**Name\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_Teacher Notes – Chapter 28 - Planets and Moons**

|  |  |  |  |
| --- | --- | --- | --- |
| Average Distance from sun | ~36,000,000 | Surface temperature range | Low = - 279°F  High = 801°F |
| Rotation period (1 Day) | 58.65 Days | Diameter  (Earth = 1) | 0.38 |
| Orbital period 1 Year) | 88 Days | Mass (Earth = 1) | = .06 |
| Moons | zero | Density (E=1) | 0.98 |

**Lesson 1 – Inner Planets (Must Know Mercury)**

Closest to the sun, has no moons.

Diameter of 3,031 mi across makes the smallest planet – slightly larger than our moon.

Mercury’s surface is heavily cratered.

Orbit is highly eccentric – nowhere near a perfect circle.

Extremely thin atmosphere means it is virtually airless.

Mercury's core occupies a large fraction of the planet, about 75% of the planetary radius – compared to Earth 30%

Just like our Moon, Mercury has lost much of its internal heat and is no longer geologically active.

The surface of Mercury is shrinking faster than previously thought, photos from a NASA spacecraft MESSENGER shows that planet's crust has contracted as it cooled by as much as 4.4 miles.

**Mercury Sights**

Including the “Spider Crater” – 960 miles across

**Very Hot Venus**

|  |  |  |  |
| --- | --- | --- | --- |
| Average Distance from sun | ~67,000,000 | Surface temperature range | 864°F |
| Rotation period  (1 Earth Day) | 243 (retro) | Diameter  (Earth = 1) | 0.95 |
| Orbital period (1 Earth Year) | 224.7 | Mass (Earth = 1) | = 0.82 |
| Moons | zero | Density(Earth = 1) | 0.95 |

Venus second from the Sun and has no moons.

It diameter of 7,521 mi makes it a close sister to Earth (by 405 mi)

Hottest planet in the solar system average temperature of 862°F – hot enough to melt lead.

Although Venus is not the planet closest to the sun, its dense atmosphere traps heat in a runaway version of the greenhouse effect that warms Earth

Venus is a dry volcanic wasteland with no magnetic field and an atmosphere of carbon dioxide that is 100x denser then Earth.

Interesting fact: only about 1,000 craters & none over 500 MYO – suggest that resurfacing may have been a volcanic global cataclysm.

**Venus Sights**

100 volcanoes are visible on Venus - Maat Mons – is largest ~ 5.3 miles high close to Mauna Kea (Hawaii)

Venus also has a southern vortex (hurricane)

**Marvelous Mars**

|  |  |  |  |
| --- | --- | --- | --- |
| Average Distance from sun | ~141,600,000 | Surface temperature range | Low = -125°F High = 23°F |
| Rotation period  (1 Earth Day) | 24.6 (hours) | Diameter  (Earth = 1) | 0.53 |
| Orbital period (1 Earth Year) | 687 Earth days | Mass (Earth = 1) | = 0.11 |
| Moons | two | Density(Earth 5.5) | 0.71 |

Fourth from the sun – diameter of 4,222 mi. (Earth is 7,926)

Its thin atmosphere (1/150 of Earth) is 95% carbon dioxide.

The pressure and temperature of Mars’s atmosphere are too low (boil away) for water to exist as a liquid on Mars’s surface.

Silica found indicates that water was once present and ice has been clearly spotted on the Martian floor.

The ice cap on the North Pole is winter only while the south cap is permanent by degrading over time.

Mars’ ice caps are composed of frozen ice water coated by frozen carbon dioxide (“dry ice”).

Apparently Mars had a magnetic field but it shut down quickly.

There are no signs of plate boundaries and the large size of volcanoes is evidence the crust does not move.

**Life on Mars**

Methane (CH4) has been detected in the atmosphere, yet Methane has short life span (0.6 to 4 years), indicating that there is an active source.

To date the source is unknown but suspects include volcanic activity, serpentinization of olivine (rocks) or presence of life (microbial) forms.

**Mars Sights**

Valles Marineris – the Grand Canyon of Mars / Towering Volcanoes like Olympus Mons

**Lesson 2- What is a Gas Planet?**

The gas planets are not just balls of gas.

These planets have no distinction between liquid and gas because the substance has reached its supercritical fluid state.

Fluid planet is a more accurate term but there would be no splash, no surface.

