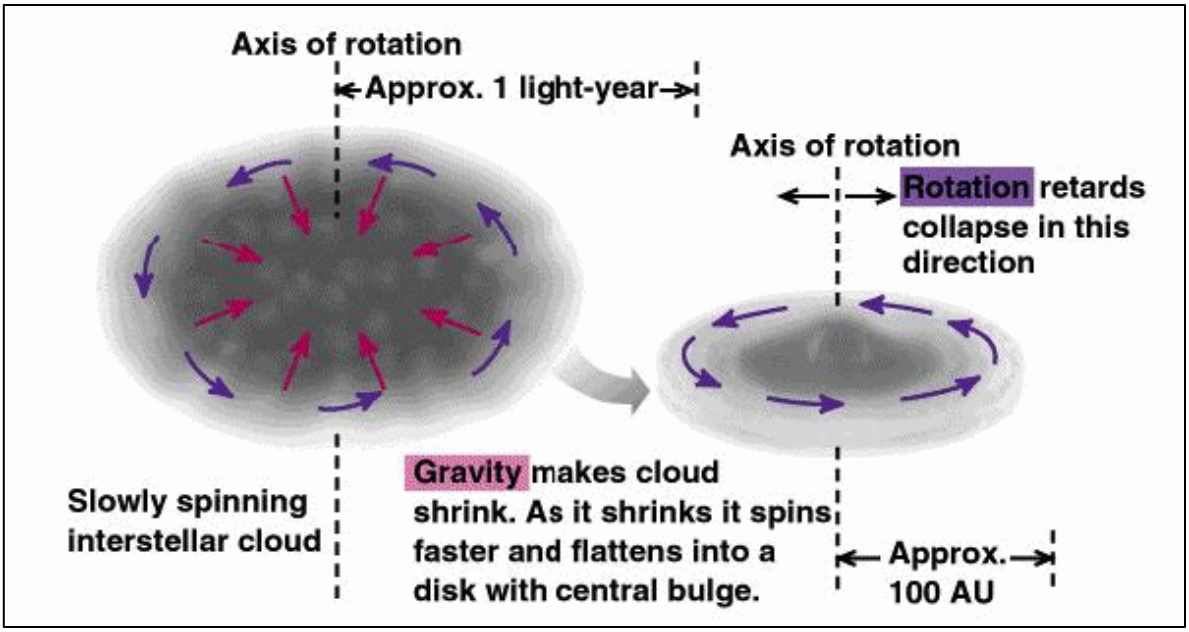
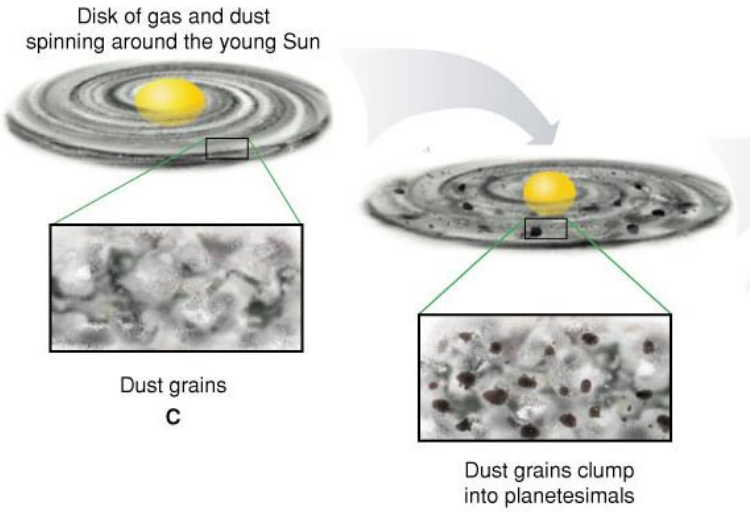
#3 Origin of the Solar System and Planetary Motion (Kepler's Laws):

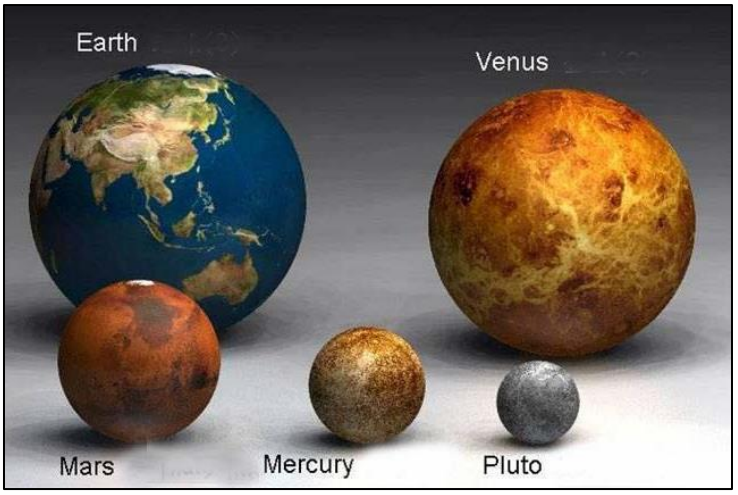
A. Origin of the Solar System (_____Theory)



