Name _____
Date _____
Period _____

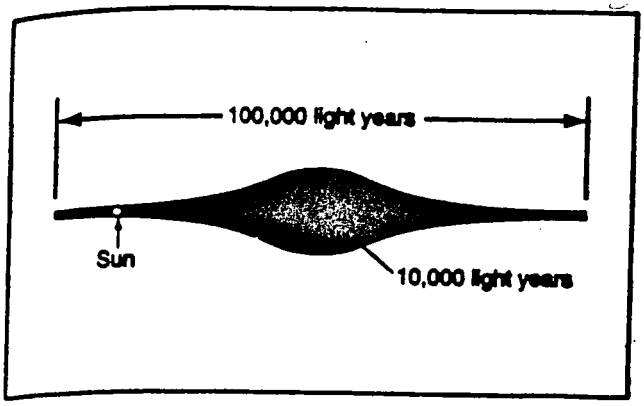
Unit 13 Notepacket
Astronomy
E. Science – Mrs. Weiler

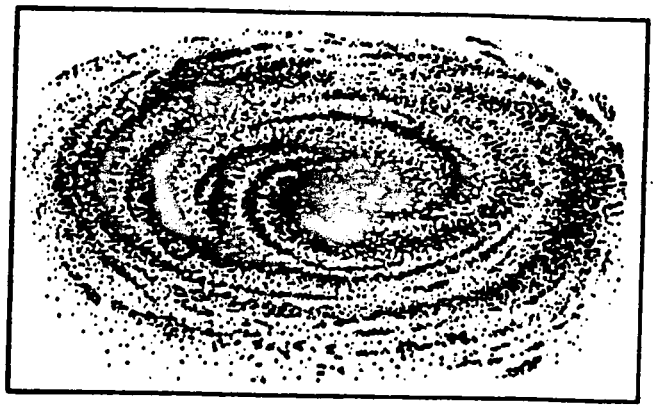
I. Origin and Age of the Universe

- o Universe means everything that exists in any place – all the space, matter, and energy that exists in any place.
- o It is extremely vast and it is more than 10 billion years old.
- o Big Bang Theory - states that all matter and energy started out concentrated in a small area and, after a gigantic explosion, matter began to organized into subatomic particles and atoms. The universe is still expanding today.
    - Evidence of the Big Bang Theory:
        - o There is microwave radiation (background radiation) from the explosion coming from all areas of the universe.
        - o The apparent red - shift of most of the galaxies.
            - The Doppler Effect is the shifting of wavelengths as an objects passes. blue - has a shorter wavelength and the object is coming towards you. red - has a longer wavelength and is moving away.