**Just Learn about Jupiter**

|  |  |  |  |
| --- | --- | --- | --- |
| Average Distance from sun | ~483,700,000 | Effective temperature range | -234°F |
| Rotation period  (1 Earth Day) | 9.925 (hours) | Diameter  (Earth = 1) | 11.21 |
| Orbital period (1 Earth) | 11.86 | Mass (Earth = 1) | = 317.8 |
| Moons | Sixty-three | Density(Earth 5.5) | 0.24 |

Fifth & largest planet from the sun, (diameter of 88,846 mi -Earth 7,926 mi), with 63 known moons.

Big enough to contain 1,400 Earths, and 11 times Earth’s diameter.

Its atmosphere is made of a mixture of hydrogen and helium gas.

Descending through the clouds would put you into an interior of mostly liquid hydrogen.

Under very high pressure, liquid hydrogen become liquid metallic hydrogen.

**Magnetosphere**

The liquid metallic hydrogen and rapid spin of Jupiter creates the strongest magnetosphere in the solar system (100x then Earth) - larger than the sun and extends past Saturn.

A magnetosphere is formed when a stream of charged particles, such as the solar wind, interacts with and is deflected by the magnetic field of a planet.

**Storms on Jupiter**

Powerful winds blow up to 330 mph and thunderstorms are present on the top 100 miles of gas.

Unlike Earth, Jupiter’s storms are powered within because Jupiter gives off more heat then it receives.

Huge oval spots, white, red and brown break up the symmetry of Jupiter’s bands –most storms come and go.

**Jupiter Sights**

Aurora’s at the poles

Storms that come and go – except the Great Red Spot.

**Stupefying Saturn**

|  |  |  |  |
| --- | --- | --- | --- |
| Average Distance from sun | ~885,900,000 | Effective temperature range | -288°F |
| Rotation period (1 Earth Day) | 10.6 (hours) | Diameter (Earth = 7,908) | 9.45 |
| Orbital period (1 Earth Year) | 29.4 | Mass (Earth = 1) | = 95.2 |
| Moons | Sixty-one | Density(Earth 5.5) | = 0.13 |

Sixth planet from the sun and the least dense planet in the solar system – It could float on water.

Second largest – diameter 74, 900 mi (Earth 7,926).

Saturn is the most oblate of the planets, and this evidence that it’s interior is mostly liquid with a small core.

**Saturn Atmosphere**

A lower internal pressure means less metallic hydrogen and a magnetic field that is 20 times weaker then Jupiter.

Like Jupiter no solid surface and high winds blow throughout the atmosphere at 1,000 mph.

At each pole, winds spiral downward into a vortex.

Like Jupiter, Saturn has bands of colored clouds that run parallel to its equator.

**Saturn Rings**

The rings are made up of: 99.9 % water ice, trace amounts of silicate materials – they are shiny unlike the dusty, dark rings of Uranus and Neptune.

**Saturn Sights**

Rings Storms found within the clouds Clouds that change color

**Understanding Uranus**

|  |  |  |  |
| --- | --- | --- | --- |
| Average Distance from sun | ~1,783,900,000 | Effective temperature range | -357°F |
| Rotation period  (1 Earth Day) | 17.24 (hours) | Diameter  (Earth = 1) | 4.01 |
| Orbital period (1 Earth Year) | 84.02 | Mass (Earth = 1) | = 14.5 |
| Moons | Twenty-seven | Density (Earth= 1) | = 0.23 |

The true oddball of the family is the seventh planet from the sun originally named (King George III)

Third-largest planet in the solar system

Uranus’ tilt is a weird 98° compared to the sun’s orbital plane.

It has the coldest temperatures of any planet in the solar system (including Neptune and Pluto that orbit farther away from the sun), with lows reaching minus 435°F

Uranus is radiating about the same energy it receives from the sun, which may account for its limited atmospheric activity, which appears featureless.

**Uranus Atmosphere**

Its atmosphere is hydrogen and helium but with less internal pressure, models suggest that it does not have a liquid metallic ocean – we’re not sure it even has a core.

It magnetosphere is tilted about 60° from the planets rotational axis.

It magnetic axis is also offset by about 1/3 off the planets radius.

The magnetic field is unusual not only because of its tilt and offset but also because of the relatively large size of its small-scale components - This suggests that the field is generated at shallow depths within the planet from the water, methane and ammonia present and not the core.