1. Planets formed _____as the Sun and from the same nebular material.
2. The Solar System is believed to be _____years old.
3. Huge gas and dust cloud became unstable.
   a. Due to gravitational attraction a condensation formed at one point becoming the_____.
   b. The cloud rotated faster as it contracted.
   c. Some gas and dust was left in a flattened disk surrounding the **protosun**.
   d. Condensation occurred within the disk forming _____which continued to move in the same direction as the disk.
4. As material in the disk became more concentrated in the protoplanets:
   a. Space between the new Sun and the protoplanets cleared;
   b. Light and Heat was able to reach them driving off lighter elements and even most of the atmosphere leaving a more dense core of heavier elements.

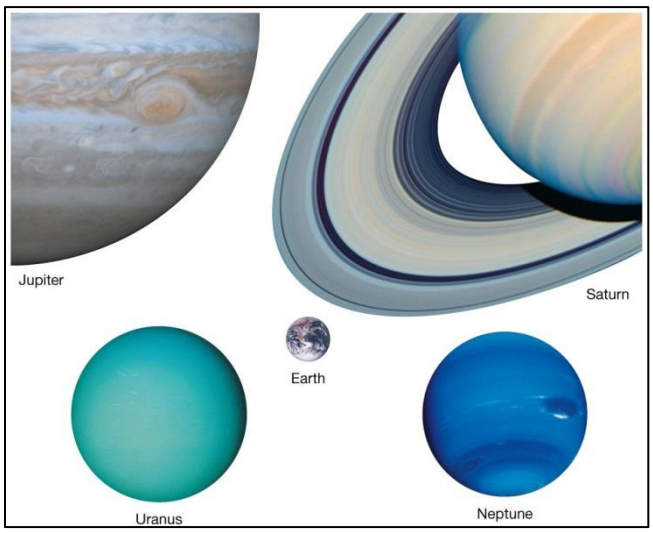


5. _____ Planets



a. Closer to the Sun and most lighter elements driven off.
b. Small, rocky, and dense
c. Mercury, Venus, Earth, Mars
d. No atmosphere.
e. Numerous impacts from objects from space (meteors, comets)
f. _____: Atmosphere evolved from the release of water from volcanoes.
g. _____: Some meteorites contain water which likely was released into the impact when the vaporized upon impact with Earth's surface.
h. Origin of Earth's Oceans: Release of water from precipitation over millions of years early in Earth history.
i. **Planets beyond Mars are made of lighter elements and are the_____.**

II. Motions of the Planets



A. Two Views of Planetary Motion in the Solar System

1. _____
(See Rev. Book *Figure 9-12*, page 450)

a. Based on celestial observations from Earth, it was thought by early civilizations (and up through the Renaissance) that:

(1) **Earth** was located at the _____of the solar system and is motionless

(2) Stars were located on a transparent sphere that rotated each day from_____.

(3) The Sun, moon, and each planet were carried by separate spheres.

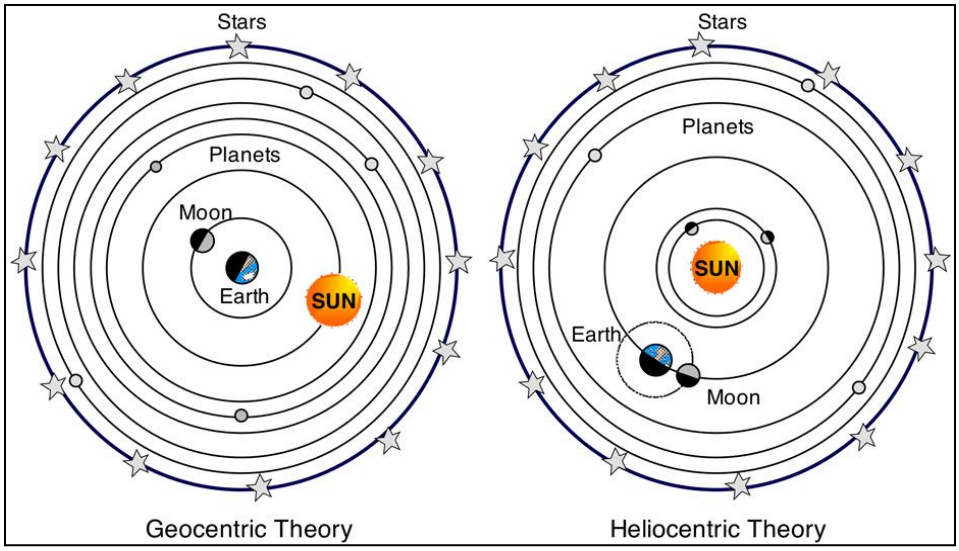
(4) Each planet is located on an _____ that rotates at a fixed rate. This was to explain the phenomenon of _____ motion.

