

I. Origin and Age of the Universe

- a. The universe

means everything that exists in any place - all the space and energy that exist in any place

- b. It is extremely Vast and its more than 14 billion years old.

- c. The Big Bang

Theory states that all matter and energy started out concentrated in a small area, and after a gigantic explosion, matter began to organize into particles + atoms.

- i. The universe is still expanding today.

- ii. Evidence of the Big Bang Theory

④ 1. There is microwave radiation (background radiation) from the explosion coming from all areas of the universe

2. The apparent red-shift of most of the galaxies

- a. The Doppler Effect is the shifting of wavelengths as an object passes. Blue - has shorter wavelengths and Red - has longer wavelengths and is moving away.

⑦

II. Galaxies

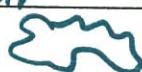
- a. Galaxies are

Collections of billions of stars and various amounts of gas and dust held together by gravity

- b. An average galaxy has over 100 billion stars and there are over 100 billion galaxies.

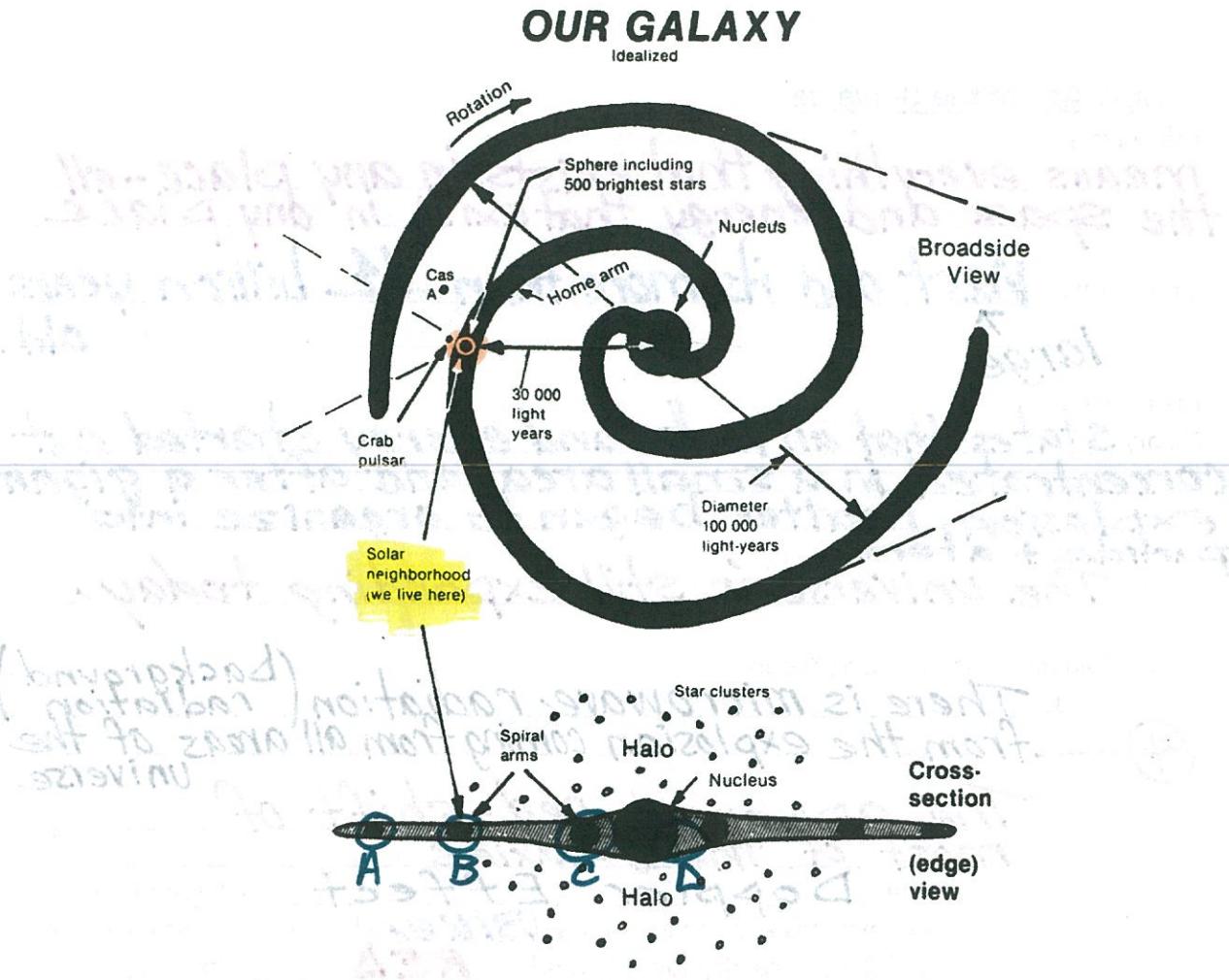
- c. There are three types of galaxies based on shape:

i. Spiral ii. elliptical iii. irregular



- d. Our solar system is part of the Milky Way Galaxy.

- i. It is a Spiral galaxy and we are located in one of the arms.



<http://pics-about-space.com/galaxy-and-planets-sketch?p=1#>

III. Stars

- a. A star is

usually a large ball of gas held together by gravity that produces tremendous amounts of energy and shines

- b. Most of the energy of stars comes from nuclear fusion.

- i. Nuclear fusion is the combining of the nuclei of smaller elements for form the nuclei of larger elements with some of the mass being converted into energy.