**Nuances of Neptune**

Almost discovered by Galileo, the orbit of Uranus suggested another planet existed and in 1846 Neptune was discovered.

Neptune is the densest of the gas planets, it has 18% more mass than Uranus and also nearly the same size 30,776 mi (Earth 7,908).

Because of its 29.6° tilt it has 41 year seasons.

Models predict a small core of heavy elements lies within slushy mantle of water, ices, and rocky materials below a hydrogen rich atmosphere.

|  |  |  |  |
| --- | --- | --- | --- |
| Average Distance from sun | ~2,795,000,000 | Effective temperature range | -353°F |
| Rotation period (1 Earth Day) | 16.11 (hours) | Diameter (Earth = 1) | 3.88 |
| Orbital period | 164.80 | Mass (Earth = 1) | = 17.15 |
| Moons | Fourteen | Density (Earth=1) | = 0.30 |

Its blue tint is caused by methane which by composition is 1 ½ more times more methane than Uranus but still does not explain the deep blue color.

Its atmosphere is intensely turbulent with wind speeds reaching 1200 mph, roughly 2x the speed of sound – odd because winds are typically powered by changes in heat and pressure but Neptune is too far from the Sun.

Neptune radiates more heat then it receives from the sun.

Neptune also has enormous storms that appear and vanish frequently including the Great Dark Spot.

Unlike the Great Red Spot on Jupiter, the Great Dark Spot proves that huge storms exist on Neptune but are much shorter in nature.

Voyager 2 solved the mystery, Neptune has rings but they are clumpy.

**Neptune’s Magnetic Field**

Like Uranus its magnetic field is also off – kilter at a 47° relative to its axis which is at 29.6°.

This leads scientists to speculate that the generating process is occurring in the upper layers of the planet and not in its core.

**Lesson 3 – Jupiter’s Moons**

From inside out the main moons of Jupiter are Io, Europa, Ganymede and Callisto. Discovered by Galileo in 1610.

**Moon # 1 - Io**

Io, the innermost, is volcanically the most active object in the solar system.

Heat for the volcanoes is generated by the tug-of-war among Jupiter and neighboring moons, Europa and Ganymede.

Io’s is slightly larger than our moon with a diameter 2,250 mi. (2,159) and its surface is pizza like with white, red, yellow and brown deposits.

The erupting moon even has an atmosphere, albeit very thin.

Io’s atmosphere consist of a very thin layer of sulfur dioxide gas from its volcanoes.

But with no magnetic field Io is uninhabitable -- in case you were wondering.

**Moon #2 - Europa**

Europa is slightly smaller than our moon in diameter 1,938 mi. (2,159 moon) and based on the spectrometer it has a rocky interior with an iron core.

It is white in color with water ice at its surface, which appears to be fractured and grooved.

**Water on Europa**

Between the rock and ice may lie an ocean of salty liquid water 62 miles deep – bigger than our own planet.

Europa is one of the smoothest objects in the Solar System when considering the lack of large scale features such as mountains or craters.

The apparent youth and smoothness of the surface only adds fuel to speculation that water is under the surface of ice.

**What is the Red stuff?**

Spectrographic evidence suggests that the dark, reddish streaks and features on Europa's surface may be rich in salts such as magnesium sulfate, deposited by evaporating water that emerged from within.

Its atmosphere is very, very thin and composed solely of oxygen.

**Moon #3 - Ganymede**

The third satellite to Jupiter, is the largest moon in the solar system.

Its diameter of 3,271 mi. (2,159 moon) making it larger than Mercury and three-quarters the size of Mars.

If Ganymede orbited the sun it would easily be classified as a planet.

Ganymede is relatively brownish in color with ice, and impact craters covering its molted surface.

Ganymede's surface is a mixture of two types of terrain – old (40%) and new (60%).

The cause of the light terrain's disrupted geology is not fully known, but was likely the result of tectonic activity brought about by tidal heating.

With this heat mixed with the ice found at the surface Ganymede may even have some liquid water sloshing about its ice.

**Moon #3 – Ganymede Surface**

Based on the Galileo data Ganymede is believed to have a differentiated structure much like a planet:

1) A small molten iron or iron/sulfur core 2) Surrounded by a rocky silicate mantle 3) A rocky crust with an ice layer on top.

**Moon #3 – Ganymede Atmosphere**

Ganymede has a thin oxygen atmosphere – too thin to support life.

Ganymede is the only moon in the Solar System known to possess a magnetosphere (weak 1% like Earth’s), likely created through convection within the liquid iron core.

**Moon #4 – Callisto**

Callisto is the outermost moon of Jupiter and also the third largest moon in the solar system.

Unlike Ganymede, this brownish grey moon shows no signs of plate tectonics or the heat needed to resurface – it is often referred to as Jupiter’s Dead Moon.

Its heavily crated surface appears to have been untouched since its birth, unusual for a moon this size (2,976 mi diameter, moon is 2,159)

Callisto is surrounded by an extremely thin atmosphere.

Galileo spacecraft revealed that Callisto may possibly have ice but it would be at depths greater than 62 miles and most likely be mixed with rock.

Callisto’s low density can only be explained by a composition of roughly equal parts ice and rock (a mean snowball), with no metallic core like Ganymede’s.

**Lesson 4 – Saturn’s Moons -Titan**

This moon to Saturn is far from the Sun making it intensely cold (avg.-290°F).

The second largest moon in the solar system 3,193 mi. in diameter it is larger than Mercury (3030, Moon is 2,159, Ganymede 3,271)

**Titan Atmosphere**

Yellowish brown, it far more Earthlike because it has a thick atmosphere.

Titan’s atmosphere reaches 370 miles into space and dense enough that air pressure is 1 ½ times that found on Earth.

Its atmosphere consist of 95% nitrogen and 5% methane.

**Titan’s Lakes**

Big methane raindrops occasionally drift down from the atmosphere to collect into lakes and ponds (methane is liquid @-117°F).

This moon is the only other place in the solar system to have liquid on it but these lakes of liquid ethane and methane are predominantly found in the northern hemisphere.

**Titan’s Sand Dunes**

Dune fields are the second most dominant landform on Titan.

Confined to its equatorial region, scientists think the sand on Titan is not made of silicates as on Earth, but of solid hydrocarbons, precipitated out of the atmosphere (It rains sand).

**Titan’s Volcanoes**

Titan does have volcanic activity - difficult to see because of its atmosphere - Titan’s volcanoes are cryovolcanoes, made from water and ammonia

Ammonia (like salt) would allow water to melt at a lower temperature.

**Enceladus – Moon of Saturn**

The small white (6th largest) Saturian moon measures only 318 mi wide, and bitterly cold (-330°F).

The moon’s icy surface reflects almost 100% of the sunlight – responsible for Saturn’s E-Ring.

**Activity on Enceladus**

Both Voyagers revealed a world scarred by ice ridges.

In 2005, the Cassini confirmed water-rich plumes, later defined as a “water and vapor curtain eruption”.

This discovery, along with the presence of escaping internal heat and very few impact craters in the South Polar Region leaves no doubt that Enceladus is geologically active.

These outbursts originate from four "tiger stripes" — fractures on Enceladus' South Pole.

These explosions are fed by a network of cracks that may carry water up from a giant subsurface ocean.

Cassini flying within 15 miles of its surface finds – all the ingredients needed for life.

With its ocean of water and organics present this would be the least complicated spot to go to if scientist want to learn if biological life can exist in elsewhere - Samples would only need to be captured and brought back – no landing is necessary.

**Miranda – Moon to Uranus**

Miranda is grey and like Frankenstein’s monster, it looks like it was pieced together from parts that didn't quite merge properly.

It is only one-seventh as large as Earth's moon (310 miles wide).

The unusual surface of both new and old has huge canyons; 12 times deeper as the Grand Canyon.

**Triton - Moon of Neptune**

Triton is a brown moon and is about ¾ the size of our moon.

It orbits in a retrograde motion and its path is tilted at 157° to its orbital plane.

**Triton’s Surface**

A scarred surface, with cracks, plains, and “cantaloupe” terrain shows signs of past and current activity.

Triton’s Geysers

Voyager 2 picked up great jets of nitrogen from its polar cap.

These frigid geysers may be vented through fissures in Triton’s crust by some sort of pressures below the surface.

**Triton’s Fate**

Tidal interactions between Neptune and the retrograde motion of Triton are causing the moon to gradually spin into Neptune.

It estimated in about 100 million years, Triton will begin to be torn apart and become rings that even surpass Saturn’s.