b. This is the model advanced by the Greek astronomy Ptolemy (Claudius Ptolemaeus) in the second century.

c. Difficulties with the Geocentric Model.
   (1) Through the centuries, as more and more data accumulated, the astronomers kept adjusting the model to make it work better.
   (2) By 1500 the model had become very complicated and it still didn't work well.
   (3) And, it's not correct!

2. _____

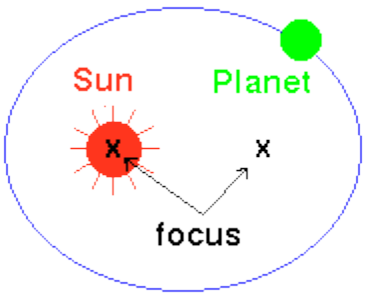
   a. The planets revolve around the_____.
   b. Polish astronomer Nicolas Copernicus proposed this model in 1543.
   c. It would be many years until the modern model of the solar system was refined. Copernicus had the Sun in the exact center of the solar system and the planets revolving in perfect circles. This was later shown to be incorrect by Kepler.
   d. Accounts for_____ motion of planets. (See Rev. Book *Figure 9-13*, page 451)



B. Kepler's Laws of Planetary Motion:

Johannes Kepler (1571-1630) used the accumulated data of Danish nobleman Tycho Brahe to develop *three laws of planetary motion*. Tycho's careful measurements of the positions of stars and planets were made without the use of a telescope over a period of 20 years and were the first long-term observations of the sky.

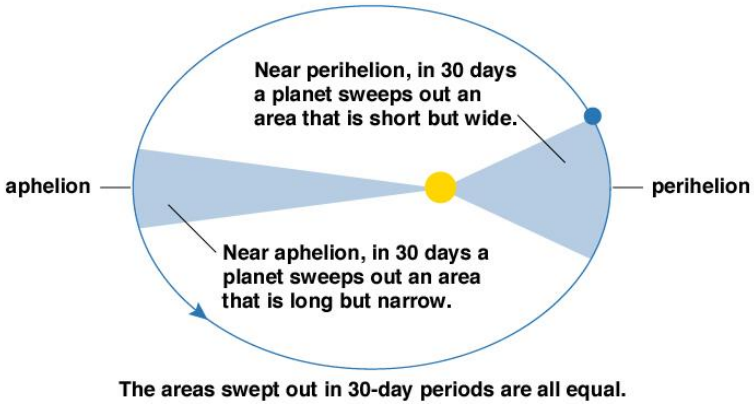
1. *Kepler's First Law of Planetary Motion*



   a. The orbit of each planet around the Sun is an _____
   b. The Sun is located at a _____ within the elliptical orbit and is *not at the exact center of the orbit.*

2. *Kepler's Second Law of Planetary Motion* (See Rev. Book *Figures 9-15* and *9-16*, page 454)

a. Each planet moves around the Sun so that an imaginary line (_____) joining the planet and the Sun will sweep over _____.



The areas swept out in 30-day periods are all equal.

b. This means that because the orbits are elliptical, the planet's travel at different speeds at different positions in the orbit.

(1) _____

(a) The planet's position in it's orbit where it is _____ to the Sun.

(b) The speed is _____ at perihelion.

(2) _____

(a) The planet's position in it's orbit where it is _____ from the Sun.

