes a complete orbit around Earth in 27 Earth days and rotates or spins at that same rate, or in that same amount of time. This causes the moon to keep the same side or *face* towards Earth during the course of its orbit.
- The moon is a rocky, solid-surface body, with much of its surface cratered and pitted from impacts.
- The moon has a very thin and tenuous (weak) atmosphere, called an exosphere.
- The moon has no moons.
- The moon has no rings.

- More than 100 spacecraft been launched to explore the moon. It is the only celestial a body beyond Earth that has been visited by human beings (The Apollo Program).
- The moon's weak atmosphere and its lack of liquid water cannot support life as we know it.
- Surface features that create the face known as the "Man in the moon" are impact basins on the moon that are filled with dark basalt rocks.

MARS

Planet Profile

Mass: 641,693,000,000,000 billion kg (0.107 x Earth)
Equatorial Diameter: 6,805
Polar Diameter: 6,755
Equatorial Circumference: 21,297 km
Known Satellites: 2
Notable Satellites: Phobos & Deimos
Orbit Distance: 227,943,824 km (1.38 AU)
Orbit Period: 686.98 Earth days (1.88 Earth years)
Surface Temperature: -87 to -5 °C
First Record: 2nd millenium BC
Recorded By: Egyptian astronomers

MARS is the fourth planet from the Sun and the second smallest planet in the Solar System. Named after the Roman god of war, it is often described as the "Red Planet" because the iron oxide prevalent on its surface gives it a reddish appearance. Mars is a terrestrial planet with a thin atmosphere, having surface features reminiscent both of the impact craters of the Moon and the volcanoes, valleys, deserts, and polar ice caps of Earth. The rotational period and seasonal cycles of Mars are likewise similar to those of Earth, as is the tilt that produces the seasons. Mars is the site of Olympus Mons, the second highest known mountain within the Solar System (the tallest on a planet), and of Valles Marineris, one of the largest canyons. The smooth Borealis basin in the northern hemisphere covers 40% of

the planet and may be a giant impact feature. Mars has two known moons, Phobos and Deimos, which are small and irregularly shaped.

OVERVIEW

- If the sun were as tall as a typical front door, Earth would be the size of a nickel, and Mars would be about as big as an aspirin tablet.
- Mars orbits our sun, a star. Mars is the fourth planet from the sun at a distance of about 228 million km (142 million miles) or 1.52 AU.
- One day on Mars takes just a little over 24 hours (the time it takes for Mars to rotate or spin once). Mars makes a complete orbit around the sun (a year in Martian time) in 687 Earth days.
- Mars is a rocky planet, also known as a terrestrial planet. Mars' solid surface has been altered by volcanoes, impacts, crustal movement, and atmospheric effects such as dust storms.
- Mars has a thin atmosphere made up mostly of carbon dioxide (CO_2), nitrogen (N_2) and argon (Ar).
- Mars has two moons named Phobos and Deimos.
- There are no rings around Mars.
- More than 40 spacecraft have been launched for Mars, from flybys and orbiters to rovers and landers that touched surface of the Red Planet. The first true Mars mission success was Mariner 4 in 1965.
- At this time in the planet's history, Mars' surface cannot support life as we know it. A key science goal is determining Mars' past and future potential for life.
- Mars is known as the Red Planet because iron minerals in the Martian soil oxidize, or rust, causing the soil -- and the dusty atmosphere -- to look red.

FACTS AND FIGURES ABOUT MARS

Discovered By	Known by the Ancients
Date of Discovery	Unknown
Orbit Size Around Sun (semi-major axis)	**Metric:** 227,943,824 km **English:** 141,637,725 miles **Scientific Notation:** 2.2794382 x 10^8 km (1.523662 A.U.) ***By Comparison:*** *1.524 x Earth*

Perihelion (closest)	**Metric:** 206,655,215 km **English:** 128,409,598 miles **Scientific Notation:** 2.06655 x 10^8 km (1.381 A.U.) ***By Comparison:*** *1.405 x Earth*
Aphelion (farthest)	**Metric:** 249,232,432 km **English:** 154,865,853 miles **Scientific Notation:** 2.49232 x 10^8 km (1.666 A.U.) ***By Comparison:*** *1.639 x Earth*
Orbit Circumference	**Metric:** 1,429,085,052 km **English:** 887,992,283 miles **Scientific Notation:** 1.429 x 10^9 km ***By Comparison:*** *1.520 x Earth*
Average Orbit Velocity	**Metric:** 86,677 km/h **English:** 53,858 mph **Scientific Notation:** 2.4077 x 10^4 m/s ***By Comparison:*** *0.808 x Earth*
Orbit Eccentricity	0.0933941 ***By Comparison:*** *5.589 x Earth*
Orbit Inclination	1.85 degrees
Equatorial Inclination to Orbit	25.2
Mean Radius	**Metric:** 3,389.5 km **English:** 2,106.1 miles **Scientific Notation:** 3.3895 x 10^3 km ***By Comparison:*** *0.5320 x Earth*
Equatorial Circumference	**Metric:** 21,296.9 km **English:** 13,233.3 miles **Scientific Notation:** 2.12969 x 10^4 km
Volume	**Metric:** 163,115,609,799 km^3

	English: 39,133,515,914 mi^3
Mass	**Metric:** 641,693,000,000,000,000,000,000 kg **Scientific Notation:** 6.4169 x 10^{23} kg ***By Comparison:*** *0.107 x Earth*
Density	**Metric:** 3.934 g/cm^3 ***By Comparison:*** *0.714 x Earth*
Surface Area	**Metric:** 144,371,391 km^2 **English:** 55,742,106 square miles **Scientific Notation:** 1.4437 x 10^8 km^2 ***By Comparison:*** *0.283 x Earth*
Surface Gravity	**Metric:** 3.71 m/s^2 **English:** 12.2 ft/s^2 ***By Comparison:*** *If you weigh 100 pounds on Earth, you would weigh 38 pounds on Mars.*
Escape Velocity	**Metric:** 18,108 km/h **English:** 11,252 mph **Scientific Notation:** 5.030 x 10^3 m/s ***By Comparison:*** *Escape velocity of Earth is 25,030 mph.*
Sidereal Rotation Period (Length of Day)	1.026 Earth days 24.623 hours ***By Comparison:*** *Earth's rotation period is 23.934 hours.*
Minimum/Maximum Surface Temperature	**Metric:** -87 to -5 °C **English:** -125 to 23 °F **Scientific Notation:** 186 to 268 K
Atmospheric Constituents	Carbon Dioxide, Nitrogen, Argon **Scientific Notation:** CO_2, N_2, Ar ***By Comparison:*** *CO_2 is responsible for the Greenhouse Effect and is used for carbonation in beverages. N_2 is 80% of Earth's air and is a crucial element in DNA.*

		Ar is used to make blue neon light bulbs.

ASTEROIDS

ASTEROIDS are minor planets, especially those of the inner Solar System. The larger ones have also been called **planetoids**. These terms have historically been applied to any astronomical object orbiting the Sun that did not show the disk of a planet and was not observed to have the characteristics of an active comet, but as small objects in the outer Solar System were discovered, their volatile-based surfaces were found to more closely resemble comets and so were often distinguished from traditional asteroids. Thus the term *asteroid* has come increasingly to refer specifically to the small bodies of the inner Solar System out to the orbit of Jupiter. They are grouped with the outer bodies—centaurs, Neptune trojans, and trans-Neptunian objects—as minor planets, which is the term preferred in astronomical circles. In this article the term "asteroid" refers to the minor planets of the inner Solar System.

There are millions of asteroids, many thought to be the shattered remnants of planetesimals, bodies within the young Sun's solar nebula that never grew large enough to become planets. The large majority of known asteroids orbit in the asteroid belt between the orbits of Mars and Jupiter or co-orbital with Jupiter (the Jupiter Trojans). However, other orbital families exist with significant populations, including the near-Earth asteroids. Individual asteroids are classified by their characteristic spectra, with the majority falling into three main groups: C-type, S-type, and M-type. These were named after and are generally identified with carbon-rich, stony, and metallic compositions, respectively.

OVERVIEW

- If all of the asteroids were combined into a ball, they would still be much smaller than Earth's moon. If the sun was as tall as a typical front door, Earth would be the size of a nickel, the moon would be about as big as a green pea and Ceres (the largest object in the main asteroid belt)
  would be as small as a sesame seed.
- Most Asteroids orbit our sun, a star, in a region of space between the orbits of Mars and Jupiter known as the Asteroid Belt.
- Days and years vary by asteroid. A day on asteroid Ida, for example, takes only 4.6 hours (the time it takes to rotate or spin once). Ida makes a complete orbit around the sun (a year in this asteroid's time) in 4.8 Earth years.
- Asteroids are solid, rocky and irregular bodies.

- Asteroids do not have atmospheres.
- More than 150 asteroids are known to have a small companion moon (some have two moons). The first discovery of an asteroid-moon system was of asteroid Ida and its moon Dactyl in 1993.
- Asteroids do not have rings.
- More than 10 spacecraft have explored asteroids. NEAR Shoemaker even landed on an asteroid (Eros). The Dawn mission is the first mission to orbit (2011) a main belt asteroid (Vesta).
- Asteroids cannot support life as we know it.
- Ceres, the first and largest asteroid to be discovered (1801 by Giuseppe Piazzi) and the closest dwarf planet to the sun, encompasses over one-third of the estimated total mass of all the asteroids in the asteroid belt.

FACTS

- The word asteroid, which means star-like, was coined by the astronomer William Herschel.
- Ceres is the largest known asteroid at 933 kilometers (580 miles) across, while the smallest known asteroid, 1991 BA, is only 6 meters (20 feet) across.
- Current theories suggest that asteroids are planetisimals (the building blocks of planets) that were never incorporated into one of the planets in our solar system.
- Apollo objects are asteroids whose orbit crosses the orbit of Earth.
- Scientists believe the extinction of the dinosaurs was due to a chain reaction following a large asteroid colliding with Earth 65 million years ago.
- An asteroid about .15 kilometers (.1 miles) in width is believed to have exploded over Siberia, causing damage within a radius of hundreds of kilometers (miles).
- The vast majority of asteroids are irregular in shape due to their small size being insufficient to exert enough gravity to pull them into a spherical shape.
- Asteroids are small, rocky objects that orbit the Sun.
- The first asteroid discovered was Ceres. Giuseppe Piazzi discovered it in 1801.
- There are almost 600,000 known asteroids in the Solar System.

- Most asteroids are found in the Asteroid Belt, a series of rings located between the orbits of Mars and Jupiter.

METEOROIDS

A **METEOROID** is a small rocky or metallic body travelling through space. Meteoroids are significantly smaller than asteroids, and range in size from small grains to 1 meter-wide objects. Most are fragments from comets or asteroids, while others are collision impact debris ejected from bodies such as the Moon or Mars.

The visible streak of light from space debris is the result of heat as it enters a planet's atmosphere, and the trail of glowing particles that it sheds in its wake is called a **meteor**, or colloquially a "shooting star" or "falling star". A series of many meteors appearing seconds or minutes apart, and appearing to originate from the same fixed point in the sky, is called a meteor shower. Incoming objects larger than several meters (asteroids or comets) canexplode in the air. If a meteoroid, comet or asteroid or a piece thereof withstands ablation from its atmospheric entry and impacts with the ground, then it is called a meteorite.

Around 15,000 tonnes of meteoroids, micrometeoroids and different forms of space dust enter Earth's atmosphere each year. A meteoroid is a chunk of space rock. If it burns up in the Earth's atmosphere, it is a called a meteor; if a piece lands, it is a meteorite.

OVERVIEW

- Meteoroids become meteors -- or shooting stars -- when they interact with a planet's atmosphere and cause a streak of light in the sky. Debris that makes it to the surface of a planet from meteoroids are called meteorites.
- Meteorites may vary in size from tiny grains to large boulders. One of the largest meteorite found on Earth is the Hoba meteorite from southwest Africa, which weighs roughly 54,000 kg (119,000 pounds).
- Meteor showers are usually named after a star or constellation which is close to the radiant (the position from which the meteor appears to come).
- Meteors and meteorites begin as meteoroids, which are little chunks of rock and debris in space.
- Most meteorites are either iron, stony or stony-iron.

- Meteorites may look very much like Earth rocks, or they may have a burned appearance. Some may have depressioned (thumbprint-like), roughened or smooth exteriors.
- Many of the meteor showers are associated with comets. The Leonids are associated with comet Tempel-Tuttle; Aquarids and Orionids with comet Halley, and the Taurids with comet Encke.
- When comets come around the sun, they leave a dusty trail. Every year the Earth passes through the comet trails, which allows the debris to enter our atmosphere where it burns up and creates fiery and colorful streaks (meteors) in the sky.
- Leonid MAC (an airborne mission that took flight during the years 1998 - 2002) studied the interaction of meteoroids with the Earth's atmosphere.
- Meteoroids, meteors and meteorites cannot support life. However, they may have provided the Earth with a source of amino acids: the building blocks of life.
- Meteoroids become meteors -- or shooting stars -- when they interact with a planet's atmosphere and cause a streak of light in the sky. Debris that makes it to the surface of a planet from meteoroids are called meteorites.

FACTS

- The blast caused by the shock waves of the Russian meteorite was picked up by infrasound sensors on the other side of the world.
- When a meteoroid hits the Earth's atmosphere, it may be travelling at 130,000mph
- It is illegal to buy or sell meteorites in South Africa.
- A foot-thick coating of Kevlar protects the International Space Station from meteoroids.
- A meteorite smaller than 2mm in diameter is called a micrometeorite
- Meteorites that are seen or otherwise detected as they land are called 'falls'; those discovered later are called 'finds'
- A meteorite smaller than 2mm in diameter is called a micrometeorite.
- If a meteoroid is more than 10 metres in diameter, it is classified as an asteroid.
- Around 500 meteorites are thought to reach the Earth's surface every year but only five or six of those are recovered for scientists to study.
- According to a study in 1985, a meteorite will hit a human being about once every 180 years.

JUPITER

PLANET PROFILE

Mass: 1,898,130,000,000,000,000 billion kg (317.83 x Earth)

Equatorial Diameter: 142,984 km

Polar Diameter: 133,709 km

Equatorial Circumference: 439,264 km

Known Satellites: 67

Notable Satellites: Io, Europa, Ganymede, & Callisto

Orbit Distance: 778,340,821 km (5.20 AU)

Orbit Period: 4,332.82 Earth days (11.86 Earth years)

Surface Temperature: -108°C

First Record: 7th or 8th century BC

Recorded By: Babylonian astronomers

JUPITER is the fifth planet from the Sun and the largest planet in the Solar System. It is a gas giant with mass one-thousandth of that of the Sun but is two and a half times the mass of all the other planets in the Solar System combined. Jupiter is classified as a gas giant along with Saturn, Uranus and Neptune. Together, these four planets are sometimes referred to as the Jovian or outer planets. The planet was known by astronomers of ancient times and was associated with the mythology and religious beliefs of many cultures. The Romans named the planet after the Roman god Jupiter. When viewed from Earth, Jupiter can reach an apparent magnitude of −2.94, bright enough to cast shadows, and making it on average the third-brightest object in the night sky after the Moon and Venus. (Mars can briefly match Jupiter's brightness at certain points in its orbit.)

Jupiter is primarily composed of hydrogen with a quarter of its mass being helium, although helium only comprises about a tenth of the number of molecules. It may also have a rocky core of heavier elements, but like the other gas giants, Jupiter lacks a well-defined solid surface. Because of its rapid rotation, the planet's shape is that of an oblate spheroid (it

possesses a slight but noticeable bulge around the equator). The outer atmosphere is visibly segregated into several bands at different latitudes, resulting in turbulence and storms along their interacting boundaries. A prominent result is the Great Red Spot, a giant storm that is known to have existed since at least the 17th century when it was first seen by telescope. Surrounding Jupiter is a faint planetary ring system and a powerful magnetosphere. There are also at least 67 moons, including the four large moons called the Galilean moons that were first discovered by Galileo Galilei in 1610. Ganymede, the largest of these moons, has a diameter greater than that of the planet Mercury.

