



## Teaching material

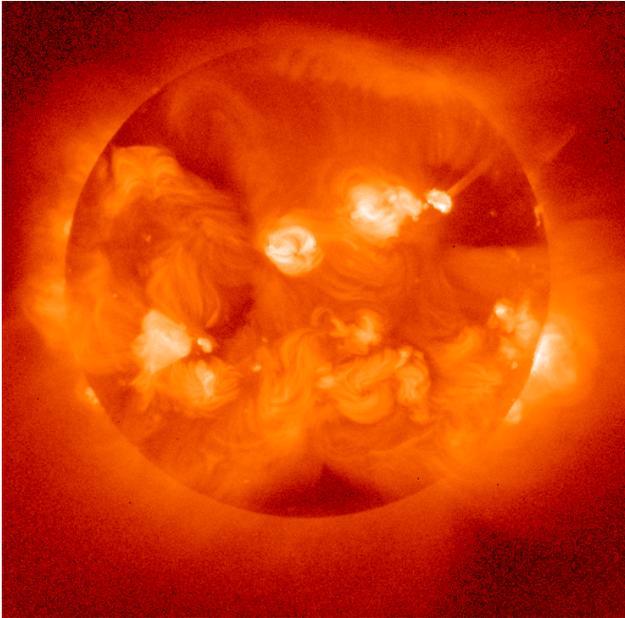
Introduction	<p>First the students are given a short pre-test to activate their thinking about the order in the solar system.</p> <p><b>PRE TEST TASK:</b>                  Draw the following objects in their correct order, the distances between the objects are not considered, just the order:</p> <p>Moon, Sun, Earth, Mars, Jupiter, Proxima Centauri, Weather satellite</p> <p>After the task, the teacher collects the papers and introduces into the idea of the role play. The actors are dressed up (optional) and each of them has the identification label hanging in front of them. (See the photo in Further information part.)</p>	
The role play	Deciding the roles	
	<p><b>ROLES</b></p> <p>Sun                  Mercury                  Venus                  Earth                  The Weather Satellite                  Proxima Centauri                  Mars                  Jupiter                  Saturn                  Uranus                  Neptunus                  Hubble telescope                  Halley's Comet                  ISS</p>	<p><b>EXTRA (OPTIONAL) MATERIALS</b></p> <p>A Lamp</p> <p>A headdress of cardboard box with antenna                  A Star</p> <p>A moon mobile                  A hula-hula hoop</p> <p>Binoculars/strong eye glasses/a telescope</p> <p>A cardboard wings for solar panel (affixed in arms)</p>
The Role Play	<p>The teacher asks presenters to come to the front and find their place in the order. The ones who have no role, yet play the role of the Asteroid belt and go to their place in the “solar system”</p> <p>Then the presentation starts with Earth, Weather satellite,</p>	

	<p>Moon, etc in their order (not the distance, there is no room). Every student reads or tells his or her role and place in the Solar system by reading or telling the facts in the Name Tag.</p>
<p>A group discussion</p>	<p>A group discussion about the experiences during the role play</p>
<p>Space mathematics</p>	<p>The students work with some of the mathematics tasks dealing with the distances and sizes in the Solar System: Large numbers tasks (examples)</p> <ol style="list-style-type: none"> <li>1. The distance of Moon from Earth is about 380 000 km. How long does it take with a rocket which goes <math>2 \cdot 10^3</math> m/s.                   ANSWER: The average speed of a rocket is 2000 m/s = 7200 km/h, thus it takes 380 000km: 7200 km/h = 52,8 h (which means two times 24 hours and 4 hours and 48 minutes)</li> <li>2. Earth revolves Sun using speed <math>1,07 \cdot 10^5</math> km/h. How many kilometres Earth goes during one year?                  ANSWER: In one year there are hours: <math>365 \cdot 24</math> h = 8760 h, thus Earth revolves during one year <math>8760 \text{ h} \cdot 1,07 \cdot 10^5 \text{ km/h} = 937,32 \cdot 10^6</math> km, which is 940 million kilometres</li> <li>3. One light-year ( or a light year) is the distance that light travels in a vacuum in one Julian year. The speed of light is 299,792,458 metres per second, which is about 300 000 km per second. How long is then the light year in kilometres?                   ANSWER: One year in seconds is <math>365 \cdot 24 \cdot 3600 = 31\,536\,000</math>.                  Thus the length of light year is <math>300\,000 \cdot 31\,536\,000 \text{ km} = 9,46 \cdot 10^{12} \text{ km}</math>.</li> <li>4. How long does it take to travel from Earth to Jupiter with a space rocket, if it's average velocity is <math>4 \cdot 10^3</math> m/s and when the distance of Jupiter from Earth is roughly 628 000 000 km.                  ANSWER: The average speed of the rocket is <math>4 \cdot 10^3 \text{ m/s} = 14400 \text{ km/h}</math>, thus it takes <math>628\,000\,000 \text{ km} : 14400 \text{ km/h} = 43\,611 \text{ h}</math> which is about 5 years.</li> <li>5. Count the area of the surface of Moon, when its' diameter is 3476 km and we assume that its' shape is</li> </ol>

