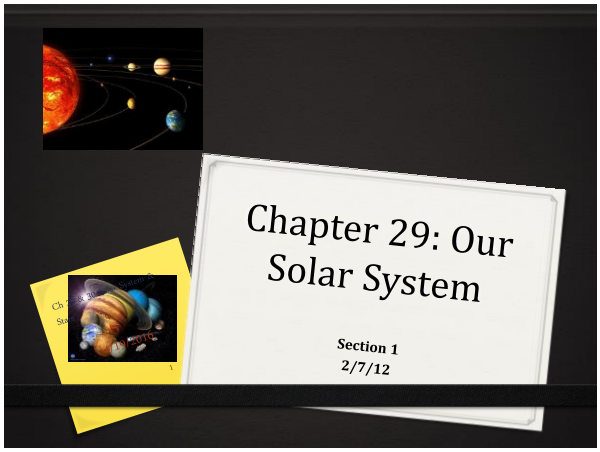
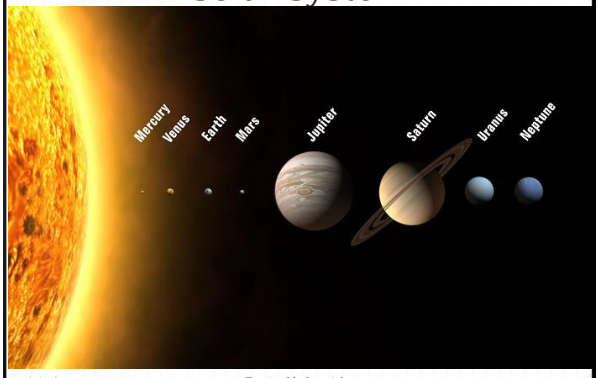


Question of the Day #1

Draw the best diagram of our solar system that you can in your notes. Make sure to include labels!

Solar System



Chapter 29 Solar System Objectives

1. **Describe early models of our solar system. This means I can:**
   a. Explain the geocentric model of the solar system and how **retrograde motion** brought change to that model.
   b. 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:**
   a. 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.**
   b. 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.

Objectives, Cont'd (p3)

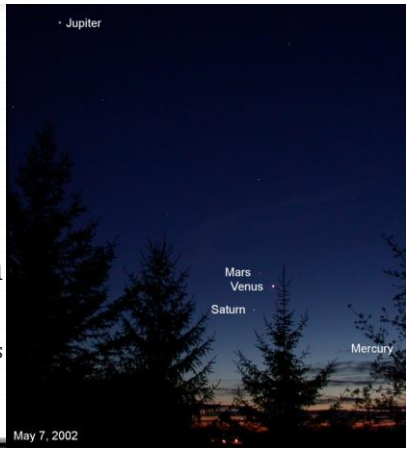
4. **Summarize the properties of the solar system that support the theory of the solar system's formation. This means I can:**
   a. Describe how the planets formed from a disk surrounding the young Sun.
   b. Define & describe how the following terms are involved in the theory of the solar system's formation: **interstellar cloud, solar nebula, planetesimal, equatorial plane.**
   c. Explain how the theory is supported by the types of elements and density differences of the inner terrestrial vs. outer gas giants.
   d. 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:**
   A. Define **asteroid.** Identify the location of the asteroid belt on a solar system diagram.
   B. Differentiate between **meteor shower, meteoroid, meteor,** and **meteorite.**
   C. 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.
   D. Discuss the location of the two main clusters of comets, including how far they are from the sun in astronomical units.

Objectives, Cont'd (p2)

6. **Compare and contrast the properties of the inner/terrestrial vs. outer/gas planets. This means I can**
   a. Describe similarities and differences in composition, size, surface, composition (main elements), density, rings, number of moons.
   b. Explain why/how the inner and outer planets are composed of different substances.
   c. Name the 4 terrestrial planets and the 4 gas planets.

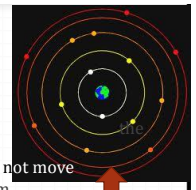
Planets May Look Like Bright "Stars" from Earth

How can scientists tell planets and stars apart??