II. Galaxies

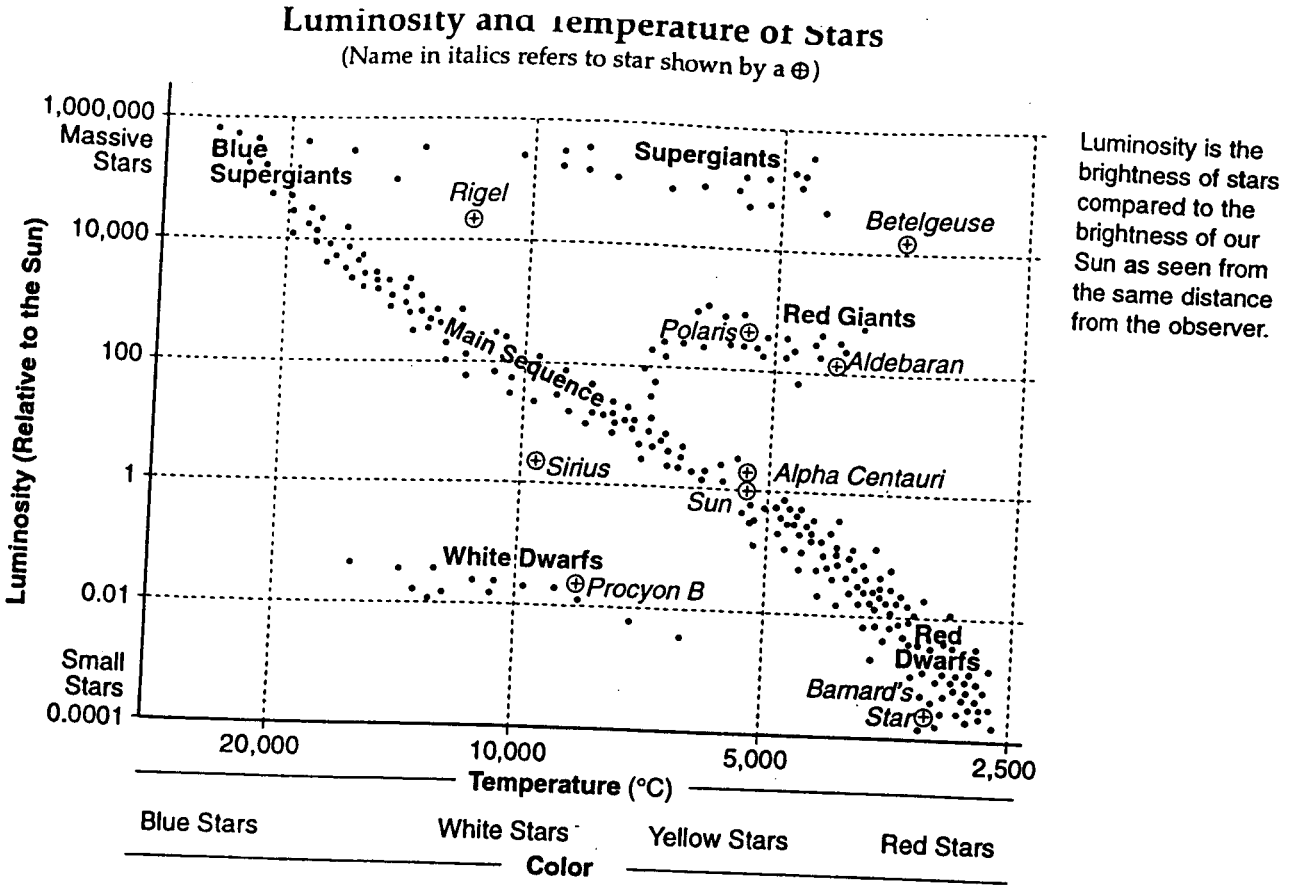
- o galaxies are collections of billions of starts and various amounts of gas and dust held together by gravity.
- o An average galaxy has over 100 billion starts, and there are over 100 billion galaxies.
- o There are three types of galaxies based on shape:
- o Our solar system is part of the Milky Way Galaxy
    - We are part of a spiral galaxy and are located in one of the arms.





III Stars

- A Star is usually a large ball of gas held together by gravity that produces tremendous amounts of energy and shines.
- Most of the energy of stars comes from nuclear fusion.
- nuclear fusion is the combining of the nuclei of smaller elements to form the nuclei of larger elements with some of the mass being converted into energy. The sun converts Hydrogen into Helium.
- The energy of nuclear fusion is eventually radiated into space as types of electromagnetic energy.
- Luminosity of a star measures how bright it would be in relation to the sun if all stars were the same distance from an observer.
    - The colors change from red to blue as their temperatures increase



- Star Types
    - Main Sequence 90% of stars. Can find them on the broad band on the luminosity chart.
        - Average size stars.
        - As the size increases, the temperature increases.
        - As the size increases, the color changes from red to blue-white.
        - Our Sun is a main sequence star of yellow color.
    - Giant Star - red, orange, and yellow giant stars are a rare type of star but are commonly seen in the night sky because of their large size.
        - Have a low temperature because they are considered to by "dying".
    - Super giant are very big stars that are very luminous.

2/14

- They sometimes explode in a tremendous event called a Super Nova
- White Dwarfs are small (about the size of the Earth).
  - They are sometimes colors besides white.
  - They are hot on the surface and low in luminosity.
  - They represent the last luminous or shining stage of low to medium mass stars.
- Black Dwarfs happens when a white dwarf cools and no longer emits electromagnetic energy.
  - It is a dead star.

IV Star Origin and Evolution

- Stars have an evolution (a life cycle)
- Stars originate from clouds of gas and dust molecules (left over from the Big Bang).
- gravity causes the gas to clump together (forming stars)
- When the mass is high enough, nuclear fusion starts and the star begins to shine.
- Most of the life of a star is as a main sequence star.
- Several things could happen once the star has spent its energy (depending on size):
  - Stars with masses similar to the Sun's mass become red giants, then a white dwarf, and then a black dwarf.
  - Stars with masses greater than the Sun's mass turn into Super Giants and then into a neutron star (more dense than a white dwarf).
  - Stars that are extremely massive will eventually collapse to form black Holes.
    - Black holes are extreme gravity fields that allow no visible light or any other form of energy to escape.

