HW due Today.
1. Read p. 175-180.
2. Summarize the historical account of Brahe and Kepler.
3. Write out Kepler’s 3 laws:
   1) Planets in orbit follow an elliptical path, the Sun is located at a focus of the elliptical path.
   2) A line connecting the planet to the Sun will "sweep out" = areas = times
   3) \( \frac{T^2}{4\pi^2} = \frac{a^3}{\mu} \)
4. Do reviewing concepts 1-3 and appl. Conc 16 on p. 193-194
   RC1: The path of Io is elliptical; Jupiter is located at one of the foci of that elliptical path.
   RC2: The earth is closer to the Sun in the N hemisphere's winter
   RC3: No, the 2nd law applies to each planet individually
4. Do reviewing concepts 1-3 and appl. Conc 16 on p. 193-194
5. Read p. 181 –182
6. Summarize Newton’s Law of gravity and the inverse square concept. Write out the equation

Newton found that the force of gravity decreases both inversely quadratically as objects get farther apart.

\[
F_g = G \frac{m_1 m_2}{d^2}
\]

**Period 4** Egg launches: prototype This Thursday Dec. 13
Final: Wednesday Dec. 19
**Period 8** Egg launches: prototype This Friday Dec. 14
Final: Thursday Dec. 20

Chapter 8
Kepler's Laws and Universal Gravitation
Aristarchus ~230 BCE

1500+ years of not caring about analytical science

Copernicus

1500

late 1500's

Kepler

1500's Copernicus proposes a new heliocentric model

Copernicus' model has issues culturally and mechanically

Tycho Brahe - late 1500's

Most advanced and precise astronomical equipment & data

Does not support Sun at center of solar system

after his dueling mishap
Johannes Kepler - early 1600's

uses the decades of data accumulated by Brahe to develop clear mathematical laws of planetary motion.

Kepler does this without any notion of gravity forces.
1. The paths of the planets around the Sun are elliptical in shape: the Sun is located at one of the foci of that ellipse.

Kepler's 2nd Law of Planetary Motion

Kepler's 2nd Law of planetary motion

An imaginary line connecting the planet to the sun will sweep out equal areas in equal times.

This tells us that the satellites (planets) move faster when closer.
Kepler's 3rd Law:

Summary of 3rd law: All the planets orbiting the same object: The ratio of their periods squared to their orbital radius cubed is a constant

\[ \frac{T_a^2}{T_b^2} = \frac{r_a^3}{r_b^3} \quad \text{or} \quad \frac{T_a^2}{r_a^3} = \frac{T_b^2}{r_b^3} \]
<table>
<thead>
<tr>
<th>Planet</th>
<th>Orbital Period, $T$</th>
<th>$T^2$</th>
<th>Average Orbital Radius, $r$</th>
<th>$r^3$</th>
<th>$T^2/r^3$</th>
</tr>
</thead>
<tbody>
<tr>
<td>units -&gt; planet</td>
<td>Earth years</td>
<td>Years squared</td>
<td>meters</td>
<td>meters$^3$</td>
<td>Yrs$^2$/m$^3$</td>
</tr>
<tr>
<td>Mercury</td>
<td>0.241</td>
<td>0.058081</td>
<td>5.79E+10</td>
<td>1.94E+32</td>
<td>3.00E-34</td>
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<tr>
<td>Venus</td>
<td>0.615</td>
<td>0.378225</td>
<td>1.08E+11</td>
<td>1.26E+33</td>
<td>3.00E-34</td>
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<tr>
<td>Earth</td>
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<td>1</td>
<td>1.49E+11</td>
<td>3.33E+33</td>
<td>3.00E-34</td>
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<tr>
<td>Mars</td>
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<td>3.538161</td>
<td>2.28E+11</td>
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<td>3.00E-34</td>
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<tr>
<td>Jupiter</td>
<td>11.88</td>
<td>141.1344</td>
<td>7.78E+11</td>
<td>4.71E+35</td>
<td>3.00E-34</td>
</tr>
</tbody>
</table>

Isaac Newton!
Newton proposes gravity is a UNIVERSAL Force!

\[ F_g = G \frac{m_1 m_2}{d^2} \]