Name\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_Period\_\_\_\_\_

**NOTE OUTLINE Chapters 29 & 30: Solar System & Stars**

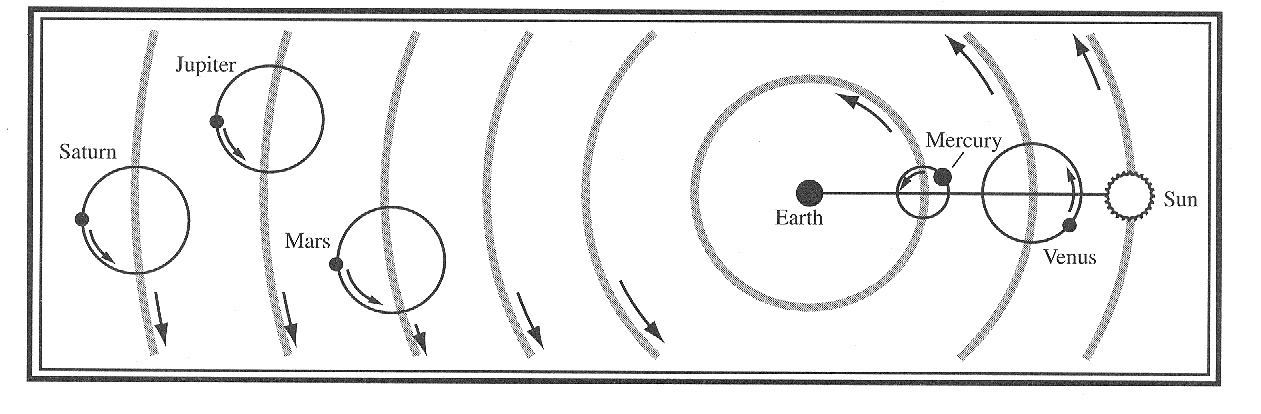
**Objectives:**

1. **Describe early models of our solar system. This means I can:**
   1. Explain the geocentric model of the solar system and how **retrograde motion** brought change to that model.
   2. Describe the contributions and changes to solar system arrangement due to the following scientists: Nicolaus Copernicus, Kepler, Isaac Newton, Galileo.
2. **Examine the modern heliocentric model of our solar system. This means I can:**
   1. Explain Kepler’s 1st Law and its relationship to the following terms **astronomical unit, perihelion, aphelion, focus, major axis, semi-major axis,** the Sun, and **eccentricity.**
   2. Determine the relative shape (elongated oval, oval, circle) of an orbit when given its eccentricity value.
3. **Relate gravity to the motions of celestial bodies. This means I can:** Describe how mass, center of mass, and distance between 2 objects affects their gravitational pull on each other.
4. **Summarize the properties of the solar system that support the theory of the solar system’s formation. This means I can:**
   1. Describe how the planets formed from a disk surrounding the young Sun.
   2. Define & describe how the following terms are involved in the theory of the solar system’s formation: **interstellar cloud, solar nebula, planetesimal, equatorial plane.**
   3. Explain how the theory is supported by the types of elements and density differences of the inner terrestrial vs. outer gas giants.
   4. Using distance from the sun and resulting temperature differences throughout the solar system, explain why lightweight gases such as hydrogen and helium are rare in the terrestrial planets but common in the gas giants.
5. **Explore remnants of solar system formation. This means I can:**
   1. Define **asteroid.** Identify the location of the asteroid belt on a solar system diagram.
   2. Differentiate between **meteor shower, meteoroid, meteor,** and **meteorite.**
   3. Label, define and describe the composition of the parts of a comet. Describe how, when, and why the tails are formed, and which direction they point.
   4. Discuss the location of the two main clusters of comets, including how far they are from the sun in astronomical units.
6. **Compare and contrast the properties of the inner/terrestrial vs. outer/gas planets. This means I can** 
   1. Describe similarities and differences in composition, size, surface, composition (main elements), density, rings, number of moons.
   2. Explain why/how the inner and outer planets are composed of different substances.
   3. Name the 4 terrestrial planets and the 4 gas planets.