V Solar System

- Solar system - the sun and all 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 or revolves around another object.
- There are 9 planets that orbit the Sun.
- An asteroid is a solid rocky and/or metallic body that orbits the sun.
  - They 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 63 known ones in our solar system.
- A comet is often compared to a dirty snowball.
  - Are composed of solids that turn into gases easily.
  - They are made of substances like ice and water.
  - When comets get near the sun, their ices 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
  - It if 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.

Evolution of the Solar System

- Scientists think that our solar system started to form approximately 5 billion years ago.
- Everything formed from a giant cloud of dust and gas that condensed (came together) into a star (the Sun) and several planets.
- Planets and moons have experienced impact events.
  - impact events are when meteoroids, asteroids, and comets crash onto the surfaces of planets and moons.

VI. Planet Characteristics

- A planet's distance from the sun has a major effect on its characteristics.
- Planets that are close to the sun are called inner terrestrial planets.
  - Close to the sun
  - Have relatively small diameters
  - Have relatively small densities
  - Rocky surfaces have impact craters
  - Have few or no moons
  - Have no rings
  - Similar to Earth
  - Mercury, Venus, Earth and Mars (Pluto too but it's the exception)
- Planets that are far away from the sun are called outer Jovian planets.
  - Far from the sun
  - Gaseous
  - Have relatively large diameter
  - Have relatively large densities
  - Have no solid surfaces (no craters) but may have a solid core.
  - Have many moons
  - Have many rings
  - Similar to Jupiter
  - Jupiter, Saturn, Uranus, and Neptune

Solar System Data

Object	Mean Distance from Sun (millions of km)	Period of Revolution	Period of Rotation	Eccentricity of Orbit	Equatorial Diameter (km)	Mass (Earth = 1)	Density (g/cm^3)	Number of Moons
SUN	—	—	27 days	—	1,392,000	333,000.00	1.4	–
MERCURY	57.9	88 days	59 days	0.206	4,880	0.553	5.4	0
VENUS	108.2	224.7 days	243 days	0.007	12,104	0.815	5.2	0
EARTH	149.6	365.26 days	23 hr 56 min 4 sec	0.017	12,756	1.00	5.5	1
MARS	227.9	687 days	24 hr 37 min 23 sec	0.093	6,787	0.1074	3.9	2
JUPITER	778.3	11.86 years	9 hr 50 min 30 sec	0.048	142,800	317.896	1.3	16
SATURN	1,427	29.46 years	10 hr 14 min	0.056	120,000	95.185	0.7	18
URANUS	2,869	84.0 years	17 hr 14 min	0.047	51,800	14.537	1.2	21
NEPTUNE	4,496	164.8 years	16 hr	0.009	49,500	17.151	1.7	8
PLUTO	5,900	247.7 years	6 days 9 hr	0.250	2,300	0.0025	2.0	1
EARTH'S MOON	149.6 (0.386 from Earth)	27.3 days	27 days 8 hr	0.055	3,476	0.0123	3.3	—

VII Planet Rotation

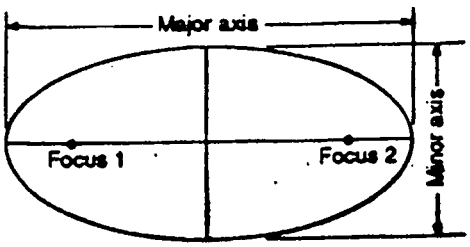
- o rotation is the spinning on an imaginary axis.
- o The period of rotation is the amount of time for a planet to spin 360 degrees. It is the length of one day on that planet.

