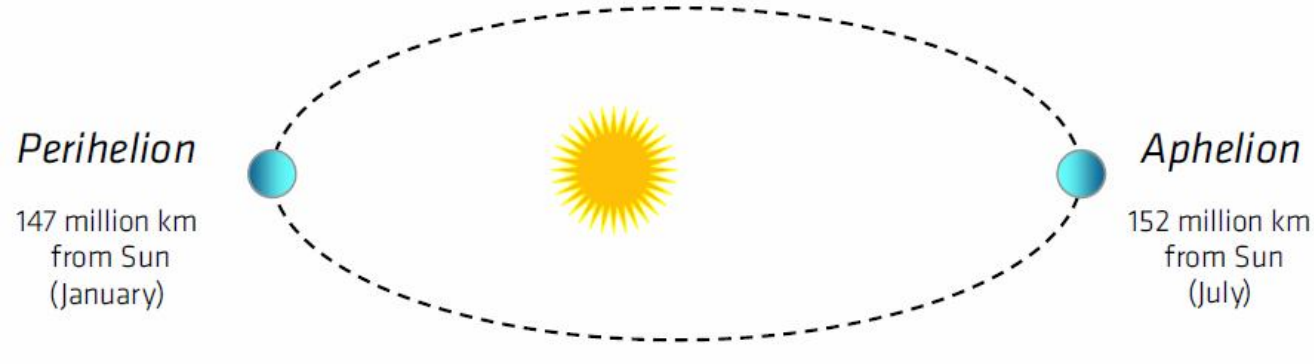
Totally Elliptical – Answer Key

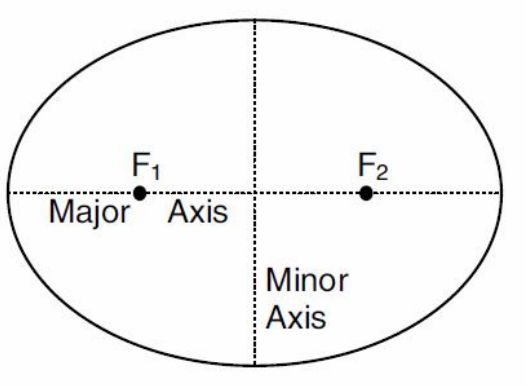
Did you know that Earth's orbit around the Sun is not a perfect circle? Although it is close to being circular, the actual shape of Earth's orbit is described by an ellipse (similar to an oval). All of the planets, their moons, the asteroids, and comets have elliptical orbits. The degree of roundness of an ellipse is called eccentricity. The orbits of all the planets in our solar system are nearly circular and are therefore said to have low eccentricity. Asteroids and comets, on the other hand, may have orbits that are highly eccentric, meaning their orbits are greatly elongated (not round).

Because Earth traces a slightly elliptical path around the Sun, the distance from Earth to the Sun varies over the course of a year. Earth's closest approach to the Sun is called the perihelion. Its most distant point from the Sun, 180° opposite the perihelion, is called the aphelion. The Sun is positioned at one of the foci of the ellipse (the other focus being an imaginary point in space). These spatial relationships are exaggerated in the diagram below.



Many people mistakenly believe that our seasons are caused by variations in the Earth-Sun distance. But notice that aphelion occurs in the middle of winter in the Northern Hemisphere. In fact, it is the tilt of Earth's axis that is responsible for our seasons, not the shape of Earth's orbit.

1) What happens to the eccentricity of an ellipse as you increase the distance between foci?



The ellipse becomes less like a circle and more like an elongated oval.

2) What is the result when the foci are so close together that they become the same point (the distance between them is zero)?

The ellipse becomes a circle.

3) The eccentricity of Earth's orbit is a very low 0.017. If eccentricity is mathematically defined as the ratio of one-half the distance between the foci and one-half the length of the major axis, what is the distance between the foci of Earth's orbit? (Hint: Use the average Earth-Sun distance of 150,000,000 km in the denominator.)

$$\text{Eccentricity} = \frac{One-half\ the\ distance\ between\ F1\ and\ F2}{One-half\ the\ length\ of\ the\ major\ axis}$$

0.017 = one-half the distance between foci / 150,000,000 km

Distance between foci = 0.017 x 150,000,000 km x 2 = 5,100,000 km (1,580,000 miles)

4) Astronomers have determined that the eccentricity of Earth's orbit changes over long periods of time, varying from 0 to about 0.06. This variation is believed to be a factor in global warming and cooling cycles. Why do you think the changing elliptical shape of Earth's path around the Sun could have an effect on global temperatures?

The changing distances between the Earth and sun would change the amount of solar energy reaching Earth at different times of the year. The changing solar energy could affect climate.