4/19/2016

Sec 29.1 Early Astronomers



Research & Ideas

1. Ancient astronomers could recognize difference between stars and planets
   - A. Planets move, stars are stationary & do not move
2. **Geocentric** Model –1st model of solar system
   - A. Geocentric = Earth is the center of the universe
     - Believed the Sun, planets, and stars orbited a stationary Earth
   - B. Problem: Didn't explain **retrograde motion** which is a sudden change in planetary motion when planets suddenly **appear** to move backwards What is "retro music", "retro Jordans" (shoes)?
     - i. Most planets appear to move from west to east
     - ii. But sometimes they suddenly appear to move east to west
     - iii. Very hard problem to solve
     - iv. Scientists began looking for a better model of the universe/solar system

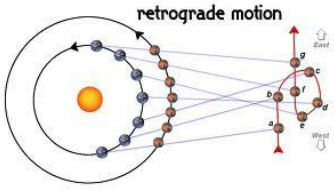
Geocentric Model of the Universe Xtra info

Problem =

Retrograde Motion

Very hard problem to solve

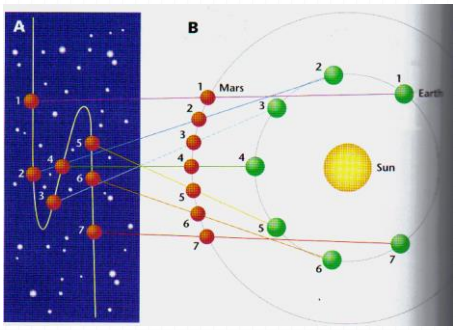
Scientists began looking for a better model of the universe/solar system.



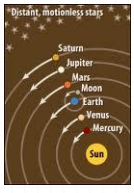
VIDEO
http://www.youtube.com/watch?v=ln1fHZvRr8o

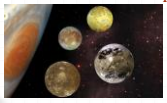
Fig 29.1 Retrograde Motion, p.776

What is the REASON Mars APPEARS to move backwards below?

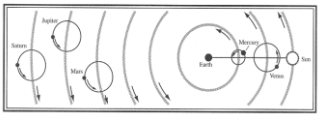


Heliocentric Model

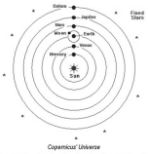




3. **Heliocentric Model** = Sun-centered
   - A. Suggested by **Copernicus** in 1543
   - B. Explained retrograde motion…So **WHY** do we see planets moving "backwards"?
     - i. Inner planets move faster than outer planets around the sun
     - ii. Earth will "pass" a slower moving planet
     - iii. The slower planet temporarily appears to move backwards
4. Galileo's discoveries also support heliocentric
   - A. 4 moons orbited Jupiter not the Earth (now known Jupiter has >= 67moons)



Cartoon



Quick History Review

http://www.youtube.com/watch?v=iiBIFlvu-X0&feature=related

http://www.youtube.com/watch?v=cWPKnQ5yyB4&feature=related

Question of the Day #3

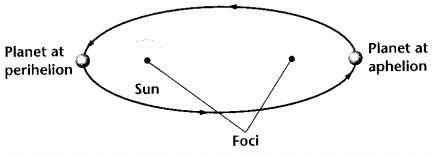
Predict the meaning of aphelion & perihelion.

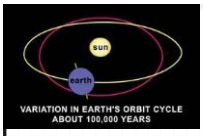
Question of the Day

****HINT: Think about other words you know that have similar prefixes and suffixes!**

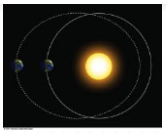
Kepler's First Law

5. **Kepler's 1st Law:** Most planets orbit the Sun in an ellipse, NOT a circle
   - A. Ellipse = Oval that is centered on **TWO** points (foci), not 1 like a circle
     - (Focus – singular, foci – plural)

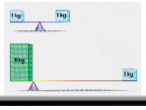


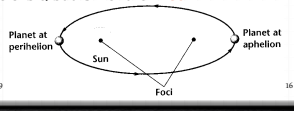


Kepler's First Law, cont. - 3



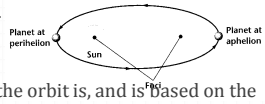
- **B. Most planets orbit the Sun in an elliptical shape**
  - i. Earth being the exception
    - Earth believed to move between an elliptical orbit and a circular orbit every 100,000 yrs or so.
    - http://www.youtube.com/watch?v=tw5MvHNw0Co
- **C. Planets orbit while staying centered around 2 points.**
  - i. The Sun is one point
- **D. Orbit is around the "center of mass" of the 2 bodies (Sun & planet)**
  - i. Sun is NOT the center of the orbit, but is 1 of the 2 foci





