GRAVITATION

G = Universal gravitational constant,

U = Gravitational potential energy

V = Gravitational potential,

E = Gravitational field

F = Gravitational force

1. $F = G\frac{Mm}{r^2}$ (attraction force)

2. Gravitational potential energy, $V = -G\frac{m_1 m_2}{r}$

3. $U_f - U_i = -\int_i^f \vec{F} \cdot d\vec{r}$

4. Gravitational potential, $V = -\frac{GM}{r}$

5. Gravitational field, $E = \frac{F}{m} = \frac{GM}{r^2}$

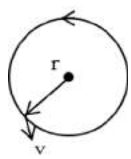
6. Escape velocity, $u \geq \sqrt{\frac{2GM}{R}}$

7. (i) $g' = g\left(1 - \frac{h}{R_e}\right)$, where 'h' is depth from the earth's surface.

(ii) $g' = \frac{g}{\left(1 + \frac{h}{R_e}\right)^2}$, where 'h' is height from the earth's surface.

8. $v = \sqrt{\frac{GM}{r}}$

9. $T = 2\pi\sqrt{\frac{r^3}{GM}}$



10. $K.E. = \frac{GMm}{2a}$, $PK.E. = -\frac{GMm}{a} \Rightarrow E = -\frac{GMm}{2a}$

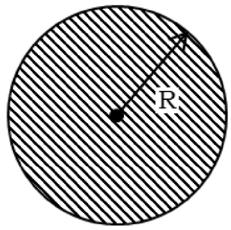
11. Gravitational field, $E = \frac{F}{m} = \frac{GM}{r^2}$

(i) Uniform solid sphere

$$E(r) = \frac{GMr}{R^3}, \quad r < R$$

$$E(r) = \frac{GM}{R^2}, \quad r = R$$

$$E(r) = \frac{GM}{r^2}, \quad r > R$$



$$V(r) = -\frac{GM}{R}\left[\frac{3}{2} - \frac{1}{2}\frac{r^2}{R^2}\right], \quad r < R$$

$$V(r) = -\frac{GM}{R}, \quad r = R$$

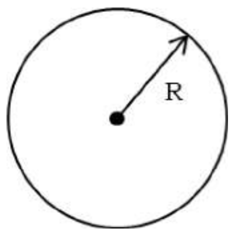
$$V(r) = -\frac{GM}{r}, \quad r > R$$

(ii) Uniform spherical shell

$$E(r) = 0, \quad r < R$$

$$E(r) = \frac{GM}{R^2}, \quad r = R$$

$$E(r) = \frac{GM}{r^2}, \quad r > R$$

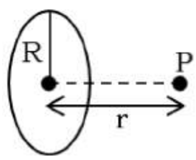


$$V(r) = -\frac{GM}{R}, \quad r \le R$$

$$V(r) = -\frac{GM}{r}, \quad r > R$$

(iii) Uniform circular ring at point on axis :

$$E(r) = \frac{GMr}{\left(R^2 + r^2\right)^{3/2}}$$



$$V(r) = -\frac{2GM}{R^2}\left[\sqrt{R^2 + r^2} - P\right]$$