Jupiter has been explored on several occasions by robotic spacecraft, most notably during the early Pioneer and Voyager flyby missions and later by the Galileo orbiter. The most recent probe to visit Jupiter was the Pluto-bound New Horizons spacecraft in late February 2007. The probe used the gravity from Jupiter to increase its speed. Future targets for exploration in the Jovian system include the possible ice-covered liquid ocean on the moon Europa.

OVERVIEW

- If the sun were as tall as a typical front door, the Earth would be the size of a nickel and Jupiter would be about as big as a basketball.
- Jupiter orbits our sun, a star. Jupiter is the fifth planet from the sun at a distance of about 778 million km (484 million miles) or 5.2 AU.
- One day on Jupiter takes about 10 hours (the time it takes for Jupiter to rotate or spin once). Jupiter makes a complete orbit around the sun (a year in Jovian time) in about 12 Earth years (4,333 Earth days).
- Jupiter is a gas-giant planet and therefore does not have a solid surface. However, it is predicted that Jupiter has an inner, solid core about the size of the Earth.
- Jupiter's atmosphere is made up mostly of hydrogen (H_2) and helium (He).
- Jupiter has 50 known moons, with an additional 17 moons awaiting confirmation of their discovery -- that is a total of 67 moons.
- Jupiter has a faint ring system that was discovered in 1979 by the Voyager 2 mission.
- Many missions have visited Jupiter and its system of moons. The Juno mission will arrive at Jupiter in 2016.
- Jupiter cannot support life as we know it. However, some of Jupiter's moons have oceans underneath their crusts that might support life.

- Jupiter's Great Red Spot is a gigantic storm (about the size of two to three Earths) that has been raging for hundreds of years

FACTS AND FIGURES ABOUT JUPITER

Discovered By	Known by the Ancients
Date of Discovery	Unknown
Orbit Size Around Sun (semi-major axis)	**Metric:** 778,340,821 km **English:** 483,638,564 miles **Scientific Notation:** 7.7834082 x 10^8 km (5.2028870 A.U.) ***By Comparison:*** *5.203 x Earth*
Perihelion (closest)	**Metric:** 740,679,835 km **English:** 460,237,112 miles **Scientific Notation:** 7.40680 x 10^8 km (4.951 A.U.) ***By Comparison:*** *5.035 x Earth*
Aphelion (farthest)	**Metric:** 816,001,807 km **English:** 507,040,015 miles **Scientific Notation:** 8.16002 x 10^8 km (5.455 A.U.) ***By Comparison:*** *5.365 x Earth*
Orbit Circumference	**Metric:** 4,887,595,931 km **English:** 3,037,011,311 miles **Scientific Notation:** 4.888 x 10^9 km ***By Comparison:*** *5.200 x Earth*
Average Orbit Velocity	**Metric:** 47,002 km/h **English:** 29,205 mph **Scientific Notation:** 1.3056 x 10^4 m/s ***By Comparison:*** *0.438 x Earth*
Orbit Eccentricity	0.04838624 ***By Comparison:*** *2.895 x Earth*

Orbit Inclination	1.304 degrees
Equatorial Inclination to Orbit	3.1 degrees
Mean Radius	**Metric:** 69,911 km **English:** 43,440.7 miles **Scientific Notation:** 6.9911 x 10^4 km ***By Comparison:*** *10.9733 x Earth*
Equatorial Circumference	**Metric:** 439,263.8 km **English:** 272,945.9 miles **Scientific Notation:** 4.39264 x 10^5 km ***By Comparison:*** *10.9733 x Earth*
Volume	**Metric:** 1,431,281,810,739,360 km^3 **English:** 343,382,767,518,322 mi^3 **Scientific Notation:** 1.43128 x 10^{15} km^3 ***By Comparison:*** *1321.337 x Earth*
Mass	**Metric:** 1,898,130,000,000,000,000,000,000,000 kg **Scientific Notation:** 1.8981 x 10^{27} kg ***By Comparison:*** *317.828 x Earth*
Density	**Metric:** 1.326 g/cm^3 ***By Comparison:*** *0.241 x Earth*
Surface Area	**Metric:** 61,418,738,571 km^2 **English:** 23,713,907,537 square miles **Scientific Notation:** 6.1419 x 10^{10} km^2 ***By Comparison:*** *120.414 x Earth*
Surface Gravity	**Metric:** 24.79 m/s^2 **English:** 81.3 ft/s^2 ***By Comparison:*** *If you weigh 100 pounds on Earth, you would weigh 253 pounds on Jupiter.*
Escape Velocity	**Metric:** 216,720 km/h

	English: 134,664 mph **Scientific Notation:** 6.020 x 10^4 m/s ***By Comparison:*** *5.380 x Earth*

SATURN

Planet Profile

Mass: 568,319,000,000,000,000 billion kg (95.16 x Earth)
Equatorial Diameter: 120,536 km
Polar Diameter: 108,728 km
Equatorial Circumference: 365,882 km
Known Satellites: 62
Notable Satellites: Titan, Rhea & Enceladus
Orbit Distance: 1,426,666,422 km (9.58 AU)
Orbit Period: 10,755.70 Earth days (29.45 Earth years)
Surface Temperature: -139 °C
First Record: 8th century BC
Recorded By: Assyrians

SATURN is the sixth planet from the Sun and the second largest planet in the Solar System, after Jupiter. Named after the Roman god of agriculture, Saturn, its astronomical symbol (♄) represents the god's sickle. Saturn is a gas giant with an average radius about nine times that of Earth. While only one-eighth the average density of Earth, with its larger volume Saturn is just over 95 times more massive.

Saturn's interior is probably composed of a core of iron, nickel and rock (silicon and oxygen compounds), surrounded by a deep layer of metallic hydrogen, an intermediate layer of liquid hydrogen and liquid helium and an outer gaseous layer. The planet exhibits a pale yellow hue due to ammonia crystals in its upper atmosphere. Electrical current within the metallic hydrogen layer is thought to give rise to Saturn's planetary magnetic field, which is slightly weaker than Earth's and around one-twentieth the strength of Jupiter's. The outer atmosphere is generally bland and lacking in contrast, although long-lived features can appear. Wind speeds on Saturn can reach 1,800 km/h (1,100 mph), faster than on Jupiter, but not as fast as those on Neptune.

Saturn has a prominent ring system that consists of nine continuous main rings and three discontinuous arcs, composed mostly of ice particles with a smaller amount of rocky debris and dust. Sixty-two known moons orbit the planet; fifty-three are officially named. This does not include the hundreds of "moonlets" comprising the rings. Titan, Saturn's largest and the Solar System's second largest moon, is larger than the planet Mercury and is the only moon in the Solar System to retain a substantial atmosphere

OVERVIEW

- If the sun were as tall as a typical front door, the Earth would be the size of a nickel and Saturn would be about as big as a basketball.
- Saturn orbits our sun, a star. Saturn is the sixth planet from the sun at a distance of about 1.4 billion km (886 million miles) or 9.5 AU.
- One day on Saturn takes 10.7 hours (the time it takes for Saturn to rotate or spin once). Saturn makes a complete orbit around the sun (a year in Saturnian time) in 29 Earth years (10,756 Earth days).
- Saturn is a gas-giant planet and does not have a solid surface.
- Saturn's atmosphere is made up mostly of hydrogen (H_2) and helium (He).
- Saturn has 53 known moons with an additional 9 moons awaiting confirmation of their discovery.
- Saturn has the most spectacular ring system, which is made up of seven rings with several gaps and divisions between them.
- Five missions have been sent to Saturn. Since 2004, Cassini has been exploring Saturn, its moons and rings.
- Saturn cannot support life as we know it. However, some of Saturn's moons have conditions that might support life.
- When Galileo Galilei was observing the planet Saturn in the 1600s, he noticed strange objects on each side of the planet and drew in his notes a triple-bodied planet system and then later a planet with arms or handles. The *handles* turned out to be the rings of Saturn.

