Earth's Motions—The Law of Orbits   Name _____

                                          Partner _____

                                          Class _____ Lab _____

                                          Date _____

Problem: Is there any sort of pattern which can be identified in the motions of satellites in their orbit around their primaries?

Objective: At the end of this laboratory activity, the students will be able to:
        1) describe the relationship between the **position** of a satellite in its orbit and its **speed** along its orbit during **equal periods/lengths of time**,
        2) describe the pattern of change in the **"radius distance"** which is the distance of the satellite from the body it is orbiting (its "primary"),
        3) describe the relationship between the areas covered or gone over by a radius line (a line drawn between the satellite and its primary) during **equal periods of time** as the satellite travels in its orbit,
        4) describe the **location of the satellite's primary** in terms of/relative to the orbital pattern of the satellite,
        5) list some of the properties that the orbits of all satellites have in common.

Background Information:
        The diagram of a hypothetical orbit of a satellite going around its primary has been divided into 12 equal sections. The **length of the arcs between the numbers is NOT the same**, BUT the **amount of time it took the satellite to travel from one number to the next IS THE SAME.** In other words it took the satellite the same amount of time to travel in its orbit from 1 to 2 as it did to travel from 2 to 3, or from 3 to 4, etc. This diagram reflects how satellites actually do travel in their orbits around their primaries. The sectors of the diagram are lettered A through L. The 12 radii are numbered from 1 to 12.

Procedure:
→**For Radius Lengths**
1) Each of the sectors in the diagram has a radius on either side of it. These need to be measured using an arbitrary scale using a "ruler" you will make for yourself. Use a 3" x 5" card to make a copy of the "DISTANCE SCALE" found on the same page as the diagram of the orbit. Make your "ruler" long enough to measure the longest radius in the diagram.
2) Measure both of the radii found on either side of Sector A. Record the lengths in the appropriate spot in the DATA TABLE.
To finally calculate the area of Sector A we will need to know the average of these two radii. So average the two lengths and enter that number in the appropriate place in the DATA TABLE. Do this all the way around the diagram. Think about what you need to

do when you get to sector L in terms of which two radii you need to use to get the average.

3) The equation we will be using to calculate the area of the sectors needs to have the SQUARE of the average radius length, so now square each of the averages and enter that number in the appropriate space in the DATA TABLE.

➔For Sector Angles

4) Use a protractor, and some common sense, to measure the angle of each sector of the diagram. Record this information in the appropriate space in the DATA TABLE.

Calculations:

5) You need to visualize this satellite orbiting its primary with its changing radius distances and sector angles. Each of the sectors created has an area of space created by the motion of the satellite. To calculate the area of this space we will use the following equation:

$$\text{RADIUS AREA} == \frac{\text{Sector Angle}}{360^o} \ \textbf{X} \ \text{Squared Average Radius Length}$$

There is a separate Calculations Table in which **you will show all your calculations**. (By showing them it is usually easier to see where you have made any errors.) Follow this procedure:

    a) Plug YOUR numbers into the equation for each sector,

    b) calculate the radius areas for each sector **to the nearest tenth**, show this number in the Calculations Table,

    c) record you final answer in the DATA TABLE **rounded off the nearest whole number.**

Graphing Your Results:

Often putting your numbers on graphs will show relationships that may not be as obvious otherwise. To help see the relationships we want to learn about in this lab work, we will make two separate graphs.

6) On the first graph use two different colored pencils to plot the 12 radius lengths you measured and also the 12 sector angles. Connect the points into two separate lines using the colored pencils.

7) On the second graph plot the data you have calculated for Radius Area. Then do a "dot-to-dot" type line connecting the plotted points. Then in a pencil of another color draw a "best fit" line "connecting" the points.