

9Th Class

➤ Gravitation

❖ Introduction:

- **Gravitation:** The force of attraction between two masses.
- **Universal Law of Gravitation:** Every point mass attracts every other point mass in the universe 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.

$$F = G \cdot m_1 \cdot m_2 / r^2$$

where:

- F is the gravitational force,
- G is the gravitational constant ($6.67 \times 10^{-11} \text{ N} \cdot \text{m}^2 / \text{kg}^2$),
- m_1 and m_2 are the masses of the objects, and
- r is the distance between the centers of the masses.

Weight and Mass:

- **Weight:** The force with which an object is attracted towards the center of the Earth or any other celestial body. $W = m \cdot g$ where:
 - W is the weight,
 - m is the mass of the object, and
 - g is the acceleration due to gravity (9.8 m/s^2 on Earth).
- **Mass:** The amount of matter in an object. It is a scalar quantity and remains constant regardless of the location.

Free Fall:

- **Free Fall:** The motion of an object under the influence of gravity only, with no other forces acting on it.
- **Acceleration due to Gravity:** The acceleration an object experiences due to the gravitational pull of a massive body.

Kepler's Laws of Planetary Motion:

1. **Law of Orbits:** Planets move in elliptical orbits with the sun at one of the foci.

2. **Law of Areas:** A line segment joining a planet and the sun sweeps out equal areas during equal intervals of time.
3. **Law of Periods:** The square of the orbital period of a planet is directly proportional to the cube of the semi-major axis of its orbit.

Escape Velocity:

- **Escape Velocity:** The minimum velocity an object must reach to break free from the gravitational attraction of a massive body.

$$v_e = \sqrt{\frac{2 \cdot G \cdot M}{R}}$$

where:

- v_e is the escape velocity,
- G is the gravitational constant,
- M is the mass of the celestial body, and
- R is the distance from the center of the celestial body to the point where escape is desired.