FACTS AND FIGURES ABOUT SATURN

Discovered By	Known by the Ancients
Date of Discovery	Unknown
Orbit Size Around Sun (semi-major axis)	**Metric:** 1,426,666,422 km **English:** 886,489,415 miles **Scientific Notation:** 1.4266664 x 10^9 km (9.53667594 A.U.) ***By Comparison:*** *9.537 x Earth*
Perihelion (closest)	**Metric:** 1,349,823,615 km **English:** 838,741,509 miles **Scientific Notation:** 1.34982 x 10^9 km (9.023 A.U.) ***By Comparison:*** *9.176 x Earth*
Aphelion (farthest)	**Metric:** 1,503,509,229 km **English:** 934,237,322 miles **Scientific Notation:** 1.50351 x 10^9 km (1.005 x 10^1 A.U.) ***By Comparison:*** *9.885 x Earth*
Orbit Circumference	**Metric:** 8,957,504,604 km **English:** 5,565,935,315 miles **Scientific Notation:** 8.958 x 10^9 km ***By Comparison:*** *9.530 x Earth*
Average Orbit Velocity	**Metric:** 34,701 km/h **English:** 21,562 mph **Scientific Notation:** 9.6391 x 10^4 m/s ***By Comparison:*** *0.324 x Earth*
Orbit Eccentricity	0.05386179 ***By Comparison:*** *3.223 x Earth*
Orbit Inclination	2.49 degrees
Equatorial Inclination to	26.7 degrees

Orbit	
Mean Radius	**Metric:** 58,232 km **English:** 36,183.7 miles **Scientific Notation:** 5.8232 x 10^4 km ***By Comparison:*** *9.1402 x Earth*
Equatorial Circumference	**Metric:** 365,882.4 km **English:** 227,348.8 miles **Scientific Notation:** 3.65882 x 10^5 km ***By Comparison:*** *9.1402 x Earth*
Volume	**Metric:** 827,129,915,150,897 km^3 **English:** 198,439,019,647,006 mi^3 **Scientific Notation:** 8.2713 x 10^{14} km^3 ***By Comparison:*** *763.594 x Earth*
Mass	**Metric:** 568,319,000,000,000,000,000,000,000 kg **Scientific Notation:** 5.6832 x 10^{26} kg ***By Comparison:*** *95.161 x Earth*
Density	**Metric:** 0.687 g/cm^3 ***By Comparison:*** *0.125 x Earth*
Surface Area	**Metric:** 42,612,133,285 km^2 **English:** 16,452,636,641 square miles **Scientific Notation:** 4.2612 x 10^{10} km^2 ***By Comparison:*** *83.543 x Earth*
Surface Gravity	**Metric:** 10.4* m/s^2 **English:** 34.3 ft/s^2 ***By Comparison:*** *If you weigh 100 pounds on Earth, you would weigh about 107 pounds on Saturn (at the equator). *Derived from a 1 bar radius of 60,268 km.*
Escape Velocity	**Metric:** 129,924 km/h **English:** 80,731 mph

	Scientific Notation: 3.609 x 10^4 m/s ***By Comparison:*** *Escape velocity of Earth is 25,030 mph.*
Sidereal Rotation Period (Length of Day)	0.444 Earth days 10.656 hours ***By Comparison:*** *0.445 x Earth*
Effective Temperature	**Metric:** -178 °C **English:** -288 °F **Scientific Notation:** 95 K

URANUS

Planet Profile

Mass: 86,810,300,000,000,000 billion kg (14.536 x Earth)
Equatorial Diameter: 51,118 km
Polar Diameter: 49,946 km
Equatorial Circumference: 159,354 km
Known Satellites: 27
Notable Satellites: Oberon, Titania, Miranda, Ariel & Umbriel
Orbit Distance: 2,870,658,186 km (19.22 AU)
Orbit Period: 30,687.15 Earth days (84.02 Earth years)
Surface Temperature: -197 °C
Discover Date: March 13th 1781
Discovered By: William Herschel

URANUS is the seventh planet from the Sun. It has the third-largest planetary radius and fourth-largest planetary mass in the Solar System. Uranus is similar in composition to Neptune, and both are of different chemical composition than the larger gas giants Jupiter and Saturn. For this reason, astronomers sometimes place them in a separate category called "ice giants". Uranus's atmosphere, although similar to Jupiter's and Saturn's in its primary composition of hydrogen and helium, contains more "ices" such as water, ammonia, and methane, along with traces of hydrocarbons. It is the coldest planetary atmosphere in the Solar System, with a minimum temperature of 49 K (−224.2 °C), and has a complex, layered cloud structure, with water thought to make up

the lowest clouds, and methane the uppermost layer of clouds. In contrast, the interior of Uranus is mainly composed of ices and rock.

It is the only planet whose name is derived from a figure from Greek mythology rather than Roman mythology like the other planets, from the Latinized version of the Greek god of the sky, Ouranos. Like the other giant planets, Uranus has a ring system, a magnetosphere, and numerous moons. The Uranian system has a unique configuration among those of the planets because its axis of rotation is tilted sideways, nearly into the plane of its revolution about the Sun. Its north and south poles therefore lie where most other planets have their equators. In 1986, images from *Voyager 2* showed Uranus as a virtually featureless planet in visible light without the cloud bands or storms associated with the other giants.[16] Terrestrial observers have seen signs of seasonal change and increased weather activity in recent years as Uranus approached its equinox. The wind speeds on Uranus can reach 250 meters per second (900 km/h, 560 mph).

OVERVIEW

- If the sun were as tall as a typical front door, Earth would be the size of a nickel and Uranus would be about as big as a baseball.
- Uranus orbits our sun, a star. Uranus is the seventh planet from the sun at a distance of about 2.9 billion km (1.8 billion miles) or 19.19 AU.
- One day on Uranus takes about 17 hours (the time it takes for Uranus to rotate or spin once). Uranus makes a complete orbit around the sun (a year in Uranian time) in about 84 Earth years.
- Uranus is a gas giant and therefore does not have a solid surface. The bulk (80 percent or more) of the mass of Uranus is made up of a hot dense fluid of "icy" materials (water (H_2O), methane (CH_4). and ammonia (NH_3)), above a small rocky core.
- Uranus has an atmosphere which is mostly made up of hydrogen (H_2) and helium (He), with a small amount of methane (CH_4).
- Uranus has 27 moons. Uranus' moons are named after characters from the works of William Shakespeare and Alexander Pope.
- Uranus has faint rings. The inner rings are narrow and dark and the outer rings are brightly colored.
- Voyager 2 is the only spacecraft to have visited Uranus.
- Uranus cannot support life as we know it.

- Like Venus, Uranus has a retrograde rotation (east to west). Unlike any of the other planets, Uranus rotates on its side, which means it spins horizontally.