	<p>a ball. ANSWER: The radius of Moon is <math>5476 : 2 \text{ km} = 1738 \text{ km}</math>, thus the area of ball is <math>4 \cdot \pi \cdot 1738^2 \text{ km}^2 = 37\,939\,289 \text{ km}^2</math>, which is <math>38\,000\,000 \text{ km}^2</math></p> <p>6. How many percentages it is form the surface of Earth, if we assume that Earth is a ball and its' diameter is 12 670 km?</p> <p>ANSWER: The area of Earth is <math>4 \cdot \pi \cdot 6335^2 \text{ km}^2 = 504\,060\,746 \text{ km}^2</math> The difference of the area of Earth and the area of Moon is <math>(504\,060\,746 - 37\,939\,289)/504\,060\,746 = 0,9247\text{km}^2</math> Thus the area of Moon is 92.2 % smaller than the area of Earth.</p>
Post test	After the teaching session it is possible to give the same task for the students as prior the role play, and test, if there has been a change.

## Name tags for the role play

(Source: Wikipedia)



### SUN

The **Sun** is the star at the centre of the Solar System. The Earth and other matter (including other planets, asteroids, meteoroids, comets, and dust) orbit the Sun, which by itself accounts for about 99.86% of the Solar Systems mass. The mean distance of the Sun from the Earth is approximately 149.6 million kilometres (1 AU), and its light travels this distance in 8 minutes and 19 seconds.



### MERCURY

**Mercury** is the innermost and smallest planet in the Solar System, orbiting the Sun once every about 88 days. The orbit of Mercury has the highest eccentricity of all the Solar System planets, and it has the smallest axial tilt. It completes three rotations about the axis for every two orbits. Its distance from the sun is 0.4 AU.



## VENUS

**Venus** is the second-closest planet to the Sun, orbiting it every 224.7 Earth days. The planet is named after Venus, the Roman goddess of love and beauty. After the Moon, it is the brightest natural object in the night sky. Because Venus is an inferior planet from Earth, it never appears to venture far from the Sun. Venus reaches its maximum brightness shortly before sunrise or shortly after sunset, for which reason it is often called the *Morning Star* or the *Evening Star*. Its distance from Sun is 0.7 AU.



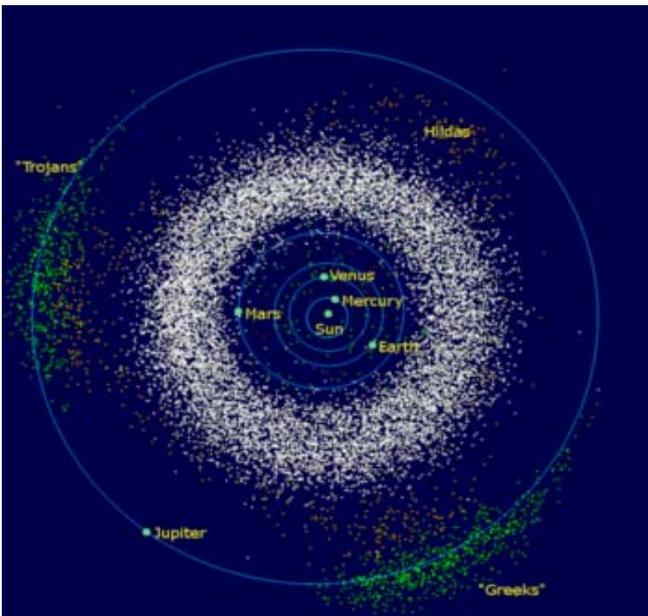
## EARTH

**Earth** is the third planet from the Sun. It is the fifth largest of the eight planets in the solar system, and the largest of the terrestrial planets (non-gas planets) in the Solar System in terms of diameter, mass and density. It is also referred to as *the World*, the *Blue Planet*, and *Terra*. Its distance from Sun is 1 AU = 150 000 km.