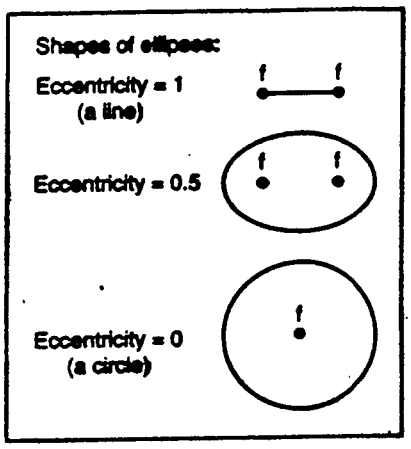
VIII Planet Revolution

- o revolution is the movement around the sun in a path called an ellipse.
- o An ellipse is the oval shape of a planets path around the sun.
  - Within the ellipse are two fixed points called foci.
  - The sun is at on foci and nothing is at the other.
  - eccentricity is the degree of ovalness of an ellipse.
  - If the eccentricity equals 1 then it would be a straight line.
  - If the eccentricity equals 0 then it would be a perfect circle.
  - You can calculate the eccentricity of an ellipse.

$$\text{eccentricity} = \frac{\text{distance between foci}}{\text{length of major axis}}$$

5/14





Find the eccentricity of the ellipse in Figure 8-14. The dots show the locations of the two foci. You will need a centimeter scale to measure the ellipse.)

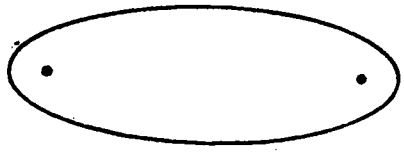


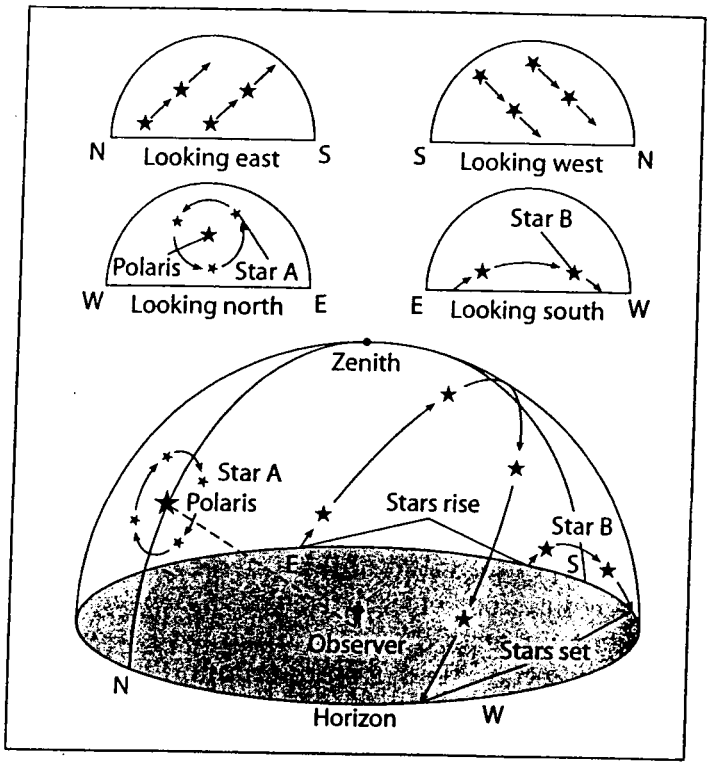
Figure 8-14.

- The elliptical shape of planetary orbits causes the planets to vary in distance from the sun during revolution.
  - The Earth is closer to the sun in the winter. (147,000,000 km)
  - The Earth is farthest from the sun in the summer. (152,000,000 km)
  - What causes the seasons?
    - tilt of the Earth's axis
    - revolve around Sun

- How come the Earth doesn't just fly into the sun because of the sun's gravity?
  - inertia is the concept that an object at rest will tend to remain at rest, and that an object in motion will maintain the direction and speed of that motion unless an opposing force affects it.
  - gravity is the attractive force that exists between any two objects in the universe.
    - The greater the masses of objects, the greater the gravity.
    - The closer the objects are the greater the gravity.
  - gravity keeps the planet near the sun while inertia keeps the planet from falling in (it keeps the planet moving in sort of the same direction).
- The period or revolution is the amount of time it takes for a planet to revolve around the sun.
  - It is equal to one year on that planet.
  - The closer a planet is to the sun, the smaller its orbit is, the smaller period of revolution, and the shorter its years are.