FACTS AND FIGURES ABOUT URANUS

Discovered By	William Herschel
Date of Discovery	13 March 1781
Orbit Size Around Sun (semi-major axis)	**Metric:** 2,870,658,186 km **English:** 1,783,744,300 miles **Scientific Notation:** 2.8706582 x 10^9 km (1.9189165 x 10^1 A.U.) ***By Comparison:*** *19.189 x Earth*
Perihelion (closest)	**Metric:** 2,734,998,229 km **English:** 1,699,449,110 miles **Scientific Notation:** 2.73500 x 10^9 km (1.828 x 10^1 A.U.) ***By Comparison:*** *18.593 x Earth*
Aphelion (farthest)	**Metric:** 3,006,318,143 km **English:** 1,868,039,489 miles **Scientific Notation:** 3.00632 x 10^9 km (2.010 x 10^1 A.U.) ***By Comparison:*** *19.766 x Earth*
Orbit Circumference	**Metric:** 18,026,802,831 km **English:** 11,201,335,967 miles **Scientific Notation:** 1.803 x 10^{10} km ***By Comparison:*** *19.180 x Earth*
Average Orbit Velocity	**Metric:** 24,477 km/h **English:** 15,209 mph **Scientific Notation:** 6.7991 x 10^3 m/s ***By Comparison:*** *0.228 x Earth*
Orbit Eccentricity	0.04725744 ***By Comparison:*** *2.828 x Earth*

Orbit Inclination	0.77 degrees
Equatorial Inclination to Orbit	97.8 degrees (retrograde rotation) (retrograde rotation) *By Comparison: 4.173 x Earth*
Mean Radius	**Metric:** 25,362 km **English:** 15,759.2 miles **Scientific Notation:** 2.5362 x 10^4 km *By Comparison: 3.9809 x Earth*
Equatorial Circumference	**Metric:** 159,354.1 km **English:** 99,018.1 miles **Scientific Notation:** 1.59354 x 10^5 km *By Comparison: 3.9809 x Earth*
Volume	**Metric:** 68,334,355,695,584 km^3 **Scientific Notation:** 6.83344 x 10^{13} km^3 *By Comparison: 63.085 x Earth*
Mass	**Metric:** 86,810,300,000,000,000,000,000,000 kg **Scientific Notation:** 8.6810 x 10^{25} kg *By Comparison: 14.536 x Earth's*
Density	**Metric:** 1.270 g/cm^3 *By Comparison: 0.230 x Earth*
Surface Area	**Metric:** 8,083,079,690 km^2 **English:** 3,120,894,516 square miles **Scientific Notation:** 8.0831 x 10^9 km^2 *By Comparison: 15.847 x Earth*
Surface Gravity	**Metric:** 8.87 m/s^2 **English:** 29.1 ft/s^2 *By Comparison: If you weigh 100 pounds on Earth, you would weigh 91 pounds on Uranus.*
Escape Velocity	**Metric:** 76,968 km/h

	English: 47,826 mph **Scientific Notation:** 2.138 x 10^4 m/s ***By Comparison:*** *1.911 x Earth*
Sidereal Rotation Period (Length of Day)	-0.718 Earth days (retrograde) -17.23992 hours (retrograde) ***By Comparison:*** *0.72 x Earth*
Effective Temperature	**Metric:** -216 °C **English:** -357 °F **Scientific Notation:** 57 K
Atmospheric Constituents	Hydrogen, Helium, Methane **Scientific Notation:** H_2, He, CH_4 ***By Comparison:*** *Earth's atmosphere consists mostly of N_2 and O_2*

NEPTUNE

Planet Profile

Mass: 102,410,000,000,000,000 billion kg (17.15x Earth)
Equatorial Diameter: 49,528 km
Polar Diameter: 48,682 km
Equatorial Circumference: 155,600 km
Known Satellites: 14
Notable Satellites: Tritan
Orbit Distance: 4,498,396,441 km (30.10 AU)
Orbit Period: 60,190.03 Earth days (164.79 Earth years)
Surface Temperature: -201 °C
Discover Date: September 23rd 1846
Discovered By: Urbain Le Verrier & Johann Galle

NEPTUNE is the eighth and farthest planet from the Sun in the Solar System. It is the fourth-largest planet by diameter and the third-largest by mass. Among the gaseous planets in the

solar system, Neptune is the most dense. Neptune is 17 times the mass of Earth and is slightly more massive than its near-twin Uranus, which is 15 times the mass of Earth but not as dense. On average, Neptune orbits the Sun at a distance of 30.1 AU, approximately 30 times the Earth–Sun distance. Named for the Roman god of the sea, its astronomical symbol is ♆, a stylised version of the god Neptune's trident.

Neptune was the first planet found by mathematical prediction rather than by empirical observation. Unexpected changes in the orbit of Uranus led Alexis Bouvard to deduce that its orbit was subject to gravitational perturbation by an unknown planet. Neptune was subsequently observed on 23 September 1846 by Johann Galle within a degree of the position predicted by Urbain Le Verrier, and its largest moon, Triton, was discovered shortly thereafter, though none of the planet's remaining 13 moons were located telescopically until the 20th century. Neptune has been visited by one spacecraft, *Voyager 2*, which flew by the planet on 25 August 1989.

Neptune is similar in composition to Uranus, and both have compositions which differ from those of the larger gas giants, Jupiter, and Saturn. Neptune's atmosphere, while similar to Jupiter's and Saturn's in that it is composed primarily of hydrogen and helium, along with traces of hydrocarbons and possibly nitrogen, contains a higher proportion of "ices" such as water, ammonia, and methane. Astronomers sometimes categorise Uranus and Neptune as "ice giants" in order to emphasise these distinctions. The interior of Neptune, like that of Uranus, is primarily composed of ices and rock.[11] It is possible that the core has a solid surface, but the temperature would be thousands of degrees and the atmospheric pressure crushing. Traces of methane in the outermost regions in part account for the planet's blue appearance.

OVERVIEW

1. If the sun were as tall as a typical front door, the Earth would be the size of a nickel and Neptune would be about as big as a baseball.
2. Neptune orbits our sun, a star. Neptune is the eighth planet from the sun at a distance of about 4.5 billion km (2.8 billion miles) or 30.07 AU.
3. One day on Neptune takes about 16 hours (the time it takes for Neptune to rotate or spin once). Neptune makes a complete orbit around the sun (a year in Neptunian time) in about 165 Earth years (60,190 Earth days).
4. Like the other gas giants, Neptune does not have a solid surface. Neptune is mostly made of a very thick, very hot combination of water (H_2O), ammonia (NH_3), and methane (CH_4) over a possible heavier, approximately Earth-sized, solid core.
5. Neptune's atmosphere is made up mostly of hydrogen (H_2), helium (He) and methane (CH_4).

6. Neptune has 13 moons. Neptune's moons are named after various sea gods and nymphs in Greek mythology.
7. Neptune has six rings.
8. Voyager 2 is the only spacecraft to have visited Neptune.
9. Neptune cannot support life as we know it.

FACTS AND FIGURES ABOUT NEPTUNE

Discovered By	Urbain Le Verrier, John Couch Adams, Johann Galle
Date of Discovery	23 September 1846
Orbit Size Around Sun (semi-major axis)	**Metric:** 4,498,396,441 km **English:** 2,795,173,960 miles **Scientific Notation:** 4.4983964 x 10^9 km (3.0069923 x 10^1 A.U.) ***By Comparison:*** *30.070 x Earth*
Perihelion (closest)	**Metric:** 4,459,753,056 km **English:** 2,771,162,074 miles **Scientific Notation:** 4.45975 x 10^9 km (2.981 x 10^1 A.U.) ***By Comparison:*** *30.318 x Earth*
Aphelion (farthest)	**Metric:** 4,537,039,826 km **English:** 2,819,185,846 miles **Scientific Notation:** 4.53704 x 10^9 km (3.033 x 10^1 A.U.) ***By Comparison:*** *29.830 x Earth*
Orbit Circumference	**Metric:** 28,263,736,967 km **English:** 17,562,271,937 miles **Scientific Notation:** 2.826 x 10^{10} km ***By Comparison:*** *30.071 x Earth*
Average Orbit Velocity	**Metric:** 19,566 km/h **English:** 12,158 mph **Scientific Notation:** 5.4349 x 10^3 m/s ***By Comparison:*** *0.182 x Earth*

Orbit Eccentricity	0.00859048 *By Comparison: 0.514 x Earth*
Orbit Inclination	1.77 degrees
Equatorial Inclination to Orbit	28.3 degrees
Mean Radius	**Metric:** 24,622 km **English:** 15,299.4 miles **Scientific Notation:** 2.4622 x 10^4 km *By Comparison: 3.8647 x Earth*
Equatorial Circumference	**Metric:** 154,704.6 km **English:** 96,129.0 miles **Scientific Notation:** 1.54705 x 10^5 km *By Comparison: 3.8647 x Earth*
Volume	**Metric:** 62,525,703,987,421 km^3 **English:** 15,000,714,125,712 mi^3 **Scientific Notation:** 6.25257 x 10^{13} km^3 *By Comparison: 57.723 x Earth*
Mass	**Metric:** 102,410,000,000,000,000,000,000,000 kg **Scientific Notation:** 1.0241 x 10^{26} kg *By Comparison: 17.148 x Earth*
Density	**Metric:** 1.638 g/cm^3 *By Comparison: 0.297 x Earth*
Surface Area	**Metric:** 7,618,272,763 km^2 **English:** 2,941,431,558 square miles **Scientific Notation:** 7.6183 x 10^9 km^2 *By Comparison: 14.980 x Earth*
Surface Gravity	**Metric:** 11.15 m/s^2 **English:** 36.6 ft/s^2