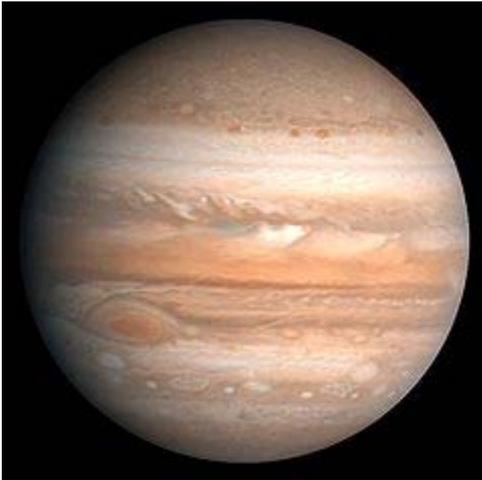
## MARS

**Mars** is the fourth planet from the Sun in the Solar System. The planet is named after Mars, the Roman god of war. It is also referred to as the "Red Planet" because of its reddish appearance, due to iron oxide prevalent on its surface. Its distance from Sun is 1,5 AU.



## ASTEROID BELT

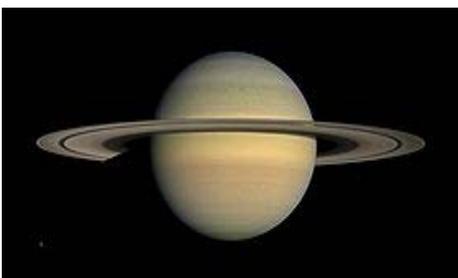
The **asteroid belt** is the region of the Solar System located roughly between the orbits of the planets Mars and Jupiter. It is occupied by numerous irregularly shaped bodies called asteroids or minor planets. The asteroid belt region is also termed the **main belt** to distinguish it from other concentrations of minor planets within the Solar System. Its distance from sun is 2,5 AU.



## JUPITER

**Jupiter** is the fifth planet from the Sun and the largest planet within the Solar System. It is a gas giant with a mass slightly less than one-thousandth that of the Sun but is two and a half times the mass of all of the other planets in our 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 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  $-2.8$ , making it on average the third-brightest object in the night sky after the Moon and Venus. Its distance from Sun is 5.2 AU



## SATURN

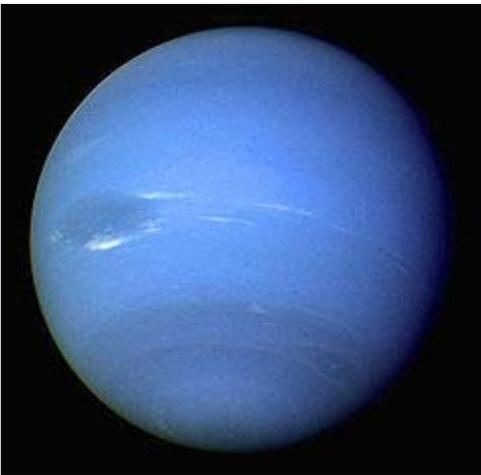
**Saturn** is the sixth planet from the Sun and the second largest planet in the Solar System, after Jupiter. Saturn, along with Jupiter, Uranus and Neptune, is classified as a gas giant. Together, these four planets are sometimes referred to as the Jovian, meaning "Jupiter-like", planets.

Saturn is named after the Roman god Saturn (that became the namesake of Saturday), equated to the Greek Kronos (the Titan father of Zeus) the Babylonian Ninurta and to the Hindu Shani. Saturn's symbol represents the god's sickle (Unicode: ♄). It's distance from Sun is 9.6 AU.



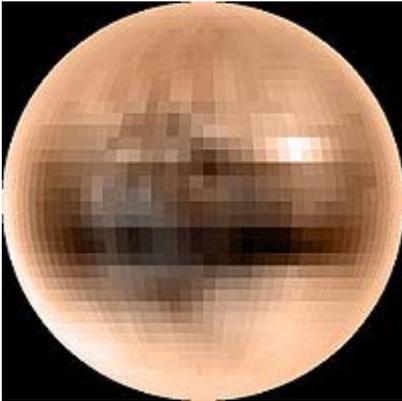
## URANUS

**Uranus** is the seventh planet from the Sun, and the third-largest and fourth most massive planet in the Solar System. It is named after the ancient Greek deity of the sky Uranus the father of Kronos (Saturn) and grandfather of Zeus (Jupiter). Though it is visible to the naked eye like the five classical planets, it was never recognized as a planet by ancient observers because of its dimness and slow orbit. Sir William Herschel announced its discovery on March 13, 1781, expanding the known boundaries of the Solar System for the first time in modern history. Uranus was also the first planet discovered with a telescope. It's distance from Sun is 19.3 AU.