Kepler's First Law, cont-4

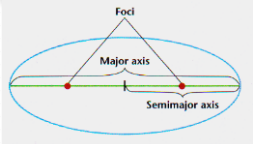
Eccentricity &Aphelion/Perihelion



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

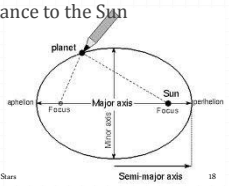
1. Planets vary in their distance from the Sun, therefore the distance between focus points is different for each planet.
2. A planet is NOT at a constant distance from the Sun
3. **Perihelion –** closest point of a planet's orbit to the Sun
4. **Aphelion –** farthest point
5. **1 Astronomical Unit (AU)**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



Kepler's First Law – cont 5

Axis – Major vs. Semimajor

6. **Major axis:** runs end to end through both foci.
   - Is the maximum diameter
7. **Semimajor axis:** ½ length of major axis.
   - Is the planet's average distance to the Sun

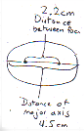


Procedure:

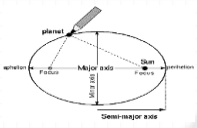
Eccentricity Mini Lab Instructions

1. Tie a piece of string into a loop that fits on a piece of cardboard when it is laid out in a circle.
2. Place a sheet of paper on the cardboard.
3. Stick 2 pins through the paper close to the center but separated from each other by 2cm. (The yellow pin represents the Sun)
4. Loop the string over the pins and use a pencil to trace around them. Keep the string taut.
5. Record the following in the data table below:
   A. Measure the major axis and the distance between the pins.
   B. Calculate the eccentricity. (See the example calculation above.)
6. Repeat steps 3-5 with foci 9 cm and 0 cm apart.

Example: Eccentricity = Distance between the foci / Distance of major axis



Eccentricity = 2.2cm / 4.5cm = 0.48



Eccentricity: Mini Lab Questions

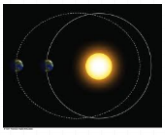
Distance foci are apart	Length of major axis in cm –Longest length (use 1 decimal)	Equation / Calculation (Show your work)	Eccentricity Value (Calculation answer)	Describe/Draw Relative Shape of Drawing
2cm				
9cm				
0cm (Just use 1 pin)				

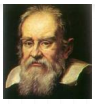
Analyze and Conclude:

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:
   A. The distance between the foci (pins) gets larger?
   B. 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 Values:
What is the range?

6. **Eccentricity has a value between 0 to 1**
   - 0 = perfect circle (Distance between the 2 foci is 0)
   - 1 = very elongated oval





Gravity (& Galileo)

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**

WHAT DID HE DISCOVER?? LET'S RECREATE GALILEO'S EXPERIMENTS:

Need: Timers, masking tape, bin of objects to drop

Experiment: Testing Gravity's Influence on Falling Objects

1. **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.
2. **Record your object choices in the data table below:

Object	Trial #1	Trial #2	Trial #3
1.			
1.			
1.			
1.			

Gravity Activity Cont'd

Time for Predictions:

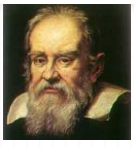
1. Out of all the objects you selected, what will fall to the ground most quickly?
2. Out of all the objects you selected, what will fall to the ground most slowly?

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?



Gravity (& Galileo)

Post-Lab Animation – Elephant vs. Feather Free-Fall

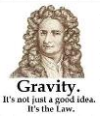
1. In the late 16th century early 17th century Galileo was working with gravity.
2. Performed experiments dropping objects off the Tower of Pisa and rolling balls down inclines
3. Gravity accelerates the fall of all objects at the same rate.
4. Air resistance causes lighter objects to fall more slowly.

Gravity (& Newton)

Sir Isaac Newton & Gravity

1. **1687 Newton published his theory 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.
3. **Basics of the Inverse Square Law:**
   - Any two objects attract each other
   - Depends upon their masses AND the distance between them.

Law



This knowledge of gravity produced the law of universal gravitation.

(Don't need to know equation)

$$F = G\frac{m_1 m_2}{d^2}$$

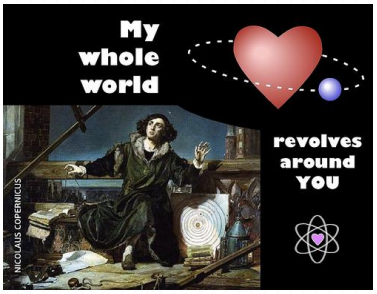
G = Constant
6.6726×10^{-11}

The larger the objects (m) the stronger the force of gravity between them.