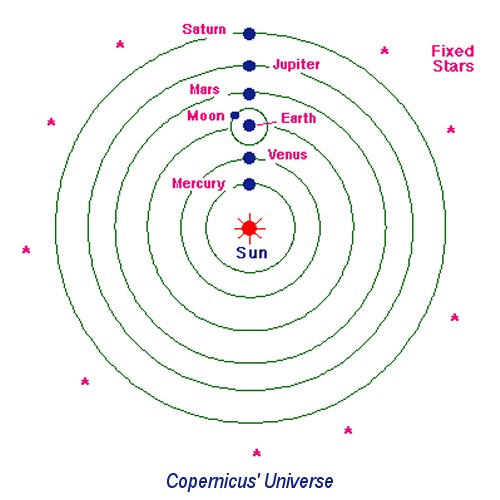
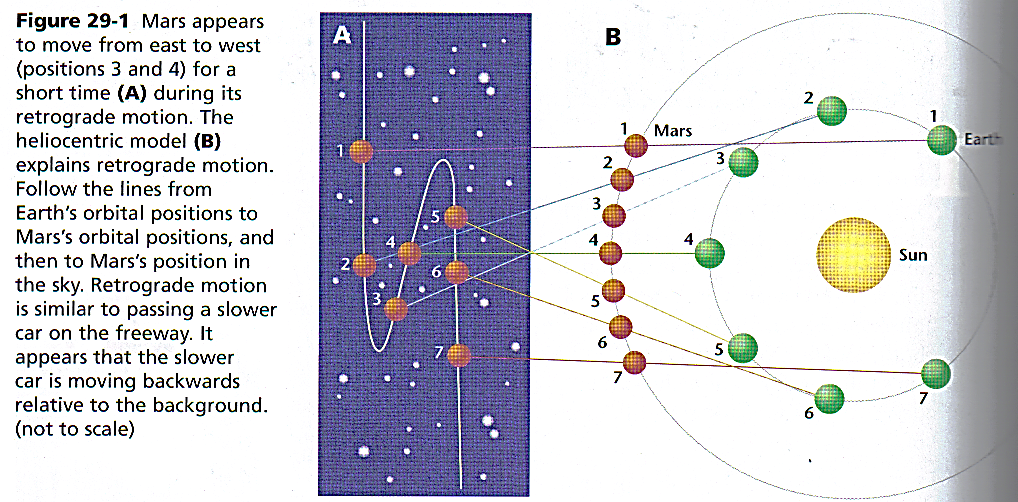
**Section 29.1 Early Astronomers**

**Research & Ideas**

* 1. Ancient astronomers could recognize the difference between stars and \_\_\_\_\_\_\_\_\_\_\_\_\_\_
     1. Planets move, stars are stationary & do not move
  2. **Geocentric** Model –1st model of solar system
     1. Geocentric = \_\_\_\_\_\_\_\_\_\_\_ is the center of the universe
        + - Believed the Sun, planets, and stars \_\_\_\_\_\_\_\_\_\_\_\_\_a stationary \_\_\_\_\_\_\_\_\_\_\_\_\_



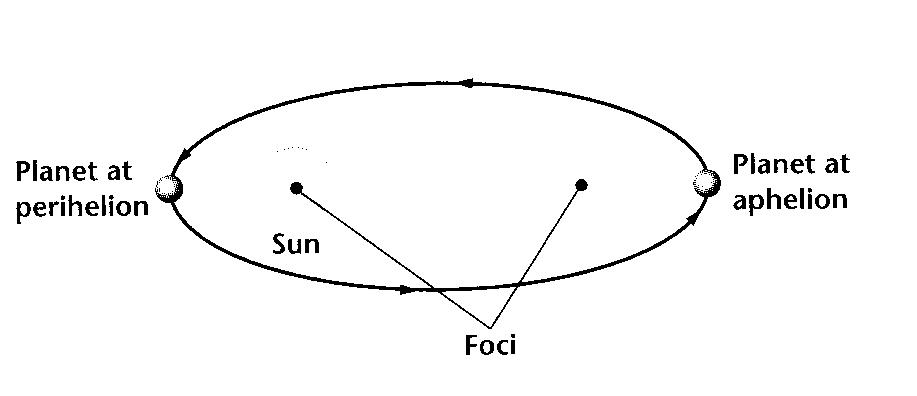
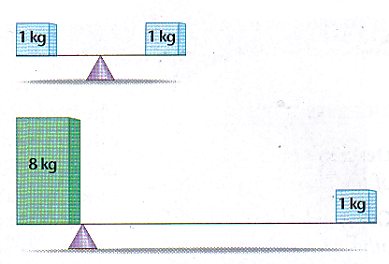
* + 1. Problem: Didn’t explain **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ motion** which is a sudden change in planetary motion when planets suddenly **appear** to move \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
       1. Most planets appear to move from \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
       2. But sometimes they suddenly appear to move \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
       3. Very hard problem to solve
       4. Scientists began looking for a better model of the universe/solar system

1. **Heliocentric Model** = \_\_\_\_\_\_\_\_\_-centered
   1. Suggested by **Copernicus** in 1543
   2. Explained retrograde motion…So **WHY** do we see planets moving “backwards”?
      1. Inner planets move \_\_\_\_\_\_\_\_\_\_\_\_\_ than outer planets around the sun
      2. Earth will “pass” a slower moving planet
      3. The slower planet temporarily appears to move\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. Galileo’s discoveries also support heliocentric
   1. 4 moons orbited \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ not the Earth (now known \_\_\_\_\_\_\_\_\_\_ has >= 67moons)
3. **Kepler’s 1st Law:** Most planets orbit the Sun in an \_\_\_\_\_\_\_\_\_\_\_\_\_, NOT a circle
   * 1. Ellipse = Oval that is centered on \_\_\_\_\_\_\_points (\_\_\_\_\_\_\_\_\_\_), not 1 like a circle

* (Focus – singular, \_\_\_\_\_\_\_\_\_ – plural)
  + 1. Most planets orbit the Sun in an \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ shape
    2. Earth being the exception
       - Earth believed to move between an elliptical orbit and a circular orbit every 100,000 yrs or so.
       - <http://www.youtube.com/watch?v=tw5MvHNw0Co>
    3. Planets orbit while staying centered around \_\_\_\_\_\_\_\_\_\_\_\_\_points.
    4. The \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ is one point
    5. **Orbit is around the “\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_of mass” of the 2 bodies (Sun & planet)**

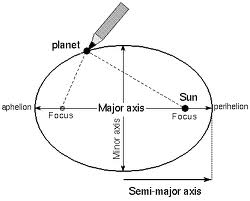
1. Sun is \_\_\_\_\_\_\_\_\_ the center of the orbit, but is 1 of the 2 \_\_\_\_\_\_\_\_

**Eccentricity =** HOW oval-shaped the orbit is, and is based on the ratio of distance between the 2 foci to the

major axis. <http://www.youtube.com/watch?v=BIBz_GQDga0>

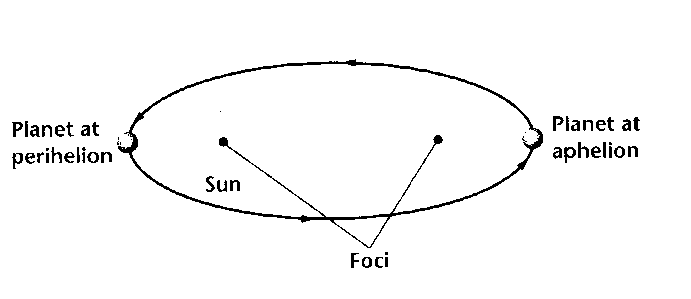
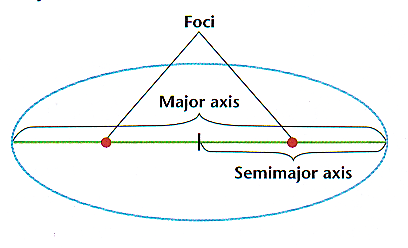
* + 1. Planets vary in their distance from the Sun, therefore the distance between focus points is different for each planet.
    2. A planet is NOT at a constant distance from the Sun
    3. **Perihelion –** \_\_\_\_\_\_\_\_\_\_\_\_\_ point of a planet’s orbit to the Sun
    4. **Aphelion –** \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_point
    5. **1 Astronomical Unit (AU)** = the **average distance** between \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + Is the unit used for distances between the Sun and planets.



1. **Major axis:** runs \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ through both foci.

* + Is the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ diameter

1. **Semimajor axis:** \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of major axis.
   * Is the planet’s \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ distance to the Sun



**Eccientricity Mini-Lab Data Table:**

**Eccentricity = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Distance foci are apart | Length of major axis in cm  (Longest length)  \*\*Use 1 decimal | Equation / Calculation  (Show your work) | Eccentricity Value (Calculation answer) | Describe/Draw Relative Shape of Drawing |
| 2cm |  |  |  |  |
| 9cm |  |  |  |  |
| 0cm  (Just use 1 pin) |  |  |  |  |