## NEPTUNE

**Neptune** is the eighth planet from the Sun in our Solar System. Named for the Roman god of the sea, it is the fourth-largest planet by diameter and the third-largest by mass. Neptune is 17 times the mass of Earth and is slightly more massive than its near-twin Uranus, which is 15 Earth masses and not as dense. On average, Neptune orbits the Sun at a distance of 30.1 AU, approximately 30 times the Earth-Sun distance.



## PLUTO

**Pluto**, is the second-largest known dwarf planet in the Solar System (after Eris) and the tenth-largest body observed directly orbiting the Sun. Classified as a planet from its 1930 discovery until 2006, Pluto is now considered the largest member of a distinct population called the Kuiper belt. On August 24, 2006, the IAU defined the term "planet" for the first time. This definition excluded Pluto as a planet, and added it as a member of the new category "dwarf planet" along with Eris and Ceres. Its distance from Sun is 30.2 AU.



## International Space Station (ISS)

The **International Space Station (ISS)** is an internationally developed research facility currently being assembled in Low Earth Orbit. On-orbit construction of the station began in 1998 and is scheduled to be completed by 2011, with operations continuing until at least 2015. The station can be seen from the Earth with the naked eye, and, as of 2009, is the largest artificial satellite in Earth orbit, with a mass larger than that of any previous space station. The ISS serves as a long-term research laboratory in space, with experiments including biology, human biology, physics, astronomy and meteorology being carried out daily in the station's microgravity environment. The station also provides a safe testing location for efficient, reliable spacecraft systems that will be required for long-duration missions to the Moon and Mars. The ISS and its experiments are operated by long-duration Expedition crews, with the station being continuously staffed since the first resident crew, Expedition 1, arrived on 2 November 2000. This has provided an uninterrupted human presence in space for the last 8 years and 353 days.

The ScienceMath-project: **The solar system – a role play**  
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Hubble telescope

The **Hubble Space Telescope (HST)** is a space telescope that was carried into orbit by the space shuttle in April 1990. It is named after the American astronomer Edwin Hubble. Although not the first space telescope, the Hubble is one of the largest and most versatile, and is well-known as both a vital research tool and a public relations boon for astronomy. The HST is a collaboration between NASA and the European Space Agency, and is one of NASA's Great Observatories.



## **WEATHER SATELLITE**

A **weather satellite** is a type of satellite that is primarily used to monitor the weather and climate of the Earth. Satellites can be either polar orbiting, seeing the same swath of the Earth every 12 hours, or geostationary, hovering over the same spot on Earth by orbiting over the equator while moving at the speed of the Earth's rotation. These meteorological satellites, however, see more than clouds and cloud systems. City lights, fires, effects of pollution, auroras, sand and dust storms, snow cover, ice mapping, boundaries of ocean currents, energy flows, etc., are other types of environmental information collected using weather satellites. Weather satellite images helped in monitoring the volcanic ash cloud from Mount St. Helens and activity from other volcanoes such as Mount Etna.



## MOON

The **Moon** is Earth's only natural satellite and the fifth largest satellite in the Solar System. The average centre-to-centre distance from the Earth to the Moon is about 384, kilometres, about thirty times the diameter of the Earth. The Moon makes a complete orbit around the Earth every 27.3 days (the orbital period), and the periodic variations in the geometry of the Earth–Moon–Sun system are responsible for the phases of the Moon, which repeat every 29.5 days (the sydic period). The Moon always shows the same side towards Earth, we never see the backside of the Moon.



## Halley's Comet or Comet Halley

Is the most famous of the periodic comets and can currently be seen every 75–76 years. Many comets with long orbital periods may appear brighter and more spectacular, but Halley is the only short-period comet that is clearly visible to the naked eye, and thus, the only naked-eye comet certain to return within a human lifetime. During its returns to the inner solar system, it has been observed by astronomers since at least 240 BC, but it was not recognized as a periodic comet until the eighteenth century when its orbit was computed by English astronomer Edmond Halley, after whom the comet is now named. Halley's Comet last appeared in the inner Solar System in 1986, and will next appear in mid-2061.