The farther apart the objects (d) the weaker the force of gravity.

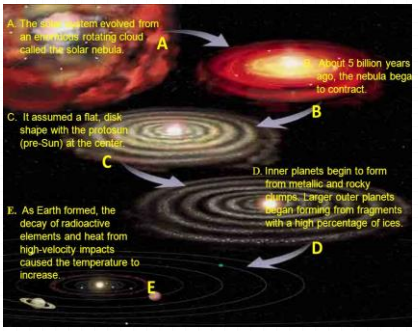
1. Distance squared weaker

Nerdy Valentines



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

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



http://images.slideplayer.com/21/6269683/slides/slide_5.jpg

Formation of Our Solar System
Section 29.4

Collapsing Interstellar Cloud Theory- of Solar System Formation

Interstellar Clouds = Huge clouds of gas & dust in space

1. Made mainly of hydrogen (H_2) and Helium (He)
2. Forms stars and planets when the cloud condenses/collapses due to gravity

Formation of Our Solar System
continued - 2

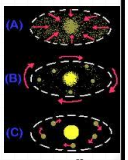
3. **These clouds usually look dark because the dust blocks light.**
   - Like Smog
   - Stars behind this cloud can't shine through it.
   - But….Sometimes the light from stars within the cloud causes these interstellar clouds to glow.

Formation of Our Solar System
continued - 3

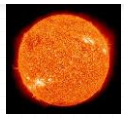
4. **Location**
   A. There are many interstellar clouds found within our Milky Way Galaxy.
   B. Astronomers look for high amounts of gas and dust

Formation of Our Solar System
continued - 4

5. **Collapsing Interstellar Cloud Theory**
   A. When enough gas and dust is present, scientists think these interstellar clouds condense because of gravity.
   B. Can form a star or planet
   C. Cloud begins collapsing slowly.
   D. The smaller it gets the faster it begins to collapse and spin
   E. This spinning motion with eventually form a flat rotating disk with a very dense center (core).



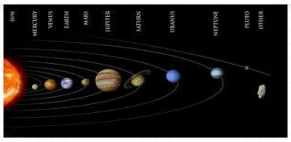
Formation of OUR Solar System



Solar Nebula

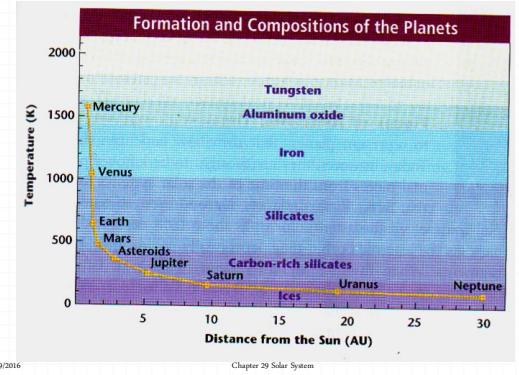
1. Scientist believe that one huge interstellar cloud called the solar nebula formed the Sun and all the planets.
2. The Sun formed first in the center of this cloud.
   - Fits with why our Sun is the brightest and most dense thing in our solar system.
3. In the center of the cloud it was the hottest
4. On the edges of the cloud it was the coldest

Formation of OUR Solar System

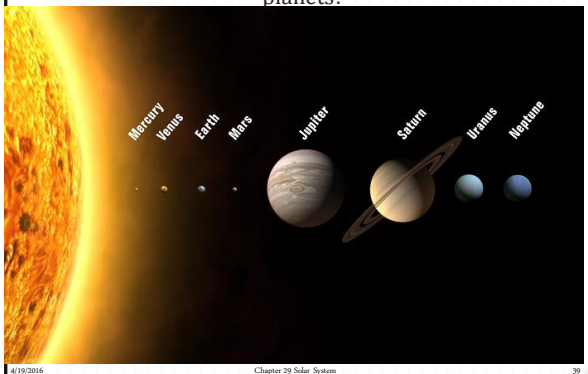


5. **This difference in temperature as the solar system cooled caused different materials to condense at different distances/regions from the sun**
   - A. Heavy metals (iron, lead, etc.) condense at high temperatures and became solids close to the Sun
   - B. Lighter elements with smaller atomic mass (hydrogen, helium, etc) don't condense until the temperature is very cold. They remained gaseous and didn't become solid until they were further from the Sun
   - C. **This is why** inner planets and outer planets have such different compositions

