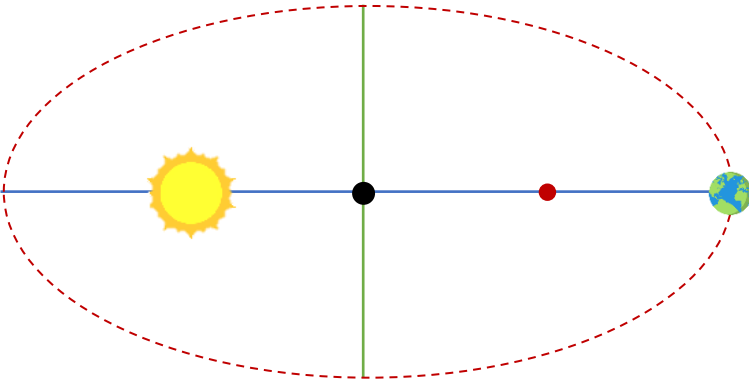


CONCEPT: Kepler's First Law

- All orbits are _____ (even circular ones!) with the Sun at one focus. Nothing physical at other focus.



- Major axis → _____ axis (Length: _____)
 - Closest distance: Perihelion/periapsis
 - Farthest distance: Aphelion/apoapsis
 - Semi-major axis: $a =$ _____
- Minor axis → _____ axis (Length: _____)

- Eccentricity of orbit (e) → # between 0 and 1, measures how _____ the orbit is.

- Lower #s (near 0) are *nearly* [CIRCULAR | ELLIPTICAL]
- Higher #s (near 1) are *very* [CIRCULAR | ELLIPTICAL]
- Eccentricity relates the aphelion & perihelion with the semi-major axis:

$$R_a = \underline{\hspace{2cm}}$$

$$R_p = \underline{\hspace{2cm}}$$

EXAMPLE: Earth's closest distance to the Sun is $1.471 \times 10^{11} \text{m}$, while its farthest distance is $1.521 \times 10^{11} \text{m}$. Calculate **a)** Earth's semi-major axis and **b)** orbital eccentricity.

ELLIPTICAL ORBITS

$$a = \frac{R_a + R_p}{2}$$

$$R_a = a(1 + e)$$

$$R_p = a(1 - e)$$

PRACTICE: Pluto's orbit is the most eccentric of the 9 large objects in our solar system, with $e = 0.25$. The total distance from Pluto's closest to farthest point from the Sun is $1.18 \times 10^{13} \text{m}$. a) How close does it get to the Sun? b) How far does it get from the Sun?

ELLIPTICAL ORBITS

$a = \frac{R_a + R_p}{2}$
$R_a = a(1 + e)$
$R_p = a(1 - e)$