8th Grade Unit 3: The Solar System

*lesson 1: How have people modeled the solar system?*

*vocab: heliocentric, geocentric, parallax*

solar system- a star/sun and all the bodies that orbit around it in space

there have been 2 main models for the solar system over time

* our current model is the heliocentric model (or sun centered solar system)
* earliest models were geocentric models (or Earth centered solar system)

Aristotle

* ancient Greek philosopher in the 4th century BCE
* put the moon, sun, planets and stars on a series of plains or levels
* said that the positions of the stars should change if the Earth moved around the Sun
* parallax- the apparent shift in position of an object when viewed from different locations
* but the stars are so far away that parallax can’t be seen with the naked eye

Aristarchus

* ancient Greek astronomer and mathematician 3rd century BCE
* said to have been the first to propose the heliocentric model
* attempted to measure the relative distances of the Sun and Moon
* his ratio was too small but an import step in the use of geometry and observation

to solve scientific problems

Ptolemy

* ancient Egyptian (Alexandria) mathematician, astronomer, and geographer 2nd century CE (AD)
* wrote one of the few books that have survived time, *Almagest*
* used careful observations of the planets to make a geocentric model that was used

for the next 1,400 years

* said all bodies in space move at a constant speed, planets moved in perfect circles and

travel in a wheel on wheel system

* allowed accurate predictions about future motion of planets

Copernicus

* Nicolaus Copernicus polish astronomer in 15&16 centuries AD (CE)
* simplified the Ptolemy model, removed the wheel on wheel
* created the first heliocentric model based on naked eye observations
* still said planets traveled in perfect circles
* fit the observations/data much better than the Ptolemy model

Kepler

* Johannes Kepler German mathematician and astronomer 16&17 CE (AD)
* 3 laws of planetary motion
	+ 1st law- law of ellipses; planets travel in an ellipse
	+ 2nd law- talked about planet’s speed; closer to sun=faster
	+ 3rd law- talked about the distance from sun and time to orbit it

Galileo

* 16th and 17th century Italian astronomer
* used to scientific method to approach questions
* improved the telescope significantly
* observed the large moons of Jupiter
* proved that Earth wasn’t the only planet that could be orbited
* added support to the heliocentric model
* phases of Venus; just like phases of the moon

*lesson 2: Why is gravity important in the solar system?*

*vocab: gravity, orbit, aphelion, perihelion, centripetal force, solar nebula, planetesimals*

Gravity- a force of attraction between objects that is due to their masses

* every object in the universe pulls on every other object
* greater mass = greater gravitational force
* objects w/ less mass get attracted/pulled towards objects w/ greater mass
* closer the distance between the objects the greater the force
* gravity is the weakest force in nature (ex. magnet can pull a paper clip up against gravity)
* it allows for formation of planets, stars, and galaxies creation
* orbit- the path a body in space takes as it is pulled around another by gravity

Kepler’s Laws

* 1st Law said that planets move in ellipses
	+ an oval with 2 focal points
	+ the sun at one focus
	+ perihelion- the point in the orbit when the planet is closest to the sun
	+ aphelion- the point in the orbit when the planet is farthest from the sun
* 2nd said as a planet moves in its orbit it sweeps equal areas in equal time; or a planet travels

faster when closer to the sun and slower when farther away

* 3rd said there is a relationship between the time it takes to orbit the Sun and the size

of the orbit (a math formula)

* bigger the orbit the slower the planet

Law of Universal Gravitation

* created by Isaac Newton inspired/using Kepler’s laws
* mathematical description of gravity
* before gravity could be measured with technology (1600’S)
* says that all objects in the universe attract each other through

gravitational force; gravity depends on mass and distance

* ex.

Gravity and planetary motion:

* when swinging a ball on a string around your head there is an inward force

that pulls the ball in the circular path called centripetal force

* think of gravity as the string holding the planets in place

Solar system formation:

* formed 4.6 billion years ago (b.y.a)
* first formed was the Sun from a solar nebula (cloud of gas and dust that will form a star)
* a force from outside to nebula started it to move together with gravity
* the sun formed from a protostellar disk (rotating disk of dense gas and dust)
	+ heated up by friction the core of the sun became 15 million degrees Celsius
	+ temp. started the process of fusion
* left-over material from the protostellar disk form planetesimals (large body in space that could

become a planet)

* heat from fusion melted the dust which stuck together to form pebbles that

stuck together to form bigger and bigger things

* planetesimals orbit the sun in a protoplanetary disk where the planets form
	+ due to density and gravity the heavier materials closer to the sun creating

 terrestrial planets (Mercury, Venus, Earth, Mars)

* least dense materials are left on the outside creating the gas giants

 (Jupiter, Saturn, Uranus, Neptune)

*Iesson 3: What are the properties of the Sun?*

*vocab: nuclear fusion, sunspot, solar flare, prominence*

Sun Statistics

|  |  |
| --- | --- |
| avg. dist. from Earth | 149.6 million km (1 astronomical unit) |
| diameter | 1,390,000 km |
| avg. density | 1.41 g/㎤ (water is 1 g/㎤) |
| rotation period | 25 days (equator), 35 days (poles) |
| avg. surface temp. | 5,527 ℃ |
| core temp. | 15,000,000 ℃ |
| composition | 74% hydrogen, 25% helium, 1% other |

* every second 4 million tons of solar matter is turned into energy
* given off as heat and light (41% visible light, 9%UV , 50% infrared)
* made of charged gas called plasma (same stuff as lightning)

(diagram of sun’s layers)

core- very dense center of the sun; 15,000,000 ℃; hot enough to power nuclear fusion of hydrogen

radiative zone- layer of the sun where light created by fusion leaves the core

convection zone- where energy travels to the surface through convection (hot rises, cold falls)

photosphere- basically the surface, where energy escapes into space; avg. temp. 5,527 ℃

chromosphere- atmospheric layer; temp. increases as altitude rises to approx. 6,000℃

corona- outer layer of atmosphere; temp. 2,000,000 ℃

Nuclear fusion- the process by which 2+ low mass atoms fuse to form a higher mass atom (happens

in the nucleus)

* E=MC² formula created by Einstein to show that energy and mass are interchangeable
* E=energy; m=mass; c=speed of light
* explained the huge amount of energy made by the sun
* proton=positive charge; electron=negative charge; neutron=neutral/no charge

(diagram of hydrogen fusion)

There are approx. 10³⁸ collisions between hydrogen nuclei in the core every second.

Heat moves within the sun by:

* radiation- heat transfer by electromagnetic waves (light)
	+ from the Sun to Earth in space and from the core through the radiative zone
	+ particles in the r.z. are to dense for the energy to travel through other means
	+ convection- heat transfer by the movement of matter (gas or liquid)
		- hot matter rises b/c it’s less dense; cool matter sinks b/c it’s more dense
		- movement of matter creates convection currents (cycling of matter due to temp.

and density changes)

* occurs in the convection zone

Sun’s rotation

* rotation- a body spinning on an axis (think basketball on a finger)
* rotates in a special way called differential rotation (different latitudes rotate at different speeds)
* faster at the equator slower at the poles
* the core and radiative zone rotate together (think like Earth)

Solar activity

* sunspots- a dark area that forms on the surface of the sun
	+ 1500 C cooler than the surrounding area
	+ gas convecting below the spot is blocked from the surface
	+ some just a few km to several times the size of Earth
	+ last hours to months
	+ happen in 11 year cycles (new cycle starts when the minimum # is reached again)
	+ solar flare- an explosive release of energy that can extend out of the Sun’s atmosphere
		- blasts energy particles into space at the speed of light
		- energy is released in the whole em spectrum
		- prominence- large loops of relatively cool gas that extend several thousand km into the

Sun’s atmosphere

* can fit several Earth’s under on
* can last hours to months

*lesson 4: What is known about the terrestrial planets?*

*lesson 5: What is know about the gas giants?*

*lesson 6: What else is in our solar system?*

*The final lesson notes were the responsibility of the students. The slideshows containing the information are available on the website.*

