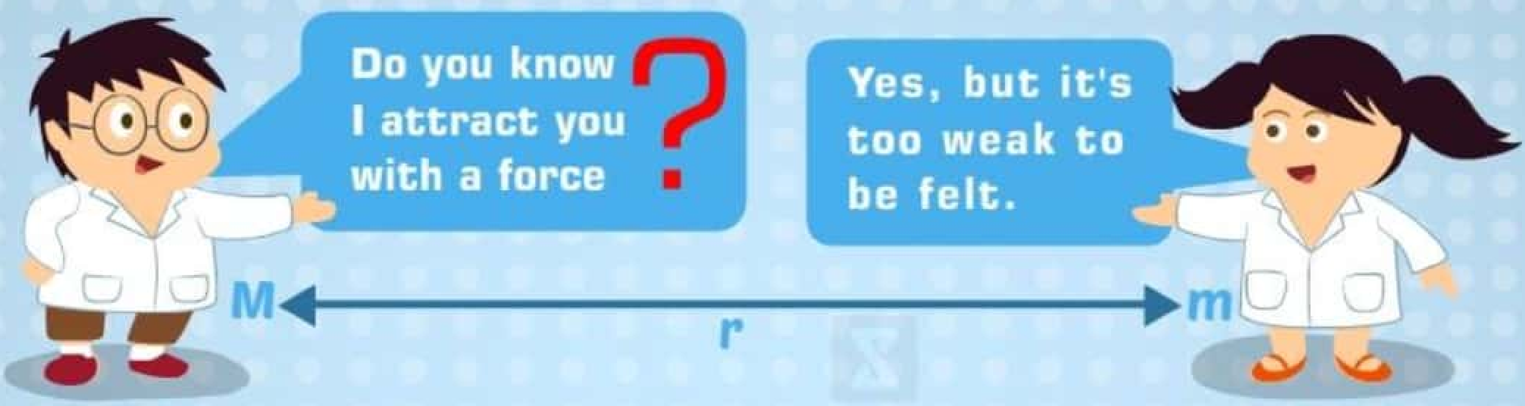
Part I

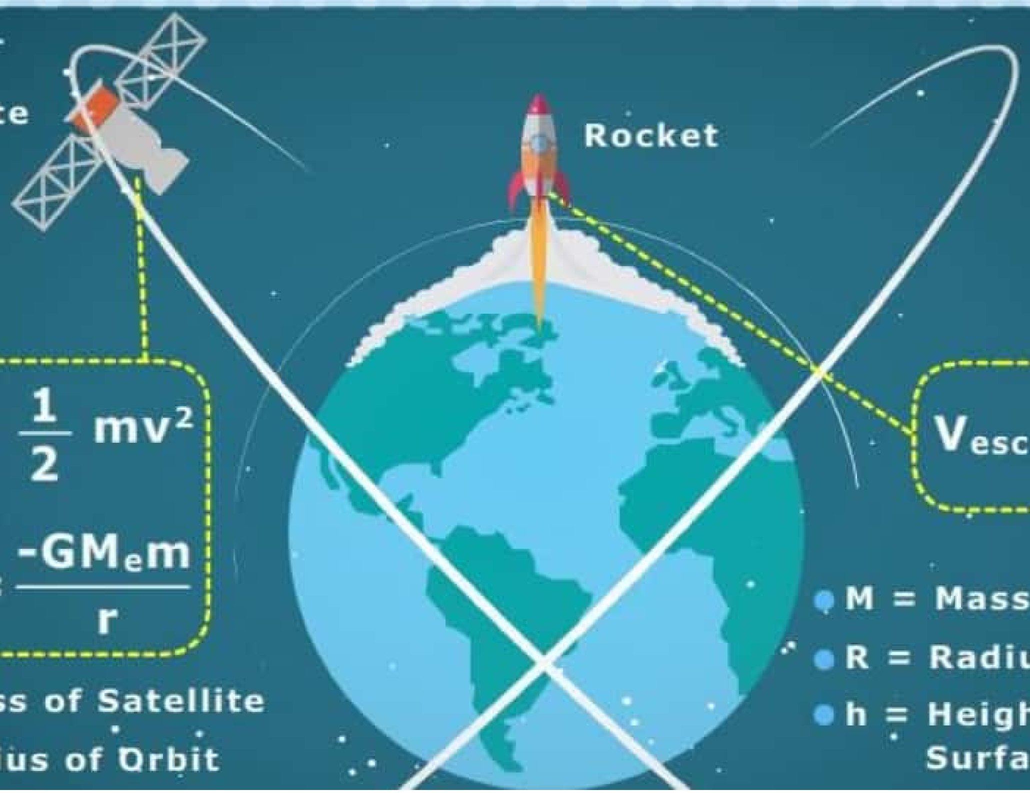
GRAVITATION



Force of attraction between them is gravitation and it is given by:

$$F = G\frac{Mm}{r^2}$$

G = Gravitational Constant



$$K.E = \frac{1}{2}mv^2$$

$$P.E = \frac{-GM_em}{r}$$

- m = Mass of Satellite
- r = Radius of Orbit

$$V_{esc} = \frac{GM_e}{R + h}$$

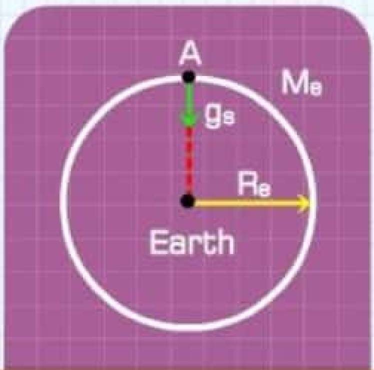
- M = Mass of Earth
- R = Radius of Earth
- h = Height from Earth Surface

Part II

GRAVITATIONAL FORCE

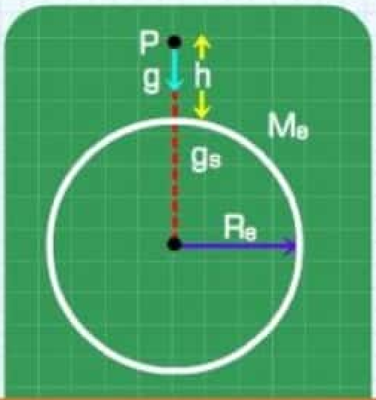
Acceleration Due to Gravity

On the surface of earth



