Assignment: Ellipse Application

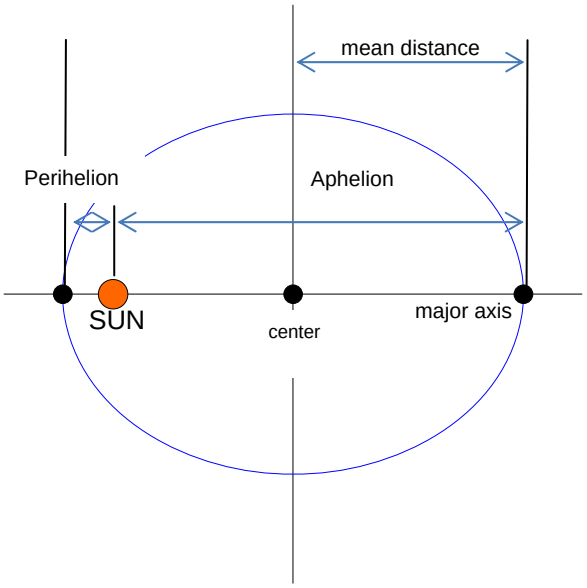
The planets in our solar system do not travel in circular orbits. Rather, their orbits are elliptical in shape with the Sun located at one of the foci of the ellipse. The major axis of the elliptical orbit lies along the *x*-axis.

The **perihelion** is the closest a planet comes to the Sun.

The **aphelion** is the planet's furthest distance from the Sun.

A planet's **mean** distance from the Sun is equal to one-half of the length of the major axis of the ellipse, as shown in the figure below.

In the sketch below, elliptical orbit is exaggerated to demonstrate the difference between the perihelion and the aphelion. In reality, the orbit is much more circular.



Think about the elliptical orbit of the planet Mercury. The closest that Mercury comes to the Sun is about 46 million miles, while the farthest away is about 70 million miles.

Use this information and the standard equation for an ellipse to solve each problem. Show all work leading to your answer. Write explanations for your answers using complete sentences. For all calculations use "million miles." For example, write "46 million miles" rather than "46,000,000."

Assignment

1. What are the aphelion and perihelion of Mercury? Explain what each of these measurements means.

2. The sum of the aphelion and perihelion is equal to the length of the major axis of the elliptical orbit. Find the approximate length of Mercury's major axis.

3. Use the length you calculated for the major axis to find Mercury's mean distance from the Sun.

4. The equation for an ellipse with a horizontal major axis is $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$. The orbit for Mercury can be plotted on the coordinate plane with the center at the origin and the Sun located at one focus. Use this information and the Mercury's calculated mean distance from the Sun to find the value of *a.* Express your answer in millions of miles.

5. To write an equation for the elliptical orbit of Mercury, it is necessary to find the value of *b*. The equation $b^2 = a^2 - c^2$ can be used to find the value of *b*. Find the value of *b* rounded to the nearest million miles. (Hint: *c* is equal to the coordinate of the focus, which is the location of the Sun. To find the Sun's location, subtract Mercury's perihelion from its mean distance from the Sun). Explain your steps.

6. Use the approximate values you calculated for *a* and *b* to write the equation for Mercury's elliptical orbit.

7. Even though planetary orbits are elliptical, some are nearly circular. What does the equation you wrote tell you about the shape of Mercury's orbit?