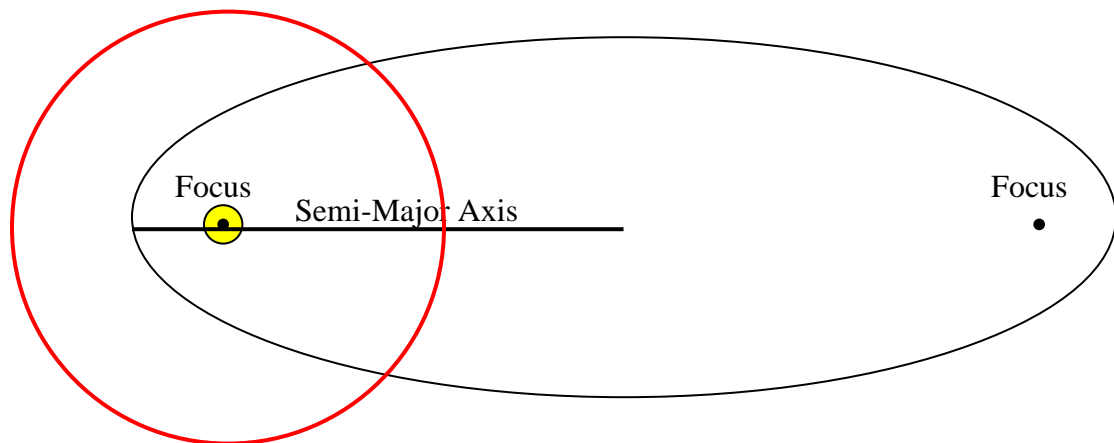


1. Comets generally have highly elliptical orbits:
 - a) Sketch the orbit of an imaginary comet whose semi-major axis is 10 AU (AU, Astronomical Unit is defined as the distance from the Earth to the Sun or about 150,000,000 km)
 - b) Label the semi-major axis, the two foci of the elliptical orbit, and the position of the Sun. **Note the Sun is located at one of the foci of the ellipse.**
 - c) Describe what happens to the shape of the orbit as the two foci move closer together. **As the two foci move closer together, the ellipse becomes less elongated and more like a circle. When the two foci coincide, the ellipse is a circle.**
 - d) Jupiter orbits the Sun in an approximately circular orbit of 5.2 AU. Show the orbit of Jupiter on your diagram (using a different color if possible). **The red circle below represents the orbit of Jupiter. Although not exactly a circle, Jupiter's orbit is much more circular than that of the comet.**



2. How does the period of a planet close to the sun compare to the period of a planet that is far from the sun? Explain.

According to Kepler's 3rd Law, P^2/a^3 is constant (where P is the period of the orbit and a is the length of the semi-major axis). In order that the ratio P^2/a^3 remain constant, the period must increase as the distance from the Sun (semi-major axis is approximately the distance from the Sun for a near circular orbit) increases.

3. A comet is in a highly elliptical orbit about the sun. Describe how the speed of the comet changes throughout the orbit.

When the comet is at its greatest distance from the Sun it is moving the slowest. The comet moves fastest as it passes in close to the Sun. (This behavior was originally understood in terms of Kepler's 2nd law.)

Advanced. The comet Halley returns to Earth every 76 years (and has been observed 28 times since the first record of its observation in 239 B.C.) Estimate its maximum possible distance from the sun.

$P^2/a^3=1 \text{ yr}^2/\text{AU}^3$ (The constant 1 is appropriate when P is measured in years and a is measured in AU.

If we cross multiply we get $P^2 = a^3$ or $a^3 = P^2 = (76)^2 = 5776$. To solve this equation we answer the question, what number multiplied by itself 3 times gives us 5776? The answer is $a = 17.9 \sim 18 \text{ AU}$. This is the length of the semi-major axis. Because it passes so close to the Sun in a highly elliptical orbit, the comet's distance from the Sun is nearly equal to the length of the entire major axis or about 36 AU.