

GRAVITATION

Gravitational force

- Every matter attract every other matter.
- Central force
- Conservative force
- Long range force
- doesn't depend on medium.

$$\vec{F}_{12} = -\vec{F}_{21} = \frac{GM_1M_2}{r^2}$$

Newton's law of Gravitation

- only valid for point mass and spherical mass system.

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

Superposition theorem

- Force bet^o 2 object doesn't depend on presence of other object.

$$F_{net} = F_1 + F_2 + F_3 + \dots$$



GP Series
 $\frac{1}{1-x} = \frac{1}{1-x} = \frac{1}{1-\frac{1}{4}} = \frac{4}{3} Gm^2$

Hollow sphere



$F_{net \text{ inside}} = 0$

Solid sphere



$$V = \frac{4}{3}\pi R^3$$

$$M = \rho V$$

$$M = \frac{M R^3}{R^3}$$

$$F = \frac{GM'm}{r^2} = \frac{GMm r^3}{R^3 r^2}$$

$$F_{at} = \frac{GMm r^3}{R^3} \quad F_{surface} = \frac{GMm}{R^2}$$



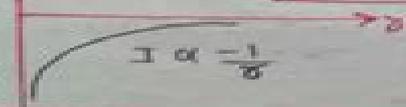
$$\alpha = \frac{d}{L+d} - 1$$

Gravitational field intensity (Grav. force on unit mass)

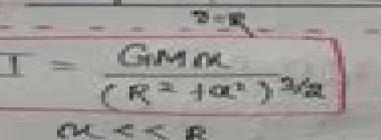
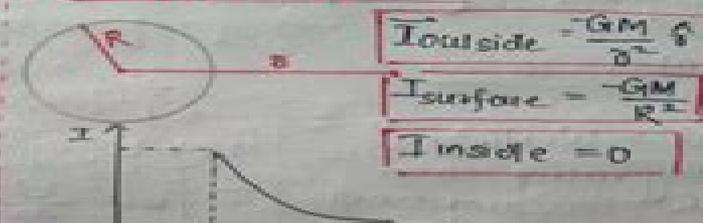
$$\vec{I} = \lim_{m \rightarrow 0} \frac{\vec{F}}{m}$$

$m_0 \rightarrow$ test mass

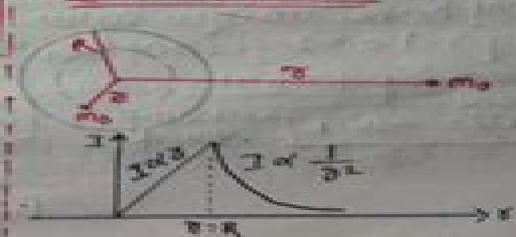
(i) due to point mass



(ii) due to hollow sphere



(iii) Solid sphere

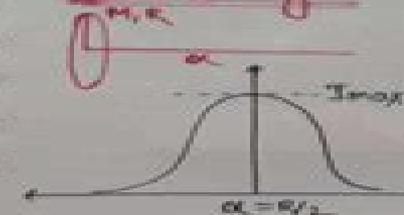


$$I_{outside} = -\frac{GM}{r^2}$$

$$I_{surface} = -\frac{GM}{R^2}$$

$$I_{inside} = -\frac{GM r^3}{R^3}$$

(iv) Axis of ring



$$I = \frac{GMx}{(R^2 + x^2)^{3/2}}$$

$$\alpha \ll R$$

$$I = \frac{GM\alpha}{R^3}$$

$$\alpha \gg R$$

$$I = \frac{GM}{\alpha^2}$$

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Lingsheng Yao



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