① The sun converts Hydrogen into Helium.

ii. The Energy of nuclear fusion is eventually radiated into space as types of electromagnetic energy.

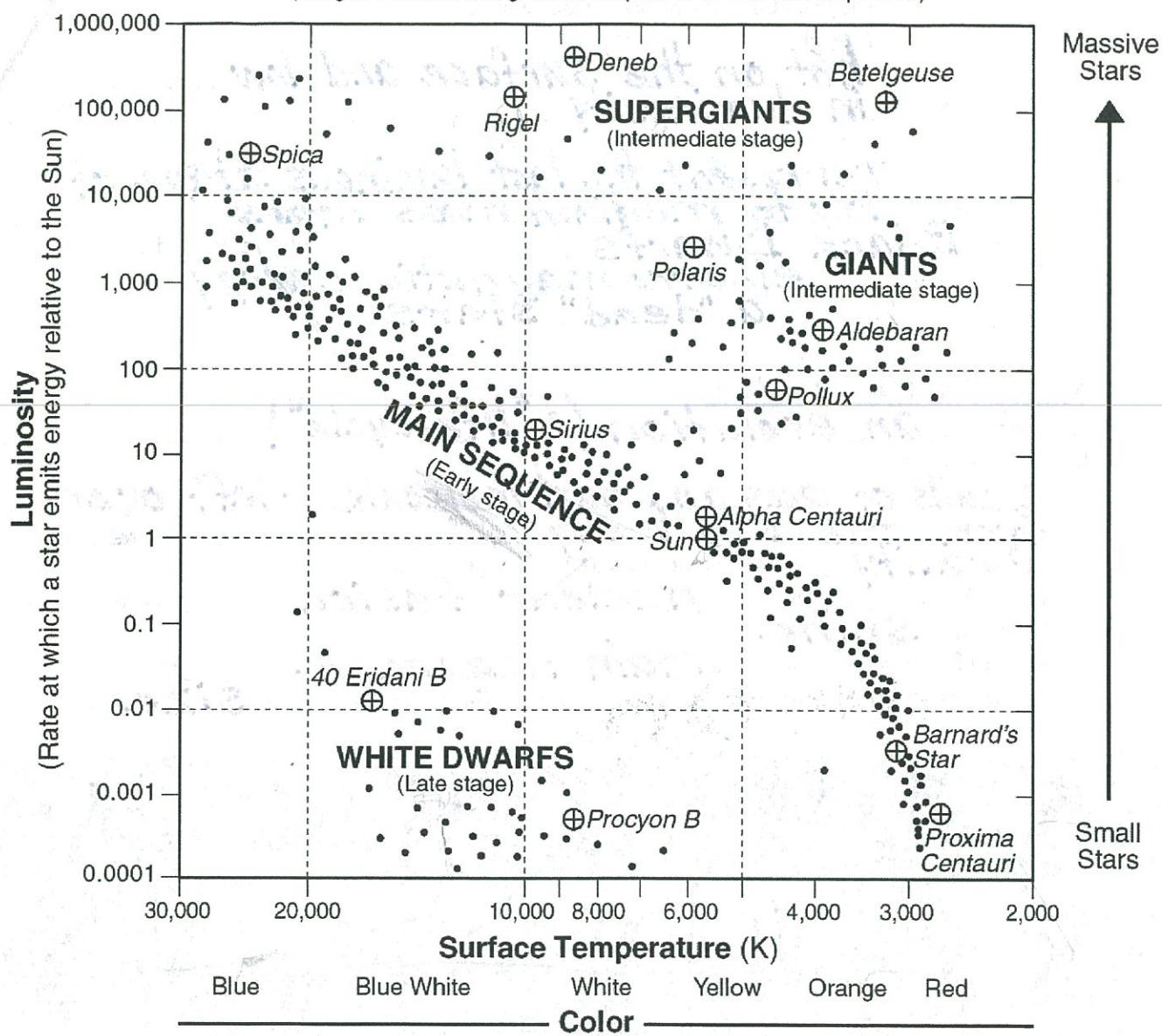
- iii. Luminosity

of a star measures how bright it would be in relation to the sun if all the stars were the same distance from the observer

Characteristics of Stars

(Name in italics refers to star represented by a \oplus .)

(Stages indicate the general sequence of star development.)



c. Star Types

i. Main Sequence are 90% of stars.

1. are average-sized stars
2. As the size increases, the temperature increases.
3. As the size increases, the color changes from red to blue.
4. Our Sun

is a main sequence star of average size + temperature, it's yellow.

ii. Giant Stars

1. red, orange and yellow giant stars are rare. They are commonly seen in the night sky because they are massive.

- Have low temperatures because of their large size.

③

iii. Super Giant

stars are very big stars that are very luminous.

1. They sometimes explode in a tremendous event called a Super Nova.

iv. White Dwarfs

are small, about the size of the Earth.

1. They can be other colors besides white.

2. They are

hot on the surface and low in luminosity

3. They

represent the last luminous stage of low to medium mass stars

v. Black Dwarfs

happen when a white dwarf cools and no longer emits

electromagnetic energy

1. They are

"dead" stars

(4)

IV. Star Origin and Evolution

- a. Stars have an evolution (a "life cycle")

- b. Stars originate from

Clouds of gas and dust molecules - left over from the big bang

- c. Gravity causes the stars to clump together (forming stars).

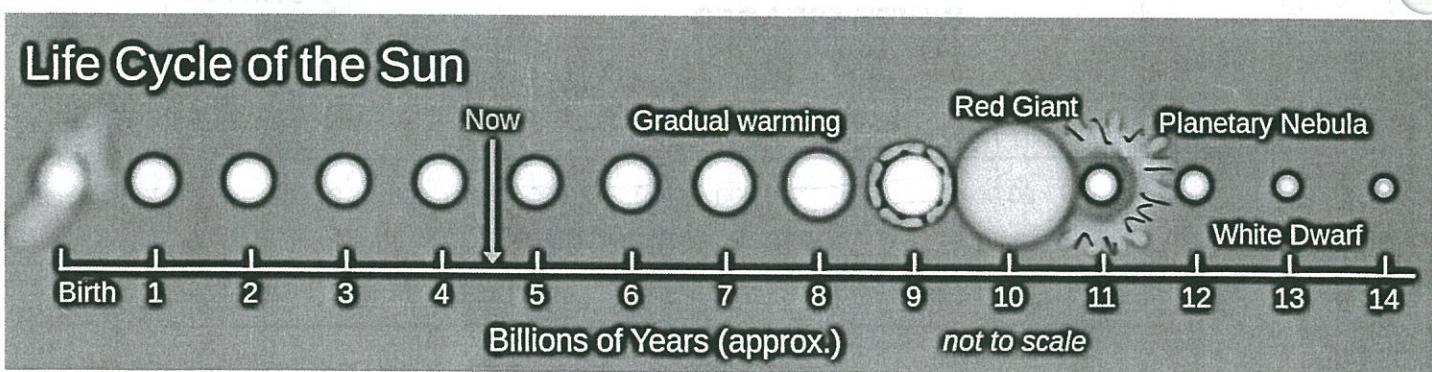
- d. When the mass is high enough, nuclear fusion begins to shine.

- e. Most of the "life" of a star is as a main sequence.

star.

- f. Several things can happen once the star has spent its energy (depending on size)

Life Cycle of the Sun



https://en.wikipedia.org/wiki/Formation_and_evolution_of_the_Solar_System

- i. Stars with masses similar to the Sun's mass

become Red Giants, then White Dwarfs and then Black Dwarfs.

- ii. Stars with masses greater than the Sun's mass

turn into Super giants, then into neutron stars (more dense than a white dwarf.)

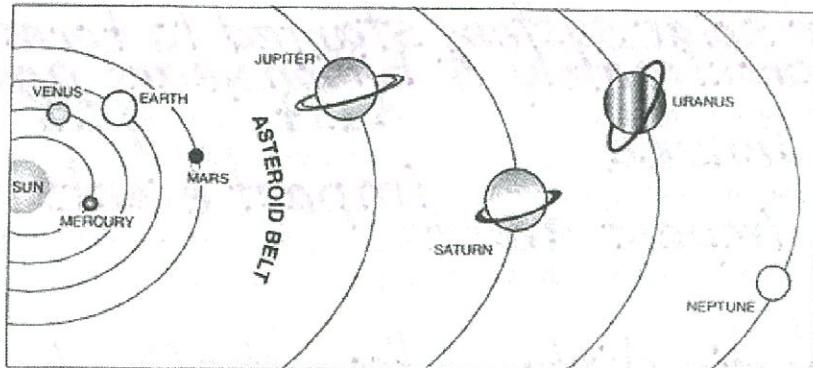
- iii. Stars that are extremely massive

will eventually collapse to form a Black Hole.

1. Black Holes are extreme gravity fields that allow no visible light or any other form of energy to escape

(4)

(4)



Solar system showing inner and outer planets.

- The Solar System is the Sun and all the objects that orbit the Sun under its gravitational influence
- 99 % of the mass in the solar system belongs to the sun
- A satellite is any object that orbits (revolves) around another object.
- There are 8 planets that orbit the Sun.
- An asteroid is a solid, rocky/metallic body that orbits the Sun.
 - Have irregular shapes
 - There is a known asteroid belt between Mars and Jupiter.
 - Are smaller than planets.
- A moon is a body that orbits a planet or an asteroid
 - There are over 177 known moons in our solar system.
http://ssd.jpl.nasa.gov/?sat_discovery
- A comet is often compared to a dirty snowball. They are composed of solids that easily turn into gases.
 - They are made of substances like ice and water.
 - When comets get near the sun, their ice turn to gas.
 - Some solids are released – forming spectacular tails visible in the Earth's sky.
- Meteoroids are very small fragments that orbit the sun.
 - Most are very small.
 - They leave a visual streak in the sky when they enter the atmosphere and are called meteors.
 - If it actually touches the Earth's surface it is then called a meteorite.
 - Some meteorites have sufficient mass to create a depression in the Earth's crust called an impact crater.

i. Evolution of the Solar System

- i. Scientists think that

our solar system started to form approximately 5 billion years ago

- ii. Everything formed from a giant cloud of dust and gas that condensed into a star and several planets.

- iii. Planets and moons have experienced impact events.

- ④ 1. Impact events happen when meteoroids, asteroids and comets crash onto the surfaces of planets and moons.

VI. Planet Characteristics

- a. A planet's distance from the Sun has a major effect on its characteristics.

- b. Inner Planets (terrestrial) are close to the Sun.

- i. Have relatively small diameters.

- ii. Have relatively high densities.

Rocky surfaces and impact craters

- iii. Have few or no moons.

- iv. Similar to Earth

Mercury, Venus, Earth + Mars

- c. Outer Planets (Jovian) are far from the Sun.

- i. Have relatively large diameters.

- ii. Have relatively low densities.

iii. Surface of planets are not solid, core may be solid.

- iv. Have many moons.

- v. Have many rings

vi. Similar to Jupiter

Jupiter, Saturn, Uranus, Neptune

⑦

Solar System Data

Celestial Object	Mean Distance from Sun (million km)	Period of Revolution (d=days) (y=years)	Period of Rotation at Equator	Eccentricity of Orbit	Equatorial Diameter (km)	Mass (Earth = 1)	Density (g/cm³)
SUN	—	—	27 d	—	1,392,000	333,000.00	1.4
MERCURY	57.9	88 d	59 d	0.206	4,879	0.06	5.4
VENUS	108.2	224.7 d	243 d	0.007	12,104	0.82	5.2
EARTH	149.6	365.26 d	23 h 56 min 4 s	0.017	12,756	1.00	5.5
MARS	227.9	687 d	24 h 37 min 23 s	0.093	6,794	0.11	3.9
JUPITER	778.4	11.9 y	9 h 50 min 30 s	0.048	142,984	317.83	1.3
SATURN	1,426.7	29.5 y	10 h 14 min	0.054	120,536	95.16	0.7
URANUS	2,871.0	84.0 y	17 h 14 min	0.047	51,118	14.54	1.3
NEPTUNE	4,498.3	164.8 y	16 h	0.009	49,528	17.15	1.8
EARTH'S MOON	149.6 (0.386 from Earth)	27.3 d	27.3 d	0.055	3,476	0.01	3.3

⑧

VII. Planet Rotation

- Rotation is the spinning on an imaginary axis.
- The Period of Rotation is the amount of time it takes a planet to spin 360° = to "one day".

VIII. Planet Revolution

- Revolution is the movement around the Sun in a path (in the shape of an ellipse).

- An Ellipse is the oval shape of an orbit.

- Within the ellipse are two fixed points called foci.

- The sun is at one focus and

nothing is at the other focus

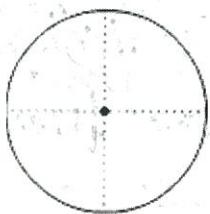
- Eccentricity is the degree of ovalness of an ellipse.

- You can calculate the eccentricity of an ellipse.

- If the eccentricity equals 0, the orbit would be a circle.

- If the eccentricity equals 1, the orbit would be a straight line.

~~straight line~~



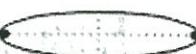
$$e = 0$$



$$e = 0.5$$

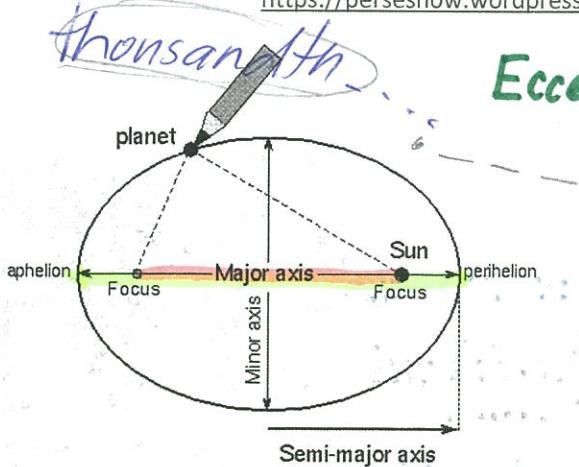


$$e = 0.75$$



$$e = 0.95$$

<https://perseshow.wordpress.com/2014/12/06/14-johannes-kepler-and-planetary-motion/>



Eccentricity = distance between foci / length of major axis

$$= \frac{3.5}{5.0} \text{ cm}$$

$$\frac{3.6}{5.1}$$

$$= .70578$$

$$= .706$$

Drawing an ellipse: loop string around thumb tacks at each focus and stretch string tight with a pencil while moving the pencil around the tacks. The Sun is at one focus.

<http://kaffee.50webs.com/Science/activities/Astro/Activity-Ellipses.Orbits.htm>

- iv. The elliptical shape of planetary orbits causes

the planets to vary in distance from the sun

1. The Earth is closer to the Sun in the

Winter - Jan 4th - Perihelion
147,000,000 km

2. The Earth is farther from the Sun in the

Summer - July 5th - Aphelion
152,000,000 km

3. What causes the seasons?

tilt of the Earth on its axis
revolution of the Earth around the Sun

- d. Why doesn't the Earth fly into the Sun because of the Sun's gravity?

i. Gravity keeps us near the Sun while inertia keeps us from getting too close.

1. Inertia is a concept that

an object in motion will maintain the direction and speed of the motion until an opposing force affects it.

2. Gravity is

the attractive force that exists between any 2 objects in the universe.

- a. The greater the masses of objects, the greater the gravity.

b. The closer the objects are, the greater the gravity.

- e. The Period of Rotation is

the amount of time it takes for a planet to revolve around the Sun

- i. It is equal to "one year" on that planet.

- ii. The closer a planet is to the Sun,

1. The smaller its orbit

2. The smaller the period of revolution

3. The shorter its years are.

IX. Apparent Motions of Celestial Objects

- a. Apparent motion is

the motion that an object appears to make

- b. Celestial objects are

objects in the sky outside the Earth's atmosphere (sun, stars, moon....)

- c. Celestial sphere is

an imaginary sphere encircling the Earth on which all objects of night sky appear

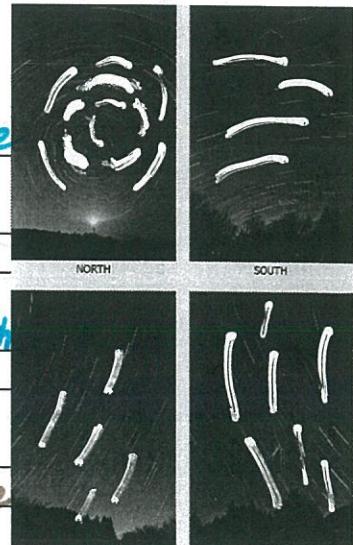
- d. An arc is

a uniformly curved line that is part of a circle, the path of a star through the sky.

- e. Most celestial objects appear to move across the sky.

i. Rising in the east (in general)

ii. Setting in the West



<http://www.kadamsphoto.com/nightphotography/analyzing-star-trails-part-one-shape-of-the-lines/>

- f. All motion appears to move at a constant rate.

i. 360° in one day, 15° in one hour, 1 degree every 4 minutes

- g. Circumpolar stars are

appear to completely move in a circle around Polaris every 24 hours the North Star ↑

- h. Daily motion is

the movements of celestial objects over a 24 hour period.

X. Apparent Motions of the Planets

- a. As seen from the Earth the planets

~~exhibit daily motions similar to that of stars~~
exhibit

- b. Over extended period of time the planets seem to

change direction in the sky.

- c. The motions of the planets are not uniform and are complex

- d. The planets seem to make loops and back and forth motions

XI. Apparent Motions of the Sun

- a. Like all other celestial objects the Sun appears to move across the sky

- b. Its path across the sky is in the shape of an arc

- c. The sun's path changes both in its length and with direction with the seasons.

- d. Within the continental United States,

- i. The sun is highest for our latitude in the sky (72 degrees in altitude) in the summer.

- ii. The sun is lowest for our latitude in the sky (28 degrees in altitude) in the winter.

- iii. the noon sun is never directly overhead.

- e. The sun is always at its highest position in the sky at noon. in the South

- f. Solar noon is

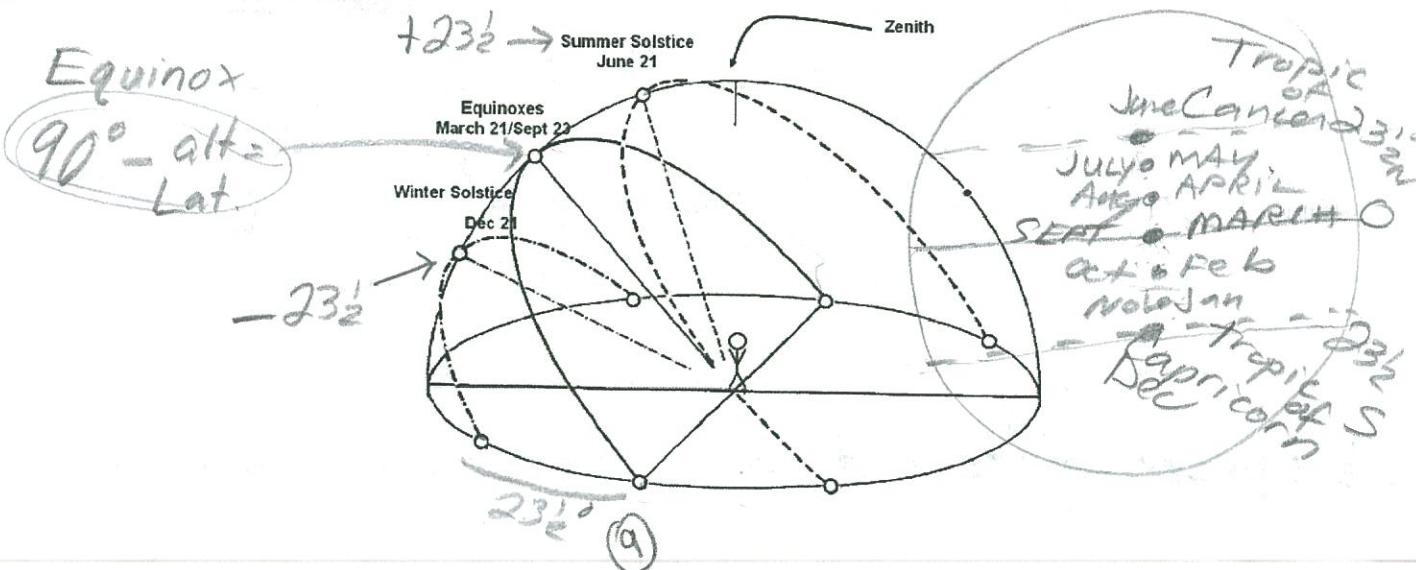
the time at which the Sun reaches its highest point in the sky.

