Lab 14-2: **Kepler's 3rd Law**

Purpose: Find the relationship between the period of a planet and its distance to the Sun.

Procedure:

1. Using Logger Pro, make a graph of Period vs Radius for the planets of our solar system. (Technically, Pluto isn't considered a planet anymore, but we will plot it anyway.)
2. Square all the periods and cube all the radii. Put your answers in the chart.
3. Now make a graph of T^2 vs R^3. This should result in a straight line; include the best fit line.

Data:

Planet	*Period of Orbit (years)*	*Radius of Orbit (Gm)*		*T^2 (yr^2)*	*R^3 (Gm^3)*
Mercury	0.24	58.3			
Venus	0.62	108			
Earth	1.00	150			
Mars	1.88	227			
Jupiter	11.86	778			
Saturn	29.46	1430			
Uranus	84.01	2870			
Neptune	164.8	4500			
Pluto	247.7	5900			

Graphs:

Either print out the graphs, or sketch them here. Make sure to put the correct labels and units and any slopes.

Conclusions:

1. From your graph, what is the equation that relates the period of a planets' orbit to the radius of its orbit?

2. The asteroid Ceres is 414 billion meters away from the sun. How long would it take to go around the sun?

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3. If it took an asteroid 35 years to go around the Sun, what would be the radius of its orbit?

Derivation:

Exciting New Section! Let's derive an expression that relates the period of a planets orbit to the radius of its orbit. We will use the following letters to represent the following things:

M = mass of Sun
m = mass of a planet
T = period of planet's orbit
R = radius of planet's orbit
v = speed of planet around sun

1. What would be the force of gravity between the planet and the Sun?

2. Are there any other forces acting on the planet?

3. The planet is moving in a circle around the sun. What is the centripetal force on the planet?

4. Why does the force of gravity have to be equal to the centripetal force?

5. Set the centripetal force equal to the gravitational force. Then simplify what you can.

6. Almost done! If you know the radius and the period for something moving in a circle, how would you calculate its speed?

7. Now the hardest part: substitute your equation for "v' into the v that you had in step 5. Simplify what you can (first squaring the term for v) and solve for T^2.

8. What does the slope of your graph from the lab depend on? Look at what you just derived in #7.

9. How do astronomers determine the masses of planets with moons and stars with orbitting bodies?