**Eccentricity Mini-Lab Questions, Analyze and Conclude:**

1. What do the 2 pins represent?
2. For planets orbiting in our solar system, what is always one of the foci?
3. How does the eccentricity number AND the shape change as:
   1. The distance between the foci (pins) gets larger?
   2. The distance between the foci (pins) gets smaller?
4. What is the eccentricity value of a perfect circle? \_\_\_\_\_How far apart are the foci of a circle?\_\_\_\_

**Eccentricity Notes Continued:**

1. **Eccentricity has a value between \_\_\_\_\_\_\_\_\_\_\_\_\_\_**
   * 0 = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (Distance between the 2 foci is \_\_\_\_\_)
   * 1 = very \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**GRAVITY: Recreating Galileo’s Experiments:**

**Experiment: Testing Gravity’s Influence on Falling Objects**

\*\*Pick 4 objects of different weights from across the room. You can use anything safe to drop. If you want to use anything of the teacher’s, please ask before you grab it.

\*\*Record your object choices in the data table below:

|  |  |  |  |
| --- | --- | --- | --- |
| **Object** | **Trial #1** | **Trial #2** | **Trial #3** |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |

**Time for Predictions:**

1. Out of all the objects you selected, what will fall to the ground most quickly?
2. Out of all the objects you selected, what will fall to the ground most slowly?

**Procedure:**

1. Time to test your predictions.
2. Go into the hallway and mark a height on the wall using masking tape. This is your start position from which each object will be dropped.
3. Pick the first 2 objects in your data table and hold them up to the start line.
4. Count to 3 to give the timer time to get the stop watch ready.
5. Drop the objects.
6. Repeat the above steps so both pairs of objects has a total of 3 trials.
7. Grab the next pair of objects, switch jobs, and repeat steps 3-6.

**GRAVITY: Post Lab Questions**:

1. Were your predictions accurate? Why or why not?
2. What relationship did you observe between the speed an object falls towards the Earth and the amount it weighs?
   * Did any object defy this relationship? If so, why do you think this happened?

**Galileo & Gravity:**

1. In the late 16th century early 17th century Galileo was working with gravity.
2. Performed experiments dropping objects off the Tower of Pisa and rolling balls down inclines
3. Gravity accelerates the fall of all objects at the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
4. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ causes lighter objects to fall \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Sir Isaac Newton & Gravity**

1. 1687 **Newton** published his Law of Universal Gravitation.
   * Also called the inverse square law
2. This theory helped discover Neptune.
   * Watched Uranus’s movements:
     + Gravity of something large was affecting the movements of the planet.

1. Basics of the Inverse Square Law:
   * Any two objects \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_each other
   * Depends upon their \_\_\_\_\_\_\_\_\_\_\_\_\_ AND the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ between them.
2. **Summary of Law of Gravity:** 
   * The larger the objects the stronger the force of gravity between them.
   * The farther apart the objects the weaker the force of gravity.

**How Do Scientists Determine Theories for How Our Solar System Formed?**

1. Scientists Examined
   1. Why the planets are so different.
      * + Especially Outer vs. Inner Planets
   2. Asteroids, Meteorites, and Comets.

**Section 29.4: Formation of Our Solar System (Collapsing Interstellar Cloud Theory)**

**Interstellar Clouds =** Huge clouds of \_\_\_\_\_\_\_\_\_ & \_\_\_\_\_\_\_\_\_\_\_ in space

1. Made mainly of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. Forms stars and\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ when the cloud condenses/collapses due to \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
3. **These clouds usually look dark because the dust blocks \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.**
   * Like \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
   * Stars behind this cloud can’t shine through it.
   * But….Sometimes the light from stars within the cloud causes these interstellar clouds to glow.
4. **Location**
   1. There are many interstellar clouds found within our \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
   2. Astronomers look for high amounts of gas and dust
5. **Collapsing Interstellar Cloud Theory**
   1. When enough gas and dust is present, scientists think these interstellar clouds condense because of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
   2. Can form a star or planet
   3. Cloud begins collapsing slowly.
   4. The smaller it gets the faster it begins to \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
   5. This spinning motion with eventually form a \_\_\_\_\_\_\_\_\_\_\_ rotating disk with a very dense \_\_\_\_\_

