TEACHER BACKGROUND INFORMATION

(*Our Solar System*)

Our solar system consists of a star, the sun, which is orbited by eight major planets with satellites, thousands of minor planets (asteroids), comets, and meteoroids.

A. <u>THE SUN:</u>

The **sun** is a medium sized, yellow, main-sequence star of about 4.6 billion years of age with a circumference of over 4 million kilometers (2.7 million miles). Like other main-sequence stars, the sun undergoes nuclear fusion reactions within its core. These reactions produce tremendous amounts of energy which take thousands of years to reach the surface, or **photosphere,** of the sun where they are released. The photosphere has a temperature of about 5504 ° C (9939 ° F), except where sunspots are present. **Sunspots** appear as dark spots on the sun and are caused by magnetic storms on the sun's surface. Within these spots, surface temperatures are about 1500 ° C cooler than the surrounding areas. Solar flares also occur on the photosphere. **Solar flares** are streams of magnetic energy which erupt from the surface of the sun and shoot into space. The energy released from solar flares is strong enough to interfere with communication systems on Earth. Surrounding the photosphere are two hot, gaseous layers called the chromosphere and corona. The **chromosphere** ("sphere of color") is about 15,000 °C hotter than the photosphere. The chromosphere is red, and pieces of it can be seen in the form of solar prominences during a solar eclipse. A **solar prominence** arises when hot gases erupt from the surface of the sun and shoot outward or twist inward and loop back toward the sun. The **corona** ("crown") is the outermost layer of the sun and appears as a white halo around the sun during a total eclipse. The corona is the source of **solar winds**, streams of charged particles which flow outward from the sun through the solar system.

B. PLANETARY MOTIONS:

Planets **revolve** around the sun along a path called an **orbit**. The planets in our solar system have elliptical (oval-shaped) orbits (see figure 1). The time it takes for a planet to complete one revolution around the sun along its orbit is a **year**. While planets orbit the sun, they also **rotate** or spin around an axis. An **axis** is an imaginary line which runs though the north and south poles of a planet. One complete rotation around a planet's axis is a **day**. Most planets rotate from west to east, but Venus and Uranus rotate from east to west and are said to have retrograde rotations (retro: backward). With the exception of Mercury, all major planets of our solar system have an axis which is tilted in relation to the orbital plane of the planet. A tilted axis causes a planet to experience seasons as it moves around the sun.

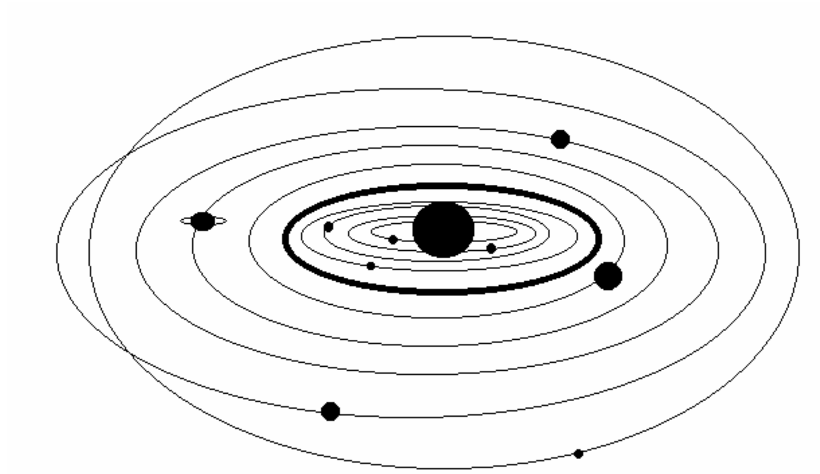

Figure 1: The orbits of the planets in our solar system. The dark sphere in the center is the sun, and the thick black band is the asteroid belt. Notice how the orbits of Pluto and Neptune cross over. (Note: Figure is not to scale.)