	By Comparison: *If you weigh 100 pounds on Earth, you would weigh 114 pounds on Neptune.*
Escape Velocity	**Metric:** 84,816 km/h **English:** 52,702 mph **Scientific Notation:** 2.356 x 10^4 m/s ***By Comparison:*** *By Comparison: 2.105 x Earth.*
Sidereal Rotation Period (Length of Day)	0.671 Earth days 16.11000 hours ***By Comparison:*** *0.67 x Earth*
Effective Temperature	**Metric:** -214 °C **English:** -353 °F **Scientific Notation:** 59 K
Atmospheric Constituents	Hydrogen, Helium, Methane **Scientific Notation:** H_2, He, CH_4 ***By Comparison:*** *Earth atmosphere consists mostly of N_2 and O_2.*

PLUTO

PLANET PROFILE

Mass: 13,050,000,000,000 billion kg

(0.00218 x Earth)

Diameter: 2,306 km

Known Satellites: 5

Notable Satellites: Charon, Nix, Hydra, Kerberos and Styx

Orbit Distance: 5,874,000,000 km (39.26 AU)

Orbit Period: 246.04 Earth years

Surface Temperature: -229°C

Discovery Date: 1st January 1801

Discovered By: Clyde W. Tombaugh

PLUTO, minor-planet designation **134340 Pluto**, is the largest object in the Kuiper belt, and the tenth-most-massive body observed directly orbiting theSun. It is the second-most-massive known dwarf planet, after Eris. Like other Kuiper-belt objects, Pluto is composed primarily of rock and ice and is relatively small, approximately one-sixth the mass of the Earth's Moon and one-third its volume. It has an eccentric and highly inclined orbit that takes it from 30 to 49 AU (4.4–7.4 billion km) from the Sun. This causes Pluto to periodically come closer to the Sun than Neptune. As of 2011, it is 32.1 AU from the Sun.

Discovered in 1930, Pluto was originally classified as the ninth planet from the Sun. However, its status as a major planet fell into question following further study of it and the outer Solar System over the ensuing 75 years. Starting in 1977 with discovery of minor planet 2060 Chiron, numerous icy objects similar to Pluto with eccentric orbits were found. The most notable of these was the scattered disc object Eris—discovered in 2005, which is 27% more massive than Pluto. The understanding that Pluto is only one of several large icy bodies in the outer Solar System prompted theInternational Astronomical Union (IAU) to formally define what it means to be a "planet" in 2006. This definition excluded Pluto and reclassified it as a member of the new "dwarf planet" category (and specifically as a plutoid). A number of scientists hold that Pluto should have remained classified as a planet, and that other dwarf planets should be added to the roster of planets along with Pluto.

Pluto has five known moons: Charon (the largest, with a diameter just over half that of Pluto), Nix, Hydra, Kerberos, and Styx. Pluto and Charon are sometimes described as a binary system because the bary center of their orbits does not lie within either body. However, the IAU has yet to formalise a definition for binary dwarf planets, and as such Charon is officially classified as a moon of Pluto.

In 2015, the Pluto system is due to be visited by spacecraft for the first time. The *New Horizons* probe will perform a flyby during which it will attempt to take detailed measurements and images of the plutoid and its moons.

OVERVIEW

- If the sun were as tall as a typical front door, Earth would be the size of a nickel and dwarf planets Pluto and Eris, for would each be about the size of the head of a pin.
- Dwarf planets orbit our sun, a star. Most are located in the Kuiper Belt, a region of icy objects beyond the orbit of Neptune. Pluto, one of the largest and most famous dwarf planets, is about 5.9 billion km (3.7 billion miles) or 39.48 AU away from the sun. Dwarf planet Ceres is in the main asteroid belt between Mars and Jupiter.
- Days and years vary on dwarf planets. One day on Ceres, for example, takes about nine hours (the time it takes for Ceres to rotate or spin once). Ceres makes a complete orbit around the sun (a year in Ceresian time) in about 4.60 Earth years.
- Dwarf planets are solid rocky and/or icy bodies, The amount rock vs. ice depends on their location in the solar system.
- Many, but not all dwarf planets have moons.
- There are no known rings around dwarf planet.
- Dwarf planets Pluto and Eris have tenuous (thin) atmospheres that expand when they come closer to the sun and collapse as they move farther away.
- The first mission to a dwarf planet is Dawn. The first mission to the Kuiper Belt is New Horizons.
- Dwarf planets cannot support life as we know it.
- Pluto was considered a planet until 2006. The discovery of a similar-sized worlds deeper in the distant Kuiper Belt sparked a debate that resulted in a new official definition of a planet that did not include Pluto.

COMETS

A **COMET** is an icy small Solar System body that, when passing close to the Sun, heats up and begins to outgas, displaying a visible atmosphere or coma, and sometimes also a tail. These phenomena are due to the effects of solar radiation and the solar wind upon the nucleus of the comet. Comet nuclei range from a few hundred metres to tens of kilometres across and are composed of loose collections of ice, dust, and small rocky particles. The coma and tail are much larger, and if sufficiently bright may be seen from the Earth without the aid of a telescope. Comets have been observed and recorded since ancient times by many different cultures.

Comets have a wide range of orbital periods, ranging from several years to several millions of years. Short-period comets originate in the Kuiper belt or its associated scattered disc, which lie beyond the orbit of Neptune. Longer-period comets are thought to originate in the Oort cloud, a spherical cloud of icy bodies extending from outside the Kuiper Belt to halfway to the next nearest star. Long-period comets are directed towards the Sun from the Oort cloud by gravitational perturbations caused by passing stars and the galactic tide. Hyperbolic comets may pass once through the inner Solar System before being flung out to interstellar space along hyperbolic trajectories.

Comets are distinguished from asteroids by the presence of an extended, gravitationally unbound atmosphere surrounding their central nucleus. This atmosphere has parts termed the coma (the central atmosphere immediately surrounding the nucleus) and the tail (a typically linear section consisting of dust or gas blown out from the coma by the Sun's light pressure or out streaming solar wind plasma). However, extinct comets that have passed close to the Sun many times have lost nearly all of their volatile ices and dust and may come to resemble small asteroids.[1] Asteroids are thought to have a different origin from comets, having formed inside the orbit of Jupiter rather than in the outer Solar System. The discovery of main-belt comets and active centaurs has blurred the distinction between asteroids and comets.

OVERVIEW

- If the sun were as tall as a typical front door, Earth would be the size of a nickel, dwarf planet Pluto would be the size of a head of a pin and the largest Kuiper Belt comet (about 100 km across, which is about one twentieth the size of Pluto) would only be about the size of a gain of dust.
- Short-period comets (comets that orbit the sun in less than 200 years) reside in the icy region known as the Kuiper Belt beyond the orbit of Neptune from about 30 to 55 AU. Long-period comets (comets

with long, unpredictable orbits) originate in the far-off reaches of the Oort cloud, which is five thousand to 100 thousand AUs from the sun.

- Days on comets vary. One day on comet Halley varies between 2.2 to 7.4 Earth days (the time it takes for comet Halley to rotate or spin once). Comet Halley makes a complete orbit around the sun (a year in this comet's time) in 76 Earth years.
- Comets are cosmic snowballs of frozen gases, rock and dust.
- A comet warms up as it nears the sun and develops an atmosphere, or coma. The coma may be hundreds of thousands of kilometers in diameter.
- Comets do not have moons.
- Comets do not have rings.
- More than 20 missions have explored comets from a variety of viewpoints.
- Comets may not be able to support life themselves, but they may have brought water and organic compounds -- the building blocks of life -- through collisions with Earth and other bodies in our solar system.

