Gravitation

(i) Gravitational law (force of attraction) :-

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

- * Central
- * Conservative
- * Independent of medium

**

$$\boxed{G = 6.67\times10^{-11}\ Nm^2kg^{-2}}$$

(*) NOTE :- Two objects will attract maximum if $m_1 = m_2$.

(ii) Acceleration due to gravity :-

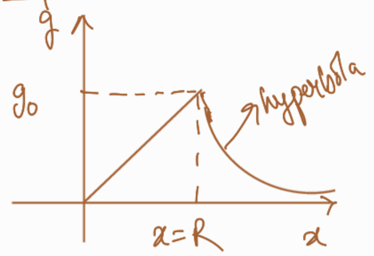
$$g = \frac{GM_e}{R_e^2}$$

(a) Variation at a height 'h' →

$$g' = g\left[1+\frac{h}{R}\right]^{-2} \quad [\text{when}, h > 600\ km]$$

$$g' = g\left[1-\frac{2h}{R}\right] \quad [\text{when}, h < 600\ km]$$

Graph b/w the variations →



(b) Variation at a depth 'd' :-→

$$g' = g\left[1-\frac{d}{R}\right]$$

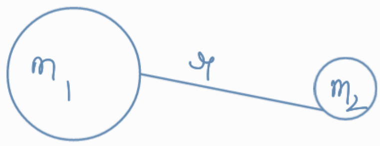
(iii) Gravity due to rotation :-

$$g' = g - \omega^2 R\cos^2\lambda$$ → Angle

• (at equator, $\lambda = 0$ → g will be maximum)
at pole, $\lambda = 90$ → g will be minimum)

(iv) Gravitational P.E →

$$U = \frac{-Gm_1m_2}{r}, \quad U_\infty = 0$$



(v) V_{escape} :→

$$\frac{1}{2}mv^2 = \frac{GMm}{r}$$

$$\boxed{\Rightarrow v = \sqrt{\frac{2GM}{R}} \quad \text{or,} \quad v = \sqrt{2gR}}$$

Kepler's laws

(i) Planets move in an elliptical path → with sun as one of the foci

(ii) $\frac{dA}{dt} = \text{const}$ → Areal Velocity

(iii) $T^2 \propto a^3$ [square of the time period is directly proportional to the cube of the semi-major axis]

Motion of Satellites

$$V_0 = \sqrt{\frac{GM_e}{r}}$$

$$V_0 = \sqrt{\frac{GM_e}{(R_e+h)}}$$

Energy → short cut Trick

** $\boxed{+B = -E = +K = -\frac{U}{2}}$

Geo-stationary Satellites :→ $T = 24$ hrs

$$T = \frac{2\pi \; r^{3/2}}{\sqrt{GM_e}} \quad , r = 35786 \text{ km}$$

Learn

$V = V_0$ → Circular Motion

$V = V_e$ → Parabolic

$V > V_e$ → Hyperbolic

$V_e > V > V_0$ → Elliptical path

$V < V_0$ → elliptical and then falls on the planet earth.