Apparent Motions of Celestial Objects

- apparent motion is a motion that an object appears to make.
  - To a person who is spinning around the room appears to move.
- Celestial object an object in the sky outside the Earth's atmosphere (the sun, moon, stars, and planets)
- Celestial sphere an imaginary sphere encircling the Earth on which all objects in the night sky appear.
- arc is an uniformly curved line that is part of a circle; the path of the sun or a star through the sky.
- Most celestial objects appear to move across the sky.
  - Rising in the east.
  - Setting in the west.
- All motion appears to move at a constant rate:
  - 360 degrees in one day.
  - 15 degrees in one hour.
  - 1 degree every 4 minutes.
- Stars completely circle Polaris every 24 hours. They are called circumpolar stars.
- daily motion the movements of celestial objects over a 24 hour period.



X Apparent Motions of Planets

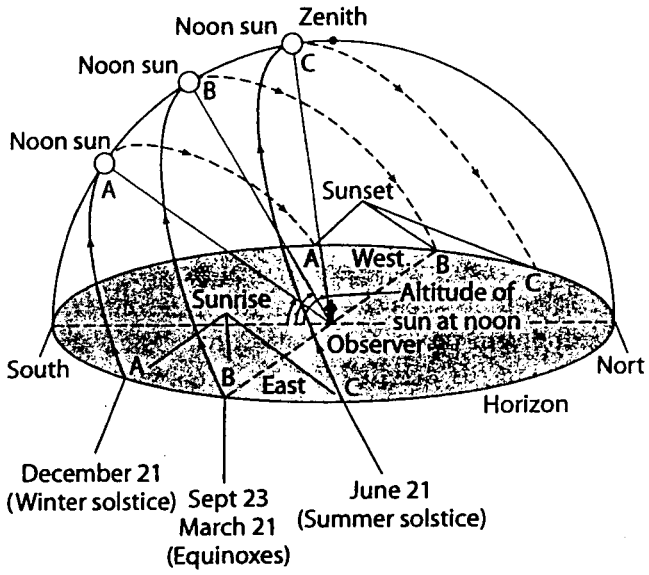
- As seen from Earth the planets exhibit daily motion similar to that of stars.
- Over extended periods of time the planets seem to change direction in the sky.
- The motions of planets are not uniform and are complex.
- The planets seem to make loops, and back and forth motions.

XI. APPARENT MOTIONS OF THE SUN

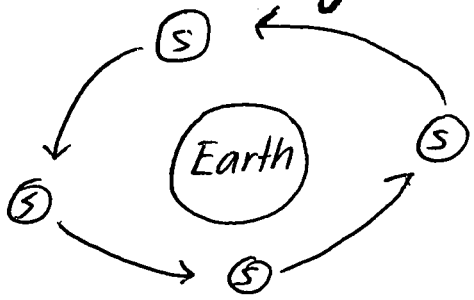
- Like all other celestial objects the sun appears to move through the sky.
- Its path across the sky is in the shape of an arc.
- The sun's path changes both in its length and its direction with the seasons.
- Within the continental United States
  - The sun is higher in the sky (72 degrees in altitude) in the summer.
  - The sun is lower in the sky (28 degrees in altitude) in the winter.
  - The noon sun is never directly overhead.
- The sun is always at its highest position in the sky at local solar noon.

- Solar noon - the time at which the sun reaches its highest point in the sky.
- Solar time - time based on the rotation of Earth as reflected in the motions of the sun.

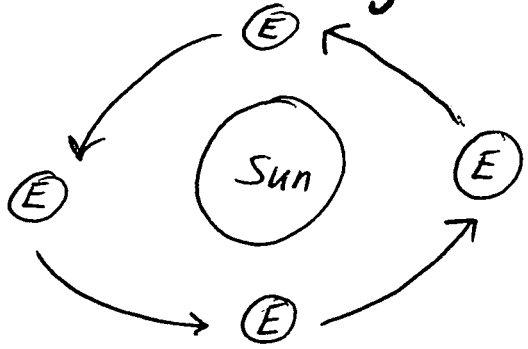
- The noon sun is only directly overhead for an observer within the tropics.



XII Geocentric Model of the Solar System



XIII Heliocentric Model of the Solar System



XIV Evidence of the Earth's Rotation

- The Focault pendulum.
  - 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.

- The Coriolis effect.
  - It is the tendency of all particles of matter moving at the Earth's surface to be deflected, or curve away, from a straight-line path.
    - right in the Northern Hemisphere
    - left in the Southern Hemisphere
  - This deflection occurs because the Earth is rotating, and therefore the Earth's surface is moving with respect to the path of the particles.