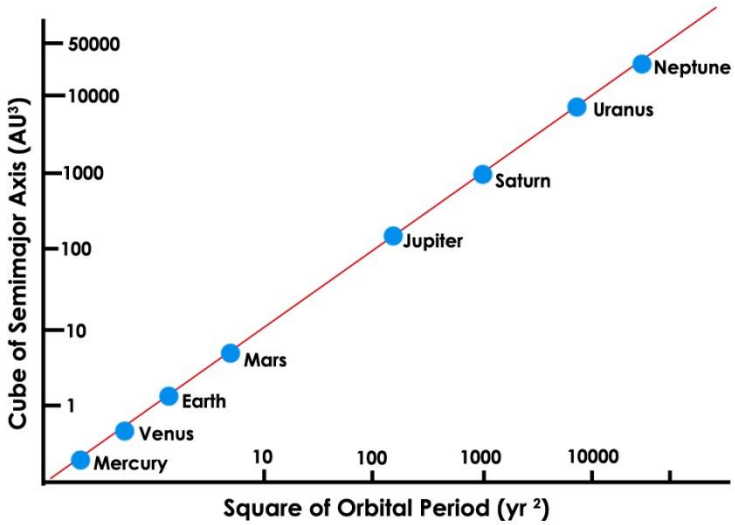
(b) The speed is _____ at aphelion.

3. *Kepler's Third Law of Planetary Motion* (Called the **Harmonic Law**)

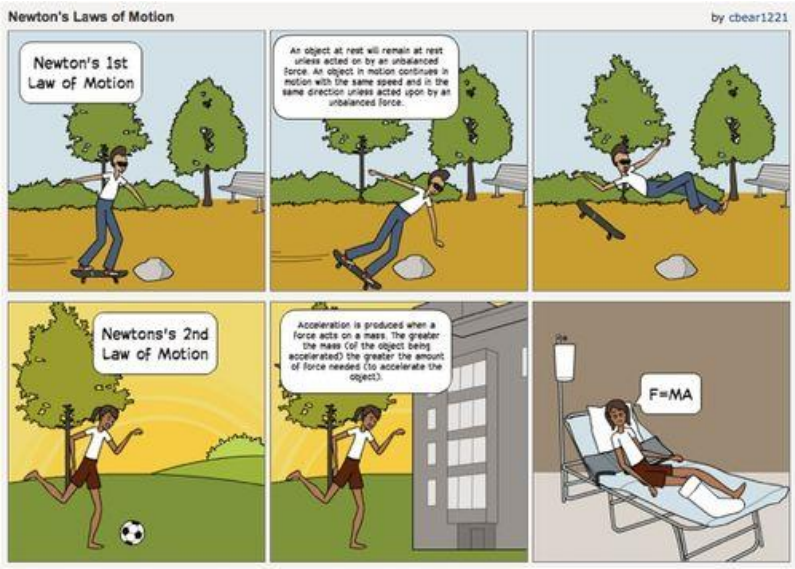
a. The time it takes the planet to revolve around the sun (it's_____) is equal to the cube it its distance from the Sun. The period (P) must be in Earth years and the distance (D) must be in astronomical units. The equation can be stated: $\mathbf{P^2 = D.^3}$

b. This further states that

_____



C. Celestial Mechanics Affecting Planetary Motions



1. *The Three Laws of Sir Isaac Newton* (1642-1727)

a. Newton's First Law

(1)Every body continues in it's state of rest, or of uniform motion unless

_____

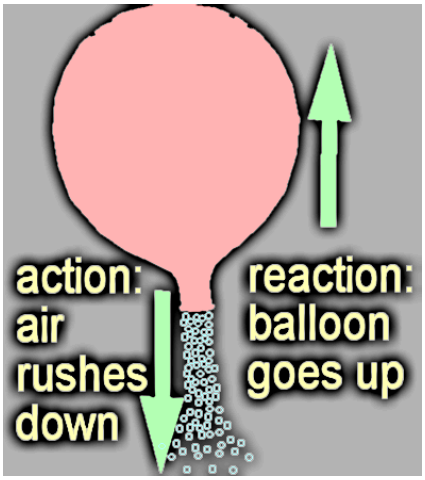
(2)An object_____ at rest or _____ to move in direction and velocity.

(3)Law of _____.

b. **Newton's Second Law:** _____

c. **Newton's Third Law:** Every action has an

_____.



2. *Newton's Universal Law of Gravitation*

a. Referred to as the _____.

b. The force of attraction between two bodies is directly proportional to the product of their masses *and* inversely proportional to the square of the distance between their centers.

c. Expressed mathematically as $F \propto G \frac{m_1 \bullet m_2}{d^2}$

(Where F is the force between the objects, m_1 is the mass of the first object, m_2 is the mass of the second object, and G is the gravitational constant which is equal to 6.67×10^{11} N • meter^2/kg^2 . A newton, is the force necessary to accelerate a 1 kilogram mass one meter per second squared. This can be expressed as 1kg •m/sec^2)