- g. Solar time is

time based on the rotation of Earth

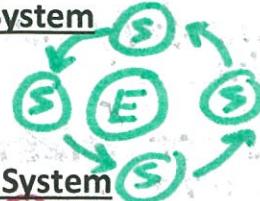
P. 4
ESRT

- h. the noon sun is only directly overhead within the tropics VERTICAL RAY



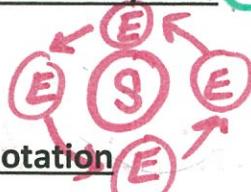
XII. Geocentric Model of the Solar System

Earth Centered
(Incorrect)



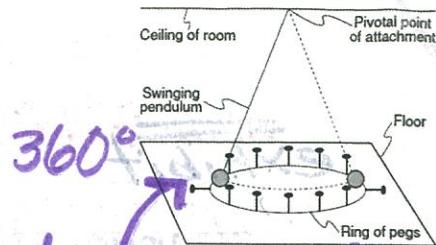
XIII. Heliocentric Model of the Solar System

Sun Centered



XIV. Evidence of the Earth's Rotation

a. The Foucault Pendulum



i. When the pendulum is allowed to swing freely, its path will appear to change in a predictable way.

- This is an evidence of the Earth's rotation because the pendulum (due to inertia) would continue to swing in the original path if the Earth didn't rotate.

b. The Coriolis Effect

N. Hemisphere right i. the tendency of all particles of matter moving at the E's surface, to be deflected

- This deflection occurs because the Earth is rotating and therefore, the Earth's surface is moving with respect to the path of the particles.

S. Hemisphere left.

xv. Evidence of the Earth's Revolution

a. The changing seasons are proof.

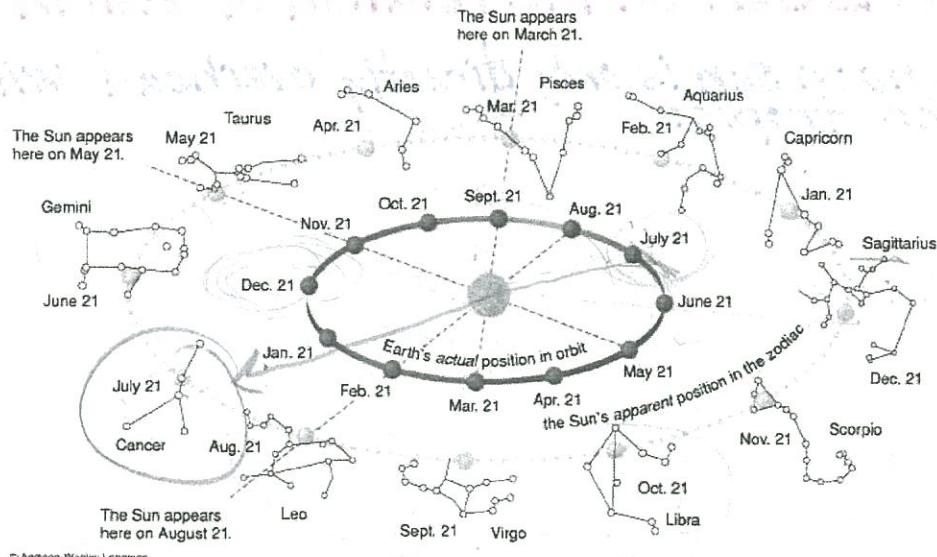
- Because we revolve around the sun, our two poles (N and S) are tipped towards the sun at different times of the year.

b. We observe different constellations throughout the year.

- A constellation is

a group of stars that form a pattern and are used to help people locate celestial objects.

- We can see

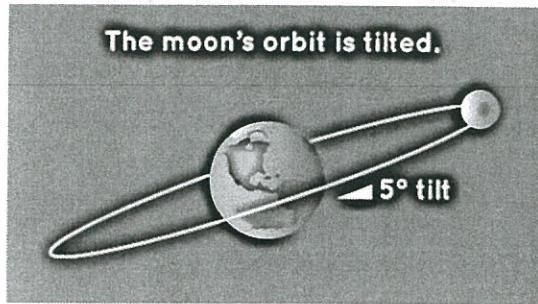


We can see different constellations each season because we are in different parts of the solar system.

- c. The angular diameter of the Sun appears to change throughout the year
- i. Angular diameter is how big the object appears to be.
- d. Small changes in the color of stars
- i. red means we are moving away
- ii. blue means we are moving towards.

XVI. Actual Motions of the Earth's Moon

- a. The revolution of the moon around the Earth (as the Earth revolves around the sun) results in many common observable events.
- b. The moon revolves around the E in an elliptical orbit that is tilted 5°
- c. The moon orbits the Earth (360 degrees) in $27\frac{1}{3}$ days.
- d. The moon returns to its original location in $29\frac{1}{2}$ days. An extra 2 days is needed to catch up to the same spot on the Earth.

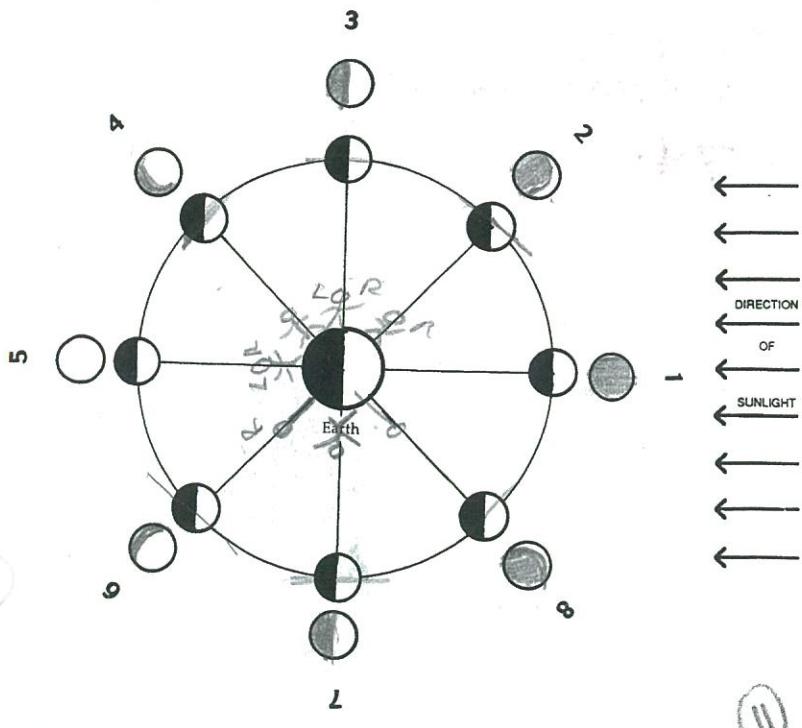


<http://www.space.com/31219-moon-mysterious-tilt-solved.html>

XVII. Phases of the Moon

- a. Half of the Moon is always receiving light from the Sun at any given time. (Except for lunar eclipses.)
- b. Since the moon revolves around the Earth, an observer on Earth sees Varying amounts of this lighted-half.

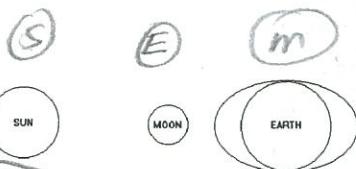
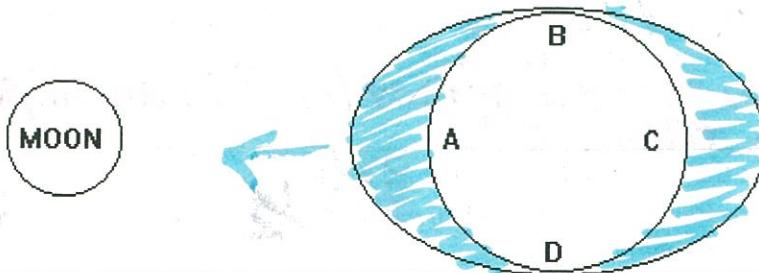
<http://kvmagruder.net/bcp/zodiacal/moon/lab.htm>



1. New Moon
2. Waxing Crescent ($3\frac{3}{4}$)
3. First Quarter ($7\frac{1}{2}$)
4. Waxing Gibbous ($11\frac{1}{4}$)
5. Full Moon ($14\frac{1}{2}$)
6. Waning Gibbous ($18\frac{1}{2}$)
7. Third Quarter ($22\frac{1}{2}$)
8. Waning Crescent (26)
9. New Moon ($29\frac{1}{2}$)

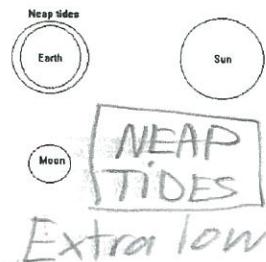
XVIII. Tides

- Tides are the cyclic rise and fall of ocean waters
- They are caused by the gravitational attraction of the moon and the Sun on the E.
- Ideally, there should be 12 hours and 50 minutes between each high tide.



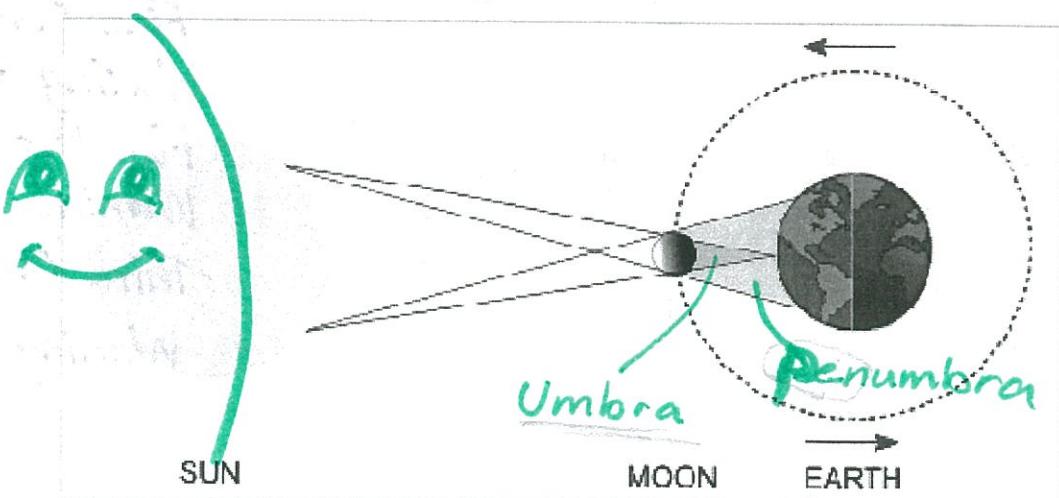
SPRING TIDES - Extra High

<http://www.cmdowns.com/tides-notes.htm>



XIX. Eclipses

- An Eclipse occurs when a celestial object partly or completely comes into the shadow of another celestial object
- A SOLAR Eclipse occurs when the moon's shadow falls on a small part of the Earth and blocks out the sun.
 - Total eclipses are Very rare
 - Once every 200 years for a particular area
 - It only affects a small part of the Earth since the Moon's shadow is so small.
 - A total eclipse only lasts for 7½ minutes.



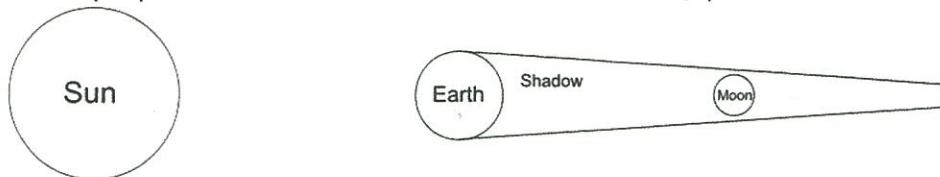
c. A Lunar eclipse is when the Earth's shadow covers the Moon.

i. It is more common to observe

1. It happens 2 times a year.

2. A total lunar eclipse will last for over 100 minutes.

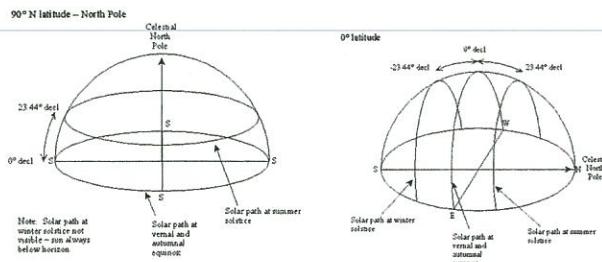
3. All the people on the dark- half of the Earth can see the eclipse.



https://commons.wikimedia.org/wiki/File:Lunar_Eclipse_diagram.svg

XX. Seasons

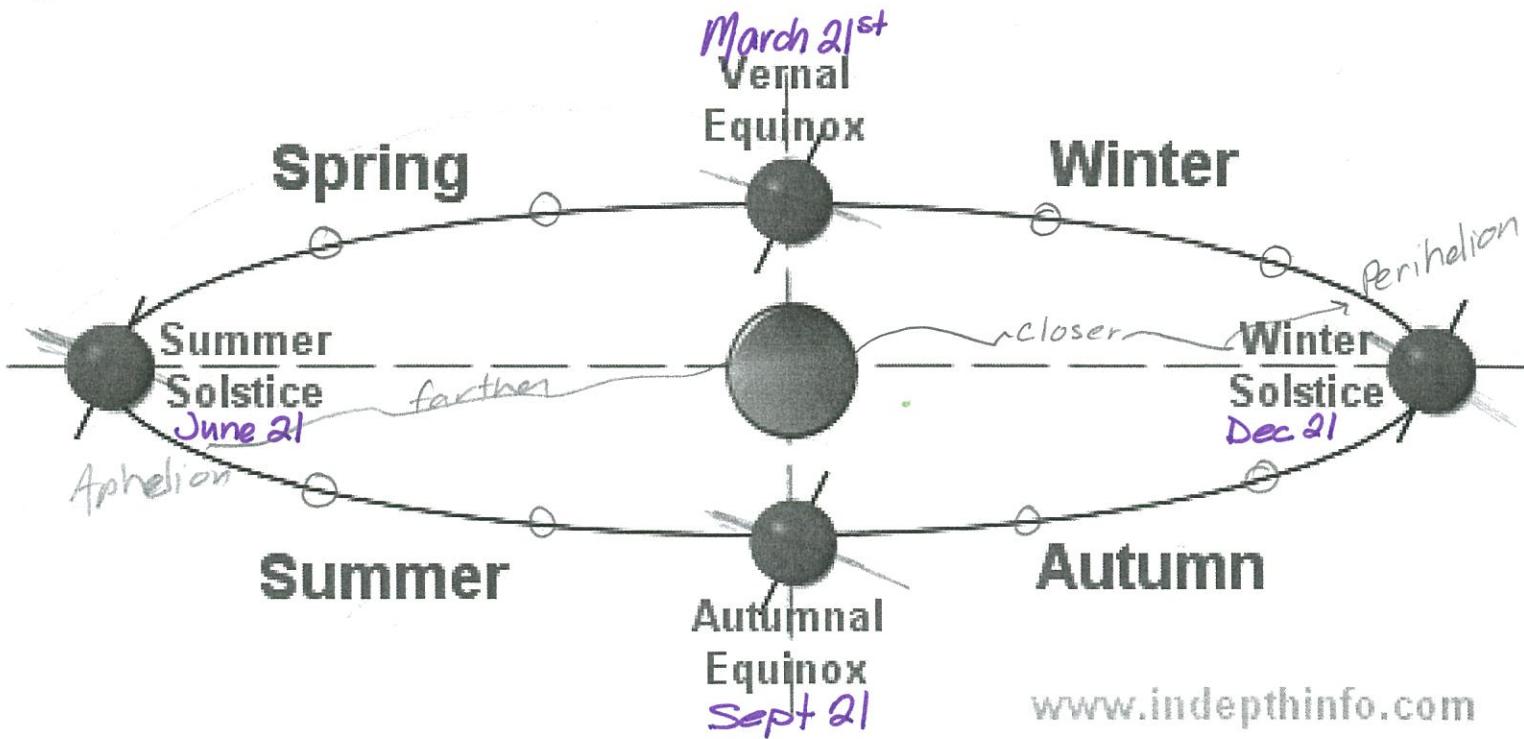
a. The sun's path through the sky changes with the latitude and the season.



b. There are 2 reasons for the seasons

i. The Earth's axis is tilted ($23\frac{1}{2}^\circ$)

ii. The Earth Revolves around the Sun.



2

3

4