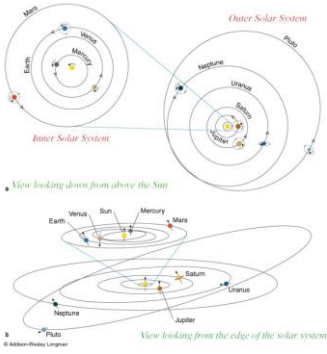
Fig 29-28 p.795 Element Composition of Planets

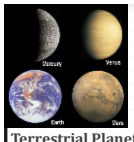


What are differences you can see between inner & outer planets?



Inner vs. Outer –Distance from Sun



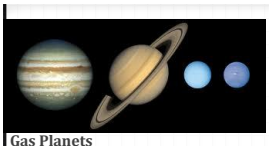


Terrestrial (Inner) Planets

Terrestrial Planets

****What does terrestrial mean? Composed of "land"**

1. **Inner Four Planets**
   - A. Closest to the Sun
   - B. Mercury, Venus, Earth, and Mars
2. **Small (Close to the size of Earth)**
   - A. Smaller because the Sun's gravity captured the majority of materials found here
3. **Solid Surfaces**
   - A. Made of Rocks and Metals. AKA "Heavy Metal" planets , because higher mass elements condensed at high temps close to the sun
4. **Few Moons**
   - A. Sun's gravity took all the loose debris

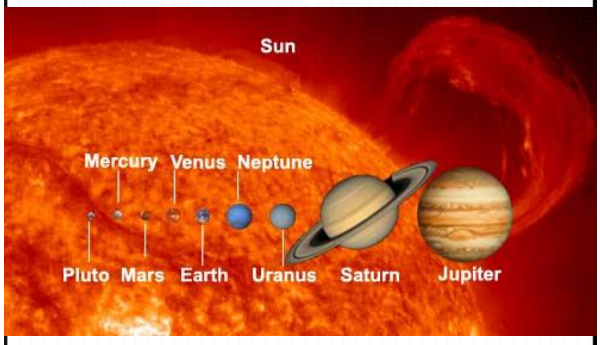


Gas Giant (Outer) Planets

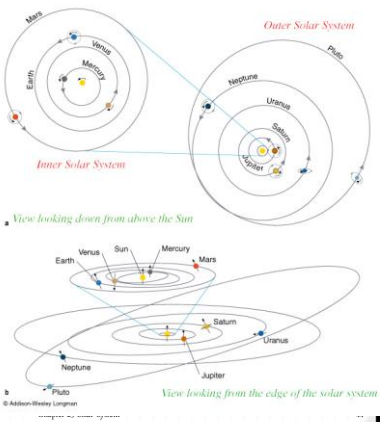
Gas Planets

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

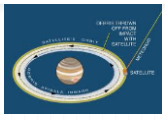
Approximate Size of Planets



Orbit Size & Equatorial Planes of Planets



Development of Outer Planets



Outer Planet Formation

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

Development of Inner Planets

Inner Planet Formation

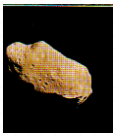
1. As materials (rock, metal, ice) condense and become solid, they collide and stick together.
2. **Planetesimals** = Space objects (100's of km in diameter) made by colliding and sticking solid particles
3. **Inner Terrestrial Planets** formed by colliding and sticking planetesimals
   - A. Made of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

Cartoon

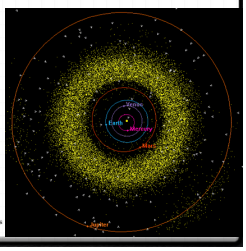
Space Rocks 101A (AKA Debris)

Asteroids = Leftover pieces of planetesimals

1. Asteroids were never planets
2. Asteroids can collide and break apart.
3. Asteroid Belt = Planetesimals left behind in a band between Jupiter & Mars
   - A. Jupiter's gravity prevented them from merging into a planet



Asteroid "Ida"
56 km (34 miles) wide
Has its own moon, "Dactyl"



Space Rocks 101M
(AKA Debris)

Meteoroid
- When an asteroid or any space material falls toward Earth and enters Earth's atmosphere.