XV Evidence of the Earth's Revolution

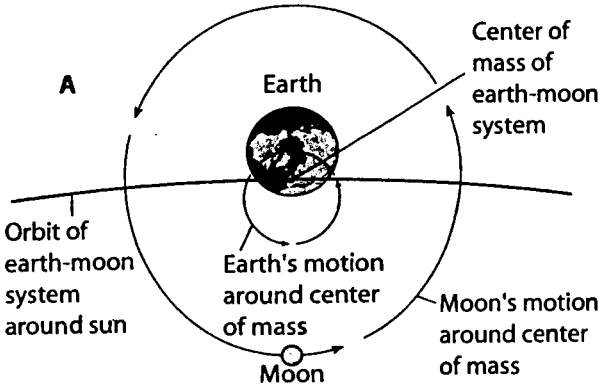
- The changing seasons are proof.
  - Because we revolve around the Sun, the two poles are tipped towards the sun at different times of the year.
- Looking at the constellations is proof.
  - A constellation is a group of stars that form a pattern and are used to help people locate celestial objects.
  - We can see different constellations each season because we are in different parts of the solar system.
- The angular diameter of the sun appears to change throughout the year.
  - angular diameter is how big it appears to be.
- Small changes in the color of stars.
  - red - means we are moving away.
  - blue - means we are moving toward.

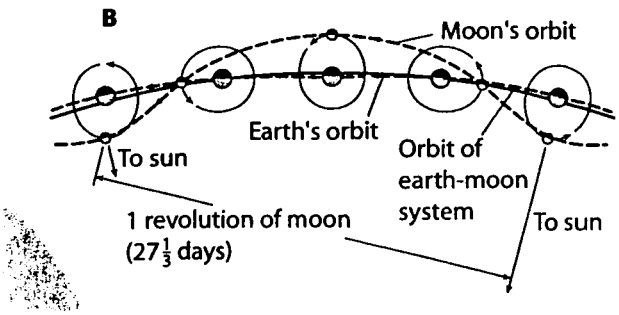
XVI Time

- o Local Solar time is the time it takes for the Earth to rotate from solar noon to solar on two successive days.
- o Solar time is a type of time that is based on the actual motions of the sun in the sky. (23hrs 56min)
- o mean solar day is exactly 24 hours.
- o mean solar time has been divided to make 24 hours a day for the convenience of time keeping.

XVII Actual Motions of the Earth's Moon

- o The revolution of the moon around the Earth (as the Earth revolves around the sun) results in many common observable events.
- o The moon revolves around the Earth in an elliptical orbit that it tilted about 5° from the Earth's orbit.
- o The moon orbits the Earth once every 27⅓ days.

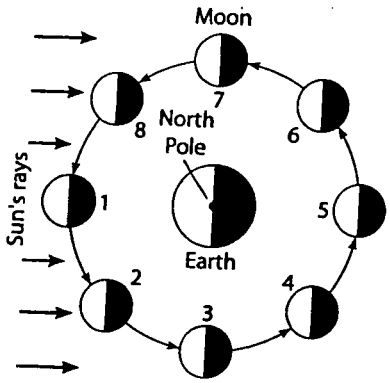




XVIII Phases of the Moon

- o Half of the moon is always receiving light from the sun at any given time (except for lunar eclipses).
- o Since the moon revolves around the Earth, an observer on Earth sees varying amounts of this lighted-half.
- o Phases of the moon are the changing amounts of the lighted moon as seen from the Earth.
- o The moon takes 27 days to revolve around us once.
- o It takes 29 days for the moon to complete one complete cycle.
  - An extra 2 is needed to catch up to the same spot on the Earth.

Earth and moon as viewed from space (looking down on the North Pole)