CELESTIAL SPHERE

In astronomy and navigation, the **celestial sphere** is an imaginary sphere of arbitrarily large radius, concentric with Earth. All objects in the observer's sky can be thought of as projected upon the inside surface of the celestial sphere, as if it were the underside of a dome or a hemispherical screen. The celestial sphere is a practical tool for spherical astronomy, allowing observers to plot positions of objects in the sky when their distances are unknown or unimportant.

Because astronomical objects are at such remote distances, casual observation of the sky offers no information on the actual distances. All objects seem equally far away, as if fixed to the inside of a sphere of large but unknown radius, which rotates from east to west overhead while underfoot, the Earth seems to stand still. For purposes of spherical astronomy, which is concerned only with the directions to objects, it makes no difference whether this is actually the case, or if it is the Earth which rotates while the celestial sphere stands still.

The celestial sphere can be considered to be infinite in radius. This means any point within it, including that occupied by the observer, can be considered the center. It also means that all parallel lines, be they millimetres apart or across the Solar System from each other, will seem to intersect the sphere at a single point, analogous to the vanishing point of graphical perspective. All parallel planes will seem to intersect the sphere in a coincident great circle (a "vanishing circle"). Conversely, observers looking toward the same point on an infinite-radius celestial sphere will be looking along parallel lines, and observers looking toward the same great circle, along parallel planes. On an infinite-radius celestial sphere, all observers see the same things in the same direction.

For some objects, this is over-simplified. Objects which are relatively near to the observer (for instance, the Moon) will seem to change position against the distant celestial sphere if the observer moves far enough, say, from one side of the Earth to the other. This effect, known as parallax, can be represented as a small offset from a mean position. The celestial sphere can be considered to be centered at the Earth's center, The Sun's center, or any other convenient location, and offsets from positions referred to these centers can be calculated. In this way, astronomers can predict geocentric or heliocentric positions of objects on the celestial sphere, without the need to calculate the individual geometry of any particular observer, and the utility of the celestial sphere is maintained. Individual observers can work out their own small offsets from the mean positions, if necessary. In many cases in astronomy, the offsets are insignificant.

STARS

A **STAR** is a massive, luminous sphere of plasma held together by its own gravity. The nearest star to Earth is the Sun, which is the source of most of the planet's energy. Some other stars are visible from Earth during the night, appearing as a multitude of fixed

luminous points due to their immense distance. Historically, the most prominent stars were grouped into constellations and asterisms, and the brightest stars gained proper names. Extensive catalogues of stars have been assembled by astronomers, which provide standardized star designations.

For at least a portion of its life, a star shines due to thermonuclear fusion of hydrogen into helium in its core, releasing energy that traverses the star's interior and then radiates into outer space. Once the hydrogen in the core of a star is nearly exhausted, almost all naturally occurring elements heavier than helium are created by stellar nucleo synthesis during the star's lifetime and, for some stars, by supernova nucleo synthesis when it explodes. Near the end of its life, a star can also contain degenerate matter. Astronomers can determine the mass, age, metallicity (chemical composition), and many other properties of a star by observing its motion through space ,luminosity, and spectrum respectively. The total mass of a star is the principal determinant of its evolution and eventual fate. Other characteristics of a star, including diameter and temperature, change over its life, while the star's environment affects its rotation and movement. A plot of the temperature of many stars against their luminosities, known as a Hertzsprung–Russell diagram (H–R diagram), allows the age and evolutionary state of a star to be determined.

A star's life begins with the gravitational collapse of a gaseous nebula of material composed primarily of hydrogen, along with helium and trace amounts of heavier elements. Once the stellar core is sufficiently dense, hydrogen becomes steadily converted into helium through nuclear fusion, releasing energy in the process. The remainder of the star's interior carries energy away from the core through a combination of radioactive and convective processes. The star's internal pressure prevents it from collapsing further under its own gravity. Once the hydrogen fuel at the core is exhausted, a star with at least 0.4 times the mass of the Sun

expands to become a red giant, in some cases fusing heavier elements at the core or in shells around the core. The star then evolves into a degenerate form, recycling a portion of its matter into the interstellar environment, where it will contribute to the formation of a new generation of stars with a higher proportion of heavy elements. Meanwhile, the core becomes a stellar remnant: a white dwarf, a neutron star, or (if it is sufficiently massive) a black hole.

Binary and multi-star systems consist of two or more stars that are gravitationally bound, and generally move around each other in stable orbits. When two such stars have a relatively close orbit, their gravitational interaction can have a significant impact on their evolution. Stars can form part of a much larger gravitationally bound structure, such as a star cluster or a galaxy.

Facts about Stars

- **Many stars you look at in the night sky seem like single, distant glimmer of light. However that is not the case.** Most stars you see in the night sky are actually two star systems, or binary star systems. They are so far away however that they just appear as one speck of light.
- **Stars go through many phases of life, much like other organic beings.** When a star is dying, it turns into a "white dwarf", when the star uses up all of the chemicals required for its nuclear fusion reaction, it will fuse a large clump, which will emit white light until it finally darkens for good.
- **Before a massive star goes into a white dwarf phase however, it undergoes an incredible chain reaction** in which it burns through the rest of its fuel at a dramatic pace and explodes due to the speed of the reaction. This reaction is known as a supernova.

- **If a star is massive enough**, after it goes supernova it can actually turn into a massive, gravity and light eating black hole.
- **Contrary to popular belief a black hole does not "suck" in the objects around it.** Due to their incredible mass, according to Einstein's general theory of relativity, they actually bend space in such a way that everything within their gravitational field is pushed towards it. A black hole's gravitational field is so strong that even light cannot escape it.
- **If a star has enough mass, it will burn up much like a white dwarf.** Instead of fading away however, it will go into a state of degeneration; these stars are rare and are called "neutron stars".
- **Neutron stars are extremely easy to recognize**. Opposed to white dwarves they are easy for astronomers to spot through telescopes because they bend the light around them, which allows them to be seen easily through infrared telescopes.
- **There are some stars that are 100 times more massive than our Sun.** These stars also can output about a million times more energy than our sun, while still maintaining the same radius.
- **Eta Carinae is one of the** largest stars **in the known galaxy**, it is designated as a hyper-giant.
- **Another hyper-giant star is designated as Pistol, it shines even brighter than Eta Carinae**, at about 10 billion times more than our sun. It emits such high amounts of radiation that scientists have already declared it impossible for anything to live in such a system.
- **The closest observable star is Sol, or as it's more commonly known, the Sun.** Although it is around 150 kilometers away, there are billions of stars just like our Sun out there in the galaxy.

- **The distances involved in measuring how far away a star is are immense.** Consider that the closest star to Earth is approximately 4.2 light years away. It would take about 70,000 years in our fastest space craft to reach it.
- **There are approximately 400 billion stars in the Milky Way galaxy alone.**
- **On a clear night, you cannot see even a fraction of these stars.** However during a clear night, in the country, with the naked eye you can see up to 19,000,000,000,000,000 miles away, very easily.
- **Every single star has almost the exact same chemical composition.** The nuclear fusion reaction which occurs in each star is identical in each star, which requires hydrogen which turns into helium. As the hydrogen burns it collapses and forms a center mass due to gravitational pull of the heavier helium.
- **The original materials that make up all stars within the galaxy were formed during the Big Bang.**
- **Stars are constantly undergoing changes in pressure and chemical makeup.** However at all times, they are in perfect balance. Consider that if stars didn't have balance, they would continue collapsing inward until they ran out of fuel. They do not because they are constantly creating a perfect balance of inward and outward pressure, and hydrogen and helium.
- **The most common type of stars within the universe is red dwarves.** These stars are common due to their low mass, and the fact that they live for a very long time before turning into white dwarves.
- **The colour of a star can tell an observer a lot of things**, as the colour of a star can show give an idea of how much mass it has, luminosity and other interesting data.
- **The coolest stars in the universe are red**, and they sit at around 3,500 Kelvin (a special temperature measurement used for stars).