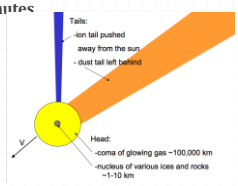
Meteor
- The streak of light produced when a meteoroid burns up in Earth's atmosphere.
- (Think of meteor shower & seeing several streaks of light)

Meteorite
- When a space object impacts Earth
- Occurs when all of the meteoroid does not burn up in Earth's atmosphere
- Leaves a crater until it weathers & erodes
  - Video: Huge Meteorites (downloaded), Meteorite Russia 2013- YouTube

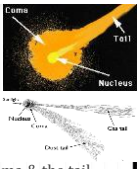
Meteor Crater: Arizona
Gosses Bluff: Australia
6km (4miles) wide
200m (650ft) deep

Space Rocks 101C

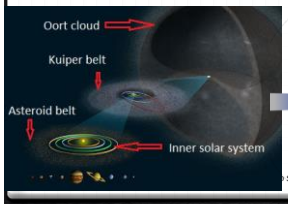
Comet
1. Small icy and rocky bodies with a highly eccentric orbit around the Sun.
2. **Meteor Shower**: Occurs when Earth passes through the **remains** of a comet's orbit
- **Video: Comets (downloaded), 10 minutes**



Space Rocks 101C



3. **Most found in 1 of 2 clusters**
   - A. Kuiper Belt – close to Pluto (30 – 50 AU) from the Sun
   - B. Oort cloud - >100,000 AU from the Sun
4. **Comet Structure (Parts of a comet)**
   - A. Icy nucleus = small, solid core
     - i. When it is heated, it releases gas & dust to form the coma & the tail
   - B. Coma = glowing gas surrounding nucleus
   - C. Tail – always points away from the Sun due to solar wind



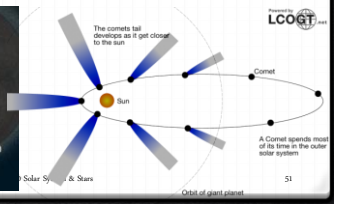
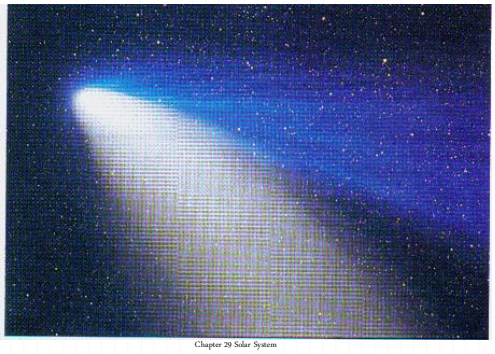


Fig 29-30 Photo of Comet Hale-Bopp in 1997
(Will not be seen again until the year 4397)



Question of the Day #1
(Was also asked earlier in PowerPoint)

Draw the best diagram of our solar system that you can in your notes.
Make sure to include labels!

Question of the Day #2

What was the problem with the geocentric theory?
How did we fix the problem?

Question of the Day #3

(Was also asked earlier in PowerPoint)

Predict the meaning of aphelion & perihelion.

Question of the Day

****HINT: Think about other words you know that have similar prefixes and suffixes!**

Question of the Day #4

Compare and Contrast Heliocentric and Geocentric Theory.

Question of the Day

You may want to use a Venn Diagram

Question of the Day #5

Review your knowledge of eccentricity….Let's see if you can calculate it on your own.

Question of the Day #6

What is retrograde motion?

Who fixed this problem?

Question of the Day #7

<u>Understanding Check</u>:

Write down as many facts as you can about interstellar clouds without peeking at your notes.

Question of the Day #8

1). What is an interstellar cloud?

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

Question of the Day #9

Test your knowledge:
Describe what each planet is made of, gas, ice, rock or metal, and why that makes sense.

Question of the Day #10

Describe the process that produces terrestrial planets.

Please record your response in your notes outline.

Question of the Day #11

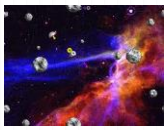
Describe the process that produces gas giant planets.

Please record your response in your notes outline.

Question of the Day #12

Use your notes to draw a diagram of a space rocks journey from being classified as an asteroid to a meteorite.

Please record your response in your note outline.



Miscellaneous Review Questions

1. List 3 characteristics common to all terrestial 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?
7. In the diagram below, what is a vocabulary term for location A?
8. Name the 4 terrestrials
9. What are 2 things that effect gravity?