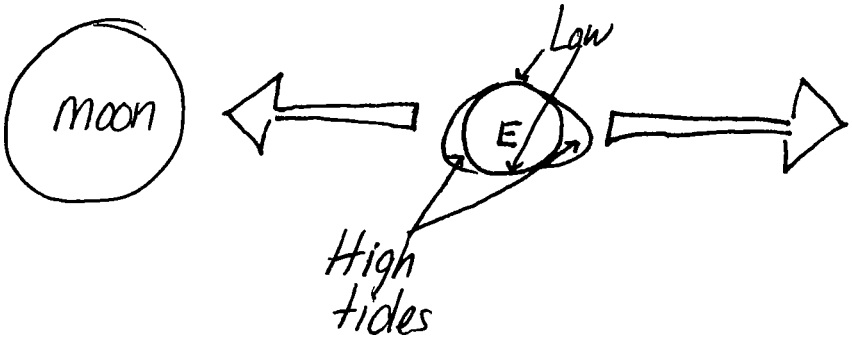


Time in days for one phase cycle		Phases as viewed from earth
0	1	New
3 3/4	2	~~New~~ crescent Waxing
7 1/2	3	First quarter
11 1/4	4	~~New~~ gibbous Waxing
14 1/2	5	Full
18 1/2	6	~~Old~~ gibbous Waning
22 1/2	7	Third quarter
26	8	~~Old~~ crescent Waning
29 1/2	1	New

XII

Tides

- o tides are the cyclic rise and fall of ocean waters
- o they are caused by the gravitational attraction of the moon and Sun.
- o Ideally there should be 12 hours and 50 minutes between each high tide.



(S) (E) (M) (full moon)

(S) (M) (E) (new moon)

(E) (M) (S) (Quarter)

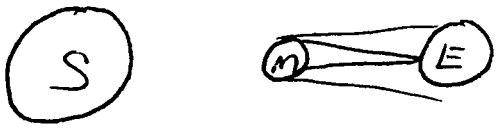
Spring tides - extra high

Neap Tides extra low

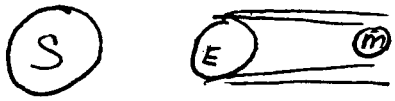
12/14

ECLIPSES

- o *eclipse* is when a celestial object partly or completely comes into the shadow of another celestial object.
- o A *Solar eclipse* occurs when the moon's shadow falls on a small part of the Earth and blocks out the sun.
  - It is very rare for a total eclipse of the sun (once every 200 years) and it only affects a small part of the Earth since the Moon's shadow is so small.
  - A total eclipse will only last for 7 ½ minutes.



- o A *Lunar eclipse* is when the Earth's shadow covers the moon.
  - It is more common, 2 total eclipses a year.
  - A total eclipse will last for over 100 minutes.
  - All the people on the dark half can see the eclipse.



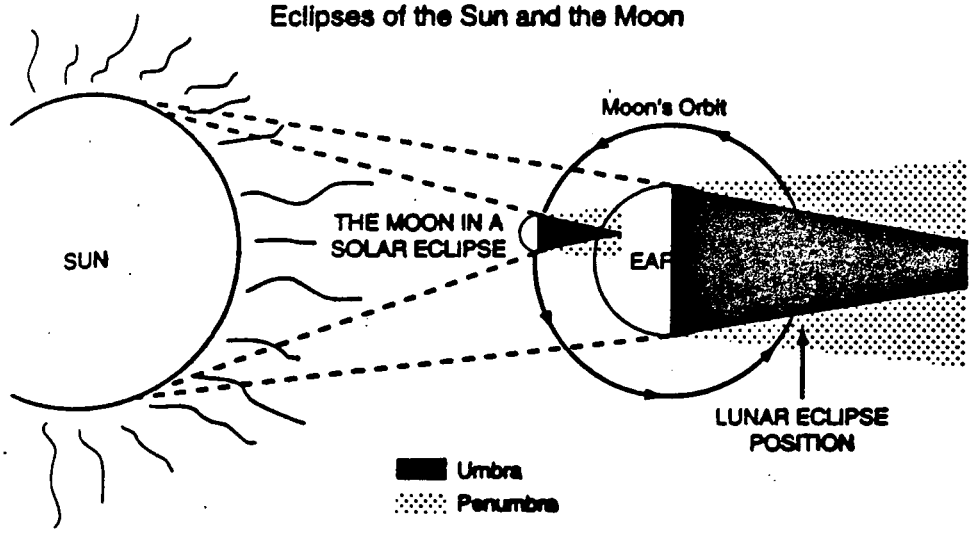


Figure 8-9. Eclipses of the sun and moon as observed from a position high above the North Pole. Eclipses of the sun fully darken a small area on the Earth. Eclipses of the moon are visible from a much larger area of the Earth.

XXI

Seasons

- The sun's path through the sky changes with the latitude and the season because:

  $23\frac{1}{2}°$

  - tilt of the Earth's axis
  - revolution around the sun