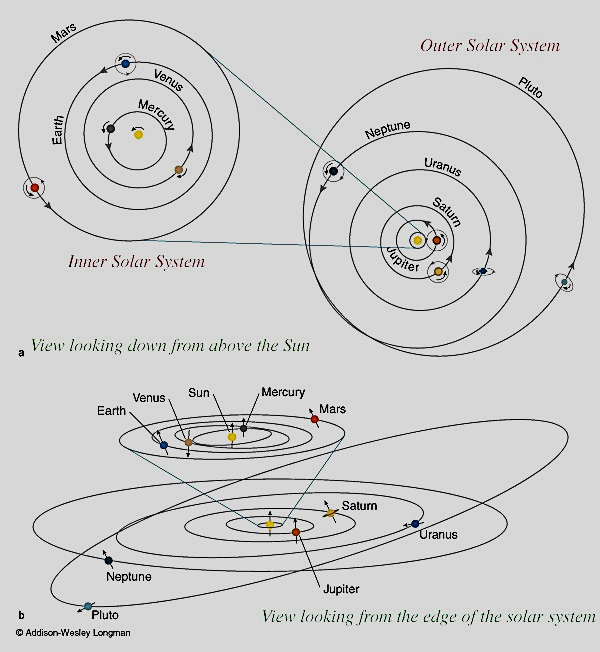
**Solar Nebula**

1. Scientist believe that one huge interstellar cloud called the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ formed the Sun and all the planets.
2. The Sun formed first in the center of this cloud.
   * Fits with why our Sun is the \_\_\_\_\_\_\_\_\_\_\_\_\_\_and most \_\_\_\_\_\_\_\_\_\_\_\_thing in our solar system.
3. In the center of the cloud it was the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
4. On the edges of the cloud it was the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
5. **This difference in temperature as the solar system cooled caused different materials to condense at different distances/regions from the sun**
   1. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (iron, lead, etc.) condense at \_\_\_\_\_\_\_\_\_\_\_\_\_temperatures and became \_\_\_\_\_\_\_\_\_\_\_ close to the Sun
   2. Lighter elements with smaller atomic mass (\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ etc) don’t condense until the temperature is very \_\_\_\_\_\_\_\_\_\_\_\_. They remained gaseous and didn’t become solid until they were \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ from the Sun
   3. **This is why** \_\_\_\_\_\_\_\_\_ planets and \_\_\_\_\_\_\_\_\_ planets have such \_\_\_\_\_\_\_\_\_\_\_ compositions

**Terrestrial Planets**

\*\*What does terrestrial mean? Composed of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. **Inner Four Planets**
   1. Closest to the Sun
   2. Mercury, Venus, Earth, and Mars
2. **Small (Close to the size of Earth)**
   1. Smaller because the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ captured the majority of materials found here
3. **Solid Surfaces**
   1. Made of Rocks and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. AKA \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_planets , because higher mass elements condensed at high temps close to the sun
4. **Few Moons**
   1. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ took all the loose debris



**Gas Giant (Outer) Planets**

1. **Outer four Planets**
   1. Farthest from the Sun
   2. Jupiter, Saturn, Uranus, Neptune
2. **Larger in size & mass**
3. **Lack Solid Surfaces**
   1. Gaseous including \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ & \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
   2. Very little rock and metal
4. **Many \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (satellites)**
5. **Ring systems**
6. **Belts & Zones: \_\_\_\_\_\_\_\_\_\_ stretched into \_\_\_\_\_\_\_\_\_\_ by \_\_\_\_\_\_\_\_\_\_ rotation of the planet**
   1. Why look “striped”
   2. Clouds made of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, methane (blue) & ammonia (NOT water like on earth)

**DEVELOPMENT & FORMATION OF THE PLANETS**

**Outer Planet Formation**

1. **The planets formed by a process in which dust and gas gravitationally attracted each other.**
   1. As size increases, gravity increases & pulls even more gas & dust in
   2. Over time this collected and formed larger and larger bodies.
2. **1st planet of the gas to form was\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**
   1. This is why \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ is the largest.
   2. Had the most materials to build with
3. **Then Saturn, Uranus and Neptune (the rest of the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_) formed**
   1. Not as large because \_\_\_\_\_\_\_\_\_\_\_\_\_ had taken most of the materials; gas, dust, and ice to make itself.
4. **“Leftovers” became \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_that form along equatorial planes of planets**

**Inner Planet Formation**

1. **As materials (rock, metal, ice) condense and become solid, they collide and stick together.**
2. **Planetesimals** = Space objects (100’s of km in diameter) made by \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ solid particles
3. **Inner Terrestrial Planets** formed by colliding and sticking \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
   1. Made of very different things, more \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
4. **Sun’s \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_took all the gas and floating debris away from inner planets.**
   1. This is why they are rocky and dense
   2. This is why moons are \_\_\_\_\_\_\_\_\_\_\_\_\_for inner planets.

**Space Rocks 101A (AKA Debris)**

**Asteroids** = Leftover pieces of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Asteroids were \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ planets
2. Asteroids can collide and break apart.
3. **Asteroid Belt** = Planetesimals left behind in a band between \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
   1. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ prevented them from merging into a planet

**Meteroid**

* When an asteroid or any space material falls toward Earth and \_\_\_\_\_\_\_\_\_ Earth’s \_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Meteor**

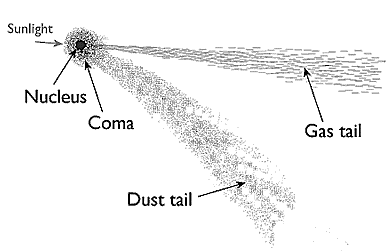
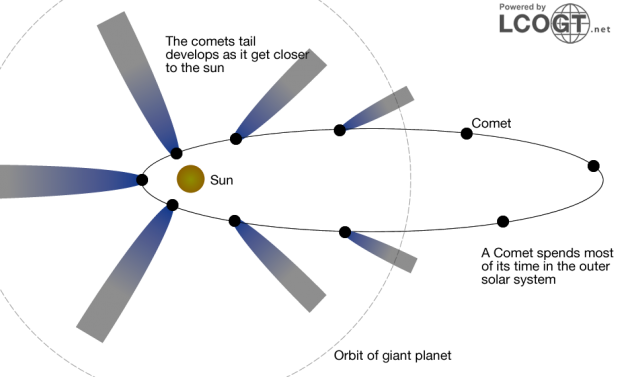
* The \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ produced when a meteoroid \_\_\_\_\_\_\_\_\_\_\_\_\_\_in Earth’s atmosphere.

**Meteorite**

* When a space object \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_Earth
* Occurs when all of the meteoroid \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ in Earth’s atmosphere
* Leaves a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ until it weathers & erodes

**Comet**

1. Small \_\_\_\_\_\_\_\_\_\_and \_\_\_\_\_\_\_\_\_\_\_\_\_\_ bodies with a highly \_\_\_\_\_\_\_\_\_\_\_\_\_\_ orbit around the Sun.
2. **Meteor Shower**: Occurs when Earth passes through the **remains** of a comet’s \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
3. **Most found in 1 of 2 clusters**
   1. Kuiper Belt – close to Pluto (30 – 50 AU) from the Sun
   2. Oort cloud - >100,000 AU from the Sun
4. **Comet Structure (Parts of a comet)**
   1. Icy nucleus = small, \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
      1. When it is heated, it releases gas & dust to form the coma & the tail
   2. Coma = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ surrounding nucleus
   3. Tail – always points \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ from the Sun due to solar\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Questions & Challenges of the Day**

1. Draw the best diagram of our solar system that you can in your notes.  
   Make sure to include labels!
2. What was the problem with the geocentric theory? How did we fix the problem?
3. Predict the meaning of aphelion & perihelion.
4. Compare and Contrast Heliocentric and Geocentric Theory.
5. Review your knowledge of eccentricity….Let’s see if you can calculate it on your own.
6. What is retrograde motion?

Who fixed this problem?

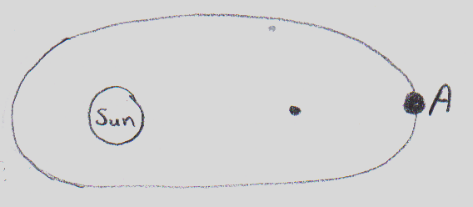
1. Understanding Check:   
   Write down as many facts as you can about interstellar clouds without peeking at your notes.
2. What is an interstellar cloud?

What must happen to an interstellar cloud to produce a star or planet?

1. Test your knowledge:   
   Describe what each planet is made of, gas, ice, rock or metal, and why that makes sense.
2. Describe the process that produces terrestrial planets.
3. Describe the process that produces gas giant planets.
4. Use your notes to draw a diagram of a space rocks journey from being classified as an asteroid to a meteorite.

**Miscellaneous Review Questions**

1. List 3 characteristics common to all terrestrial planets
2. List 3 characteristics common to all gas giants
3. Compare and contrast asteroids and comets
4. According to the solar nebular theory, what caused the inner planets to be dense and rocky and the outer planets to be light with H & He?
5. What does an eccentricity of 0.1 tell you?
6. What is retrograde motion?



1. In the diagram to the right, what is a vocabulary term for location A?
2. Name the 4 terrestrials
3. What are 2 things that effect gravity?