



Gravitation

Centripetal force :- The force acting on an object moving in a circular path and is directed towards the centre is called centripetal force. It always acts towards the centre of the circular path.

Universal Law of Gravitation :- According to Universal law of gravitation, every object in this universe attracts every other object with a force which is directly proportional to product of their masses and inversely proportional to square of distance between them.

$$F = \frac{G m_1 m_2}{d^2}$$

$G \rightarrow$ Universal Gravitation Constant

$$G = 6.67 \times 10^{-11} \text{ Nm}^2/\text{kg}^2$$

Importance of Universal law of Gravitation

- ① Gravitational force binds us to the Earth.
- ② It is the reason for the motion of moon around the Earth and planets around the Sun.
- ③ It causes tides due to the moon and the Sun.

Free Fall

- Whenever objects fall towards the Earth under gravitational force alone, we say that the objects are in free fall.
- The acceleration of an object under free fall is called acceleration due to gravity.
- It is represented by 'g'.
- $g = 9.8 \text{ m/s}^2$



$$g = \frac{GM}{R^2}$$

$M \rightarrow$ Mass of Earth

$R \rightarrow$ Radius of Earth

Variation of 'g'

① Radius at equator $>$ Radius at poles

As the value of ' R ' increases, the value of ' g ' decreases

\therefore ' g ' at equator $<$ ' g ' at poles

② As we go above the surface of the Earth, the value of ' g ' decreases.

$$g = \frac{GM}{(R+h)^2}$$

Motion under gravity

By applying equations of motion for a freely falling object,

$$a = 'g'$$

$$s = 'h'$$

we have,

$$v = u + gt$$

$$h = ut + \frac{1}{2}gt^2$$

$$2gh = v^2 - u^2$$

Take, $g = \oplus$ when an object falls downwards

$g = \ominus$ when an object is thrown upwards

Mass and Weight

• The quantity of matter contained in an object is called mass.
It's S.I unit is ' kg '.

It is a scalar quantity.

Mass of an object is constant everywhere.



• The force of attraction of the Earth on the object is known as weight of the object.

• $W = mg$

• It is a vector quantity

Weight of an object on the surface of Moon

Weight of an object on Moon (W_m) = $\frac{1}{6} \times$ Weight of an object on Earth (W_e)

$$W_m = \frac{1}{6} \times W_e$$

Thrust

The force acting on an object perpendicular to surface of an object is called thrust.

Pressure

The thrust acting per unit area is called pressure.

$$\text{Pressure} = \frac{\text{Force}}{\text{Area}}$$

• Its S.I Unit is Pascal (Pa) or N/m^2 .

Buoyant Force

The upward force exerted by the fluid on an object immersed fully or partially in it is called buoyant force. This phenomena is called buoyancy.

$$F_b = \rho V g$$

$F_b \rightarrow$ buoyant force

$\rho \rightarrow$ density of fluid

$g \rightarrow$ acceleration due to gravity

$V \rightarrow$ volume of the fluid displaced



Why do objects float or sink in water?

- Density of object $>$ Density of water \Rightarrow Object will sink
- Density of object $<$ Density of water \Rightarrow Object will float

Archimedes' Principle

When a body is immersed fully or partially in a fluid, it experiences an upward force that is equal to the weight of fluid displaced by it.

Applications of Archimedes' Principle

- ① In designing ships and submarines.
- ② In designing lactometers.
- ③ In designing hydrometers.

Relative Density

Relative Density of a substance = $\frac{\text{Density of substance}}{\text{Density of water}}$