- **Opposite to that, the hottest stars are blue** due to their incredible mass and the amount of chemical reactions occurring within them. They burn at around 6,000 Kelvin.
- **Despite many people's claims of there being "green" stars, there are no stars in the known universe which are green.** A green star is usually a side effect of a looking through a telescope on a certain wavelength.
- **There are exceptions to even this rule**, as when certain stars reach the end of their life they increase their fusion reactions by about 1000, which can lead even some red stars to burn at the same rate as a blue star.
- **The stars that have the shortest life spans are the most massive.** They lend their mass to a high density of chemicals; as such they burn their fuel much quicker than smaller stars.
- **Despite how often stars are claimed to "twinkle" this is not true.** The twinkling effect is merely the light from the star passing through the Earth's atmosphere, and it is merely deflecting the light before it reaches your eyes.

CONSTELLATIONS

In modern astronomy, a **CONSTELLATION** is an internationally defined area of the celestial sphere. These areas are grouped around asterisms (which themselves are generally referred to in non-technical language as "constellations"), which are patterns formed by prominent stars within apparent proximity to one another on Earth's night sky.

CONSTELLATION FAMILY

There are many families of constellations, constellations that are either close to one another in our view of the sky or have some other relationship (for example, depicting figures from a particular ancient myth). Some constellation families include:

- The Zodiac: 12 constellations are star groupings that lie along the ecliptic (the plane in which most of our Solar System lies). Usually, 12 constellations are listed in the Zodiac, but there is actually a thirteenth constellation that crosses the ecliptic, Ophiuchus (between Scorpio and Sagittarius). The signs of the Zodiac are

Capricornus, Aquarius, Pisces, Aries, Taurus, Gemini, Cancer, Leo, Virgo, Libra, Scorpius, Sagittarius.

- The Ursa Major Family: 10 constellations circling the northern celestial pole, including Ursa Major (containing the Big Dipper), Ursa Minor (containing Polaris, the northern pole star), Canes Venatici, Boötes, Coma Berenice, Corona Borealis, Camelopardalis, Lynx, Draco, and Leo Minor.
- The Perseus Family: 9 constellations depicting figures from the myth of Perseus, including Cassiopeia, Cepheus, Andromeda, Perseus, Pegasus, Cetus, Auriga, Lacerta, Triangulum.
- The Hercules Family: 19 constellations depicting figures from the myth of Heracles, including Hercules, Sagitta, Aquila, Lyra, Cygnus, Vulpecula, Hydra, Sextans, Crater, Corvus, Ophiuchus, Serpens, Scutum, Centaurus, Lupus, Corona Australis, Ara, Triangulum Australe, Crux.
- The Orion Family: 5 constellations, including Orion (the hunter), Canis Major and Canis Minor (Orion's two gods), Monoceros (the unicorn), Lepus (the hare).
- The Heavenly Waters (aka the Cosmic Waters): 9 constellations whose names are related to water, including Delphinus, Columba, Equuleus, Vela, Puppis, Eridanus, Piscis Austrinus, Carina, Pyxis,
- The Bayer Group: 11 Southern Hemisphere constellations depicting animals, named by Johann Bayer in 1603. Includes Hydrus, Dorado, Volans, Apus, Pavo, Grus, Phoenix, Tucana, Indus, Chamaeleon, Musca.
- The La Caille Family: 13 Southern Hemisphere constellations, named by Nicolas Louis de Lacaille in 1756. Includes Norma, Fornax, Circinus, Telescopium, Microscopium, Sculptor, Caelum, Horologium, Antlia, Pictor, Reticulum, Octans, Mensa.

The 12 Constellations of the Zodiac

The zodiac is a band of 12 constellations along the ecliptic.

Aquarius, the water bearer
Aries, the ram
Cancer, the crab
Capricorn, the goat
Gemini, the twins

The Constellations of the Northern Hemisphere (some are seasonally visible in the Southern Hemisphere):

Andromeda, the princess
Antlia, the pump
Aquila, the eagle
Auriga, the chariot driver
Bootes, the herdsman

Leo, the lion
Libra, the scales
Pisces, the fish
Sagittarius, the archer
Scorpius, the scorpion
Taurus, the bull
Virgo, the virgin

The Constellations of the Southern Hemisphere (some are seasonally visible in the Northern Hemisphere):

Apus, the bird of paradise
Ara, the altar
Carina, the ship's keel
Centauras, the centaur
Chamaeleon, the chameleon
Circinus, the compass
Crux, the southern cross
Dorado, the swordfish
Eridanus, the river
Grus, the crane
Hydrus, the water snake
Indus, the Indian
Lepus, the rabbit
Mensa, the table
Musca, the fly
Norma, the surveyor's level
Octans, the octant
Pavo, the peacock
Phoenix, the phoenix
Pictor, the easel
Reticulum, the net
Triangulum Australe, the southern triangle
Tucana, the toucan
Vela, the ship's sails
Volans, the flying fish

Caelum, the chisel
Camelopardalis, the giraffe
Canes Venatici, the hunting dogs
Canis Major, the big dog
Canis Minor, the little dog
Cassiopeia, the queen
Cepheus, the king
Cetus, the whale
Columba, the dove
Coma Berenices, Berenice's hair
Corona Australis, the southern crown
Corona Borealis, the northern crown
Corvus, the crow
Crater, the cup
Cygnus, the swan
Delphinus, the dolphin
Draco, the dragon
Equuleus, the little horse
Fornax, the furnace
Hercules, the hero
Horologium, the clock
Hydra, the water snake
Lacerta, the lizard
Leo Minor, the little lion
Lupus, the wolf
Lynx, the lynx
Lyra, the harp
Microscopium, the microscope
Monoceros, the unicorn
Ophiuchus, the sepent holder
Orion, the hunter
Pegasus, the flying horse
Perseus, the Medusa killer
Pisces Austrinus, the southern fish
Puppis, the ship's stern
Pyxis, the ship's compass
Sagitta, the arrow

Sculptor, the sculptor
Scutum, the shield
Serpens, the snake
Sextans, the sextant
Telescopium, the telescope
Triangulum, the triangle
Ursa Major, the big bear
Ursa Minor, the little bear
Vulpecula, the little fox

BEYOND THE UNIVERSE

- Edwin Hubble discovered that the Universe is in fact expanding and that at one point in time (14 billion years ago) the Universe was all collected in just one point of space.
- There are believed to be at least a hundred billion galaxies in the Universe. A galaxy is full of stars. Our sun is just one of at least a hundred billion stars in our own Milky Way galaxy, and each of those stars could have their own planetary system.
- Roughly 70 percent of the Universe is made of dark energy. Dark matter makes up about 25 percent. The rest -- everything on Earth, everything ever observed with all of our instruments, all normal matter adds up to less than 5 percent of the Universe.
- We now know that our Universe has a *foamy* structure. The galaxies and clusters of galaxies that make up the visible Universe are concentrated in a complex scaffold that surrounds a network of enormous cosmic voids.
- The Milky Way galaxy is in the Local Group, a neighbourhood of about 30 galaxies. Our nearest major neighbouring galaxy is called Andromeda.

- There are planets around other stars in our galaxy and very likely around other stars in other galaxies within the Universe. More than 900 planets have been confirmed orbiting other stars, and thousands more are awaiting confirmation.
- Other planetary systems could have the potential for life, but no signs have yet been found beyond Earth.
- Two-thirds of the galaxies within the Universe are similar to the Milky Way galaxy, in that they are spiral-shaped. The remaining third have elliptical shapes, and a few have unusual shapes like toothpicks or rings.
- The Hubble Space Telescope observed a tiny patch of sky (one-tenth the diameter of the moon) for 11.6 days and found approximately 10,000 galaxies of all sizes, shapes and colours.
- Black holes are not empty spaces in the Universe. A black hole is a great amount of matter packed into a very small area, which results in a gravitational field so strong that nothing -- not even light -- can escape.

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