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Seasons occur on a planet with a tilted axis because the amount of sunlight reaching each hemisphere varies during the planet's revolution. For example, the Earth's tilt causes the northern hemisphere to be tilted more toward the sun at times. When the northern hemisphere is tilted more toward the sun, the northern hemisphere is receiving the sun's rays more directly. The number of hours of daylight increase and the temperature is warmer because more of the sun's energy is reaching that part of Earth. Other times the northern hemisphere is tilted more away from the sun (receiving the sun's rays less directly). When the northern hemisphere is more away from the sun, days are shorter and colder because less light is striking that area of the planet. Figure 2 illustrates the placement of the Earth in its orbit when the northern hemisphere is more toward, more away, and neither toward or away from the sun. In the northern hemisphere, days are longest on the **summer solstice** (first day of summer, about June 21) when the northern hemisphere is tilted toward the sun, while days are shortest on the **winter solstice** (first day of winter, about December 21) when the northern hemisphere is tilted away from the sun. The **vernal equinox** (equin = equal)(first day of spring, about March 21) and **autumnal equinox** (first day of fall, about September 22) occur when the northern hemisphere is not pointed toward or away from the sun and have equal day and night. [Note: Remember that the seasons in the southern hemisphere are opposite those of the northern hemisphere.]

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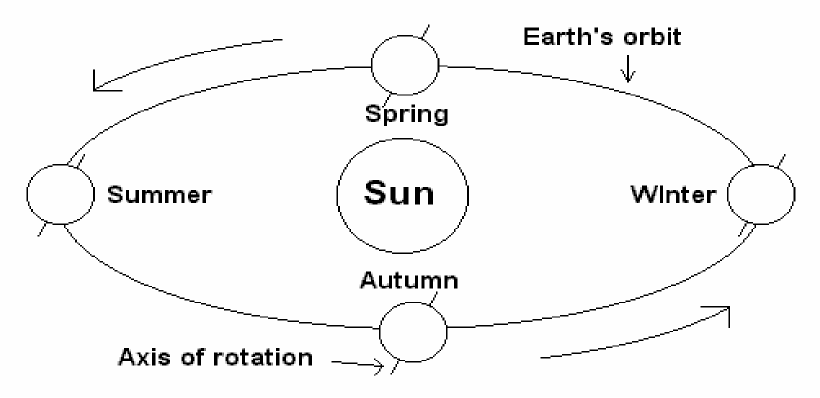

Figure 2: Diagram of position of Earth in its orbit during the seasons of the northern hemisphere. (Note: Diagram not to scale.)

C. THE PLANETS:

The following planets are listed in order from closest to furthest from the sun. Table 2 contains additional comparative information for each planet.

Mercury: Mercury is a terrestrial (terr = land) planet with only a trace of an atmosphere. Even though Mercury is the closest planet to the sun, the temperature on its surface can reach -173 ° C (-279 ° F) because it lacks a heat retaining atmosphere. Also, because Mercury's axis has no tilt, it does not experience seasons.

Venus: Although very close in size and composition to Earth, the terrestrial planet Venus has a very different atmosphere. Venus' atmosphere is comprised of carbon dioxide (causes green house effect), nitrogen, and sulfuric acid droplets. In addition, the planet is covered with thick clouds which trap heat and reflect lots of sunlight, making it highly visible in Earth's night sky. While Mercury lacks a heat retentive atmosphere, Venus' combination of a carbon dioxide rich atmosphere and heavy cloud cover keeps the planet at a toasty 462 ° C (864 ° F).

Earth: The terrestrial planet Earth has an atmosphere made of nitrogen, oxygen, and carbon dioxide. Earth's atmosphere blocks harmful x-ray, ultraviolet, and other excess radiation emitted from the sun, while trapping heat energy to warm the planet. Because it takes the Earth 365.24 days to revolve around the sun instead of only 365 days, every fourth year is a leap year where an extra day is added to our calendars to make-up for the extra revolution time. In addition, Earth is the only planet in the solar system where living organisms have been discovered.

Mars: Mars, sometimes called the Red Planet due to its reddish surface, is the last of the planets before the asteroid belt. A terrestrial planet, Mars has an atmosphere composed of carbon dioxide, nitrogen, and argon. Certain geological features on Mars indicate that at one time liquid water flowed on this planet. Any surface water today would be frozen due to its surface temperature being consistently below freezing.

Asteroid belt: The asteroid belt is a thick belt of millions of asteroids which orbit the sun every 3-6 years between Mars and Jupiter. The asteroid belt separates the eight major planets into four inner and four outer planets. The asteroids vary in size from less than a kilometer across to a quarter the size of Earth's moon. The orbits of asteroids can be altered by the gravitational fields of Mars, Jupiter, or other asteroids. When their orbits are altered, asteroids can be caught up in a planets gravitational field and become a satellite or they can impact planets, satellites, or stars.

Jupiter: Jupiter is the largest planet in our solar system. One of the gas giants (a large, gaseous planet), Jupiter is composed primarily of hydrogen and helium gases wrapped around a dense liquid core. Jupiter's faint rings are composed of tiny dust particles. Strong winds in the upper atmosphere cause what appear to be dark and light bands across the planet. Jupiter experiences many strong storm systems, with

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the Great Red Spot in the southern hemisphere being one of the largest. Three Earths would fit across the Great Red Spot which has been present for at least 100 years.

Saturn: Another gas giant, Saturn, has an atmosphere of hydrogen and helium over a liquid core. Like Jupiter, Saturn has strong winds in its upper atmosphere which give the planet a banded appearance. Saturn is surrounded by many large rings which orbit the planet at different speeds. The rings are composed of billions of particles of rock and ice, some of which are many meters across.

Uranus: Uranus is a ringed gas giant with an atmosphere of hydrogen, helium, and methane that surrounds a core of icy liquid methane, ammonia, and water. Bright clouds on Uranus are formed by crystalline methane. The presence of methane in the atmosphere and on the surface of Uranus gives the planet a blue-green color.

Neptune: The last gas giant of our solar system is Neptune. Surrounded by several rings, Neptune has a liquid core and an atmosphere of hydrogen, helium, and methane. Due to Pluto's eccentric orbit, Neptune is actually the farthest planet from the sun for twenty years once every 248 years.

Pluto: We will discuss Pluto although its planetary status is controversial. Pluto is actually a part of the **Kuiper Belt**, a belt of thousands of icy celestial objects which orbit the sun. The Kuiper Belt is believed to be the origin of some comets. For this reason, we will address Pluto as a minor planet. The other eight planets are called major planets. Pluto is the smallest and furthest minor planet from the sun. Pluto is a terrestrial planet with a rocky core and layers of frozen water, methane, nitrogen, and carbon monoxide. When Pluto nears the sun, some of the frozen material thaws, and a thin atmosphere forms which refreezes later.

Table 2: Comparative data for major planets in our solar system.

Planet (Major or Minor)	Distance from Sun	Circumference at Equator	Tilt of Axis (degrees)	Length of Day (hours)	Length of Year (Earth days)	Average Temperature or Minimum/ Maximum	Number of Known Moons	If you weigh 100 lbs on Earth, you would weigh...(lbs)
Mercury	57, 909, 175 km (35,983,095 mi)	15,329 km (9,525.1 mi)	0	1407.5	87.97	-173/427 °C (-279/801 °F)	0	38
Venus	108,208,930 km (67,237,910 mi)	38,025 km (23,627 mi)	177.3	5832 retrograde	224.7	462 °C (864 °F)	0	91
Earth	149, 597, 890 km (92,955,820 mi)	40,075 km (24, 901 mi)	23.45	23.934	365.24	-88/58 °C (-126/136 °F)	1	100
Mars	227,936,640 km (141,633,260 mi)	21,344 km (13,263 mi)	25.19	24.62	686.93	-87/-5 °C (-125/23 °F)	2	38
Jupiter	778, 412,020 km (483,682,810 mi)	449,197 km (279,118 mi)	3.12	9.925	4330.6	-148 °C (-234 °F)	63	214
Saturn	1,426,725,400 km (885,904,700 mi)	378,675 km (235,298 mi)	26.73	10.656	10755.7	-178 °C (-288 °F)	46	74
Uranus	2,870,972,200 km (1,783,939,400 mi)	160,592 km (99,787 mi)	97.86	17.24 retrograde	30,687.2	-216 °C (-357 °F)	27	86
Neptune	4,498,252,900 km (2,795,084,800 mi)	155,597 km (96,683 mi)	29.58	16.11	60,190	-214 °C (-353 °F)	13	110
Pluto	5,906,380,000 km (3,670,050,000 mi)	7,232 km (4,494 mi)	119.61	153.3	90,553	-233°C (-387 °F)	1	8