### Week 4

<table>
<thead>
<tr>
<th>Parent Information</th>
<th>Planetary Motion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Newton’s Laws of Motion:</td>
<td>1. An object in motion remains in motion until acted upon by an unbalanced force. This is called inertia.</td>
</tr>
<tr>
<td></td>
<td>2. Force = Mass x Acceleration</td>
</tr>
<tr>
<td></td>
<td>3. Every action has an equal and opposite reaction.</td>
</tr>
<tr>
<td>Kepler’s Laws of Planetary Motion</td>
<td>1. Law of Ellipses: planets orbit the sun in a path called an ellipse, not a circle. An ellipse has two foci that determine its shape. The sun is one of the foci, and there is no object at the second foci. <strong>Eccentricity</strong> refers to the degree of elongation of the ellipse. It is calculated by dividing the distance between the foci by the distance along the major axis. (see diagram)</td>
</tr>
<tr>
<td></td>
<td>2. Law of Equal Areas: Planets move faster in their orbital paths as they get closer to the sun. A line drawn from the sun to the planet will pass through equal areas of space in equal periods of time. (see diagram)</td>
</tr>
<tr>
<td></td>
<td>3. If the average distance of a planet from the sun = ( a ), and ( p ) = the orbital period (time it takes to orbit the sun once), then ( K \times a^3 = p^2 ) if you measure the period in Earth years and the distance in Astronomical Units (AU) then ( K = 1 ), so ( a^3 = p^2 ).</td>
</tr>
</tbody>
</table>

### Benchmark

**SC.912.E.5.6** Develop logical connections through physical principles, including Kepler’s and Newton’s Laws about the relationships and the effects of Earth, Moon, and Sun on each other.

### Objective

### Duration

### Materials

1. Thumbtacks
2. String (7-8 inches)
3. Tape
4. A thick piece of cardboard, about 12 inches square.
5. Graph paper
6. Markers, Crayons or Colored Pencils
7. Pencil
8. Ruler (metric)

### Procedures

1. Place a sheet of graph paper over the cardboard. Use small pieces of tape on the corners to hold it in place.
2. Place the two tacks a small distance apart (2-3 inches), pinning down the ends of the string, creating a loop. Be sure to leave some slack in the string.
3. Place your pencil inside the string loop and pull the loop taut, draw an ellipse.
4. Now measure and write down the distance between the foci AND the length of the major axis of the ellipse.
5. Divide the distance between the foci by the length of the major axis. This quantity is known as the eccentricity, "\( e \)."

\[
e = \frac{\text{distance between foci}}{\text{major axis}}
\]
9th Grade Science Summer Activity

Discussion Questions:
1. What is the eccentricity of the ellipse you drew?
2. What familiar shape is an ellipse with an eccentricity e=0.0?
3. What two forces are acting on the planets as they orbit the sun?

FCAT Practice
1. Which of the following did Isaac Newton discover about gravity?
   A. planets orbit the sun in elliptical pathways
   B. free-falling bodies accelerate at a constant rate
   C. gravity is the effect of objects with mass "bending" the space around them
   D. the law of gravitation applies to all objects in the universe, not just on Earth

Extra Help
http://www.mtholyoke.edu/courses/mdyar/ast223/orbits/orb_lect.html

LAW OF ELLIPSES:

Figure 3.2
LAW OF EQUAL AREAS:

LAW OF PERIODS: