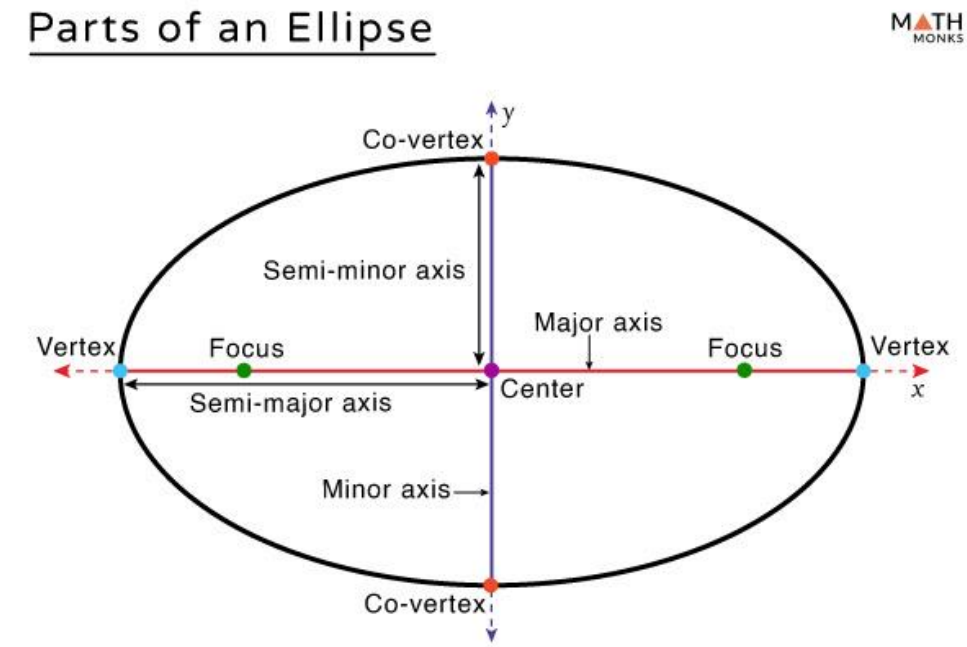
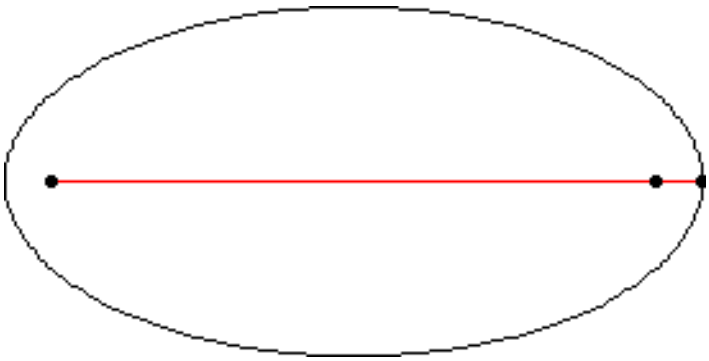
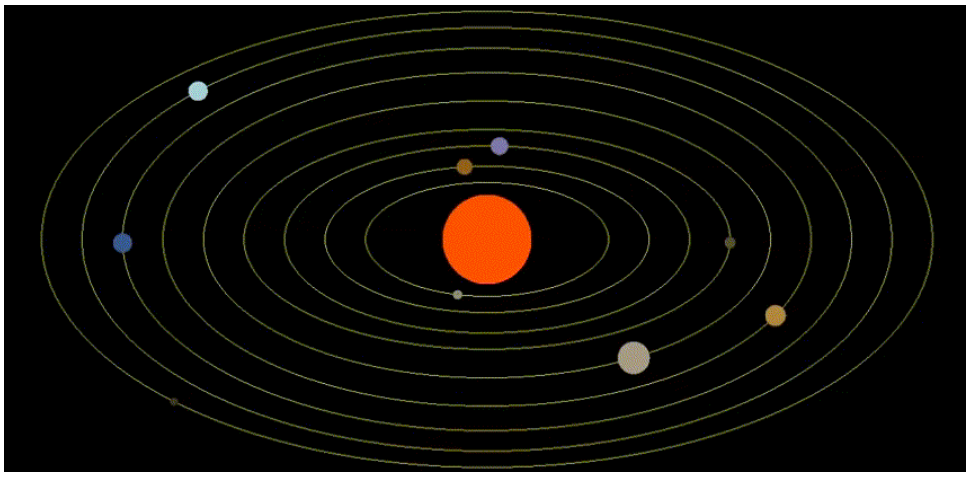
Kepler's Laws of Planetary Motion:

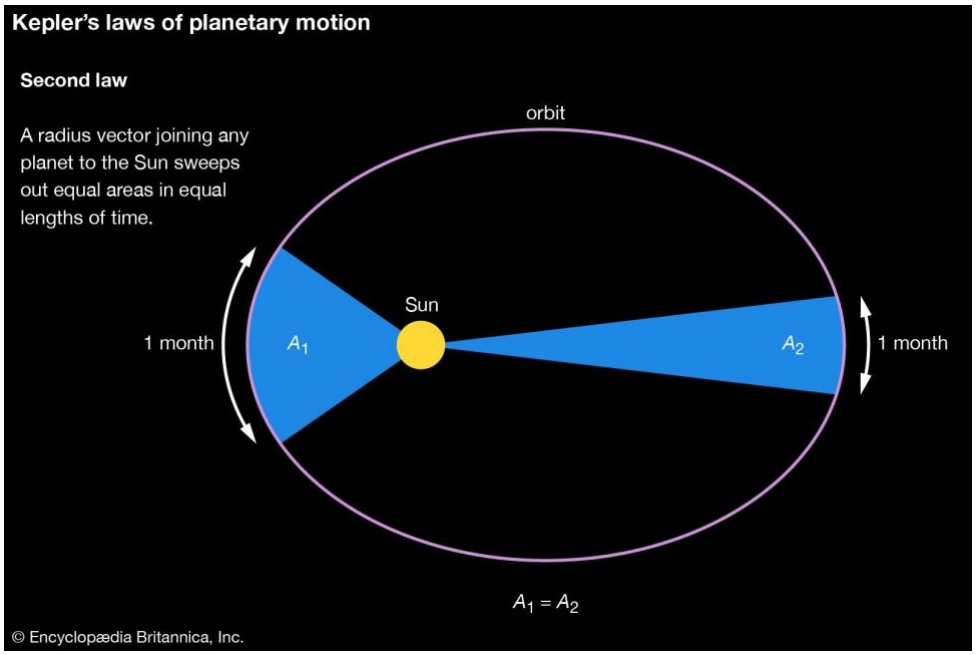
First Law (Law of Ellipses): Planets move in elliptical orbits with the Sun at one of the two foci. *Imagine an elongated circle (an ellipse). A planet doesn't go around the center of this shape but around one focal point where the Sun sits.*



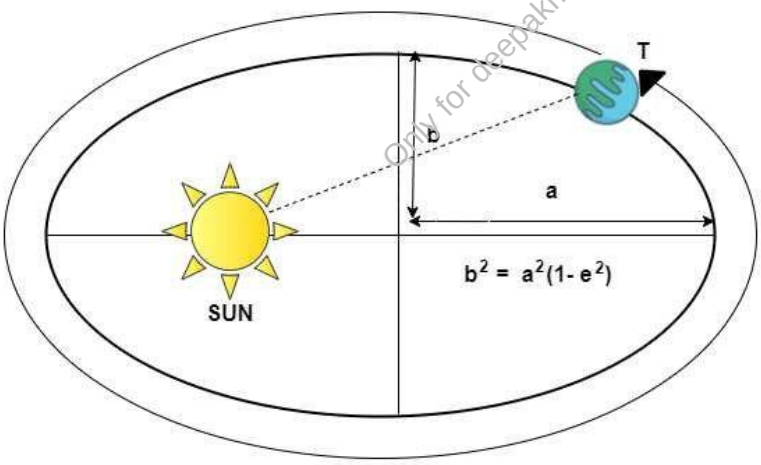




b. Second Law (Law of Equal Areas): A line segment joining a planet and the Sun sweeps out equal areas during equal intervals of time. *Think of a planet moving around the Sun. Sometimes it moves fast, sometimes slow, but if you imagine a slice of pie between the planet and the Sun, that slice will always have the same area over the same amount of time.*



c. Third Law (Law of Harmonies): The square of a planet's orbital period is proportional to the cube of the semi-major axis of its orbit. *This means that planets closer to the Sun orbit more quickly than those further away. If you know the size of a planet's orbit, you can predict how long it will take to go around the Sun.*



$T^2 \propto a^3$

T = Time to Complete Orbit

a = Length of Semi-major Axis

Kepler's Third Law of Planetary Motion

Vector vs. Scalar:

Vector: A quantity that has both magnitude (how much) and direction. *For example, a car moving at 60 mph northward. Here, 60 mph is the magnitude, and "northward" is the direction.*
Examples: Displacement, Velocity, Acceleration, Momentum , Force etc.

Scalar: A quantity that has only magnitude and no direction. *Consider temperature. If it's 30°C, it's just a magnitude. It doesn't have a direction.*
Examples: Distance, Speed, Energy, Work, Power, Electric Current etc.

Newton's Laws of Motion:

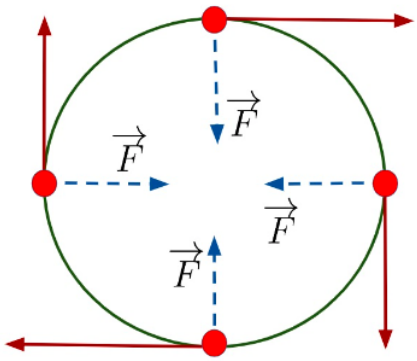
First Law (Inertia): An object will remain at rest or in uniform motion in a straight line unless acted upon by an external force. *Think of a object on a table. It won't move unless you push it, or a moving object won't stop or change its direction uncles a force is applied upon it.*

Second Law: It defines a force to be equal to change in momentum (mass times velocity) per change in time. For an object with constant mass,the force acting on an object is equal to the mass of that object times its acceleration. **(F=ma)**

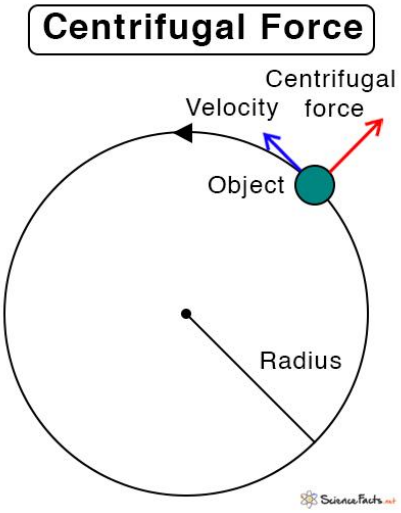
Third Law (Action and Reaction): For every action, there is an equal and opposite reaction. *Jump off a boat, and the boat moves backward. Your action of jumping (forward) has an opposite reaction (the boat moving backward).*

Centripetal and Centrifugal Force:

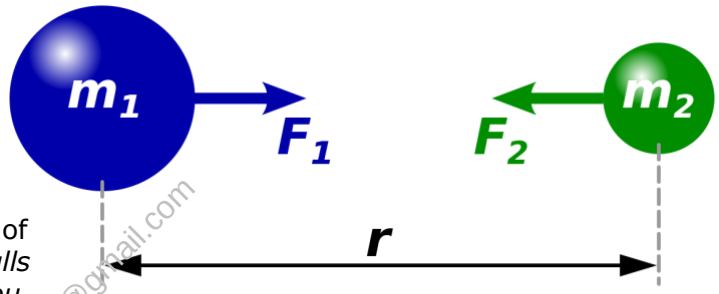
Centripetal Force: A force that acts on an object moving in a circular path, directed towards the center around which the object is moving. *Imagine twirling a ball on a string. The tension in the string pulling the ball toward the center is the centripetal force.*



Centrifugal Force: Often called a "fictitious force" because it appears when you're in a rotating frame. It seems to push objects away from the center. *Inside that twirling ball, it feels like there's a force pushing it outward. This perceived force is the centrifugal force.*



Universal Law of Gravitation:
Every particle of matter in the universe attracts every other particle with a force that is directly proportional to the product of their masses and inversely proportional to the square of the distance between their centers. *The Earth pulls you towards it (gravity), and believe it or not, you pull the Earth towards you too (just much, much less because you're much smaller). The further away two objects are, the weaker the pull.*



$$F_1 = F_2 = G \frac{m_1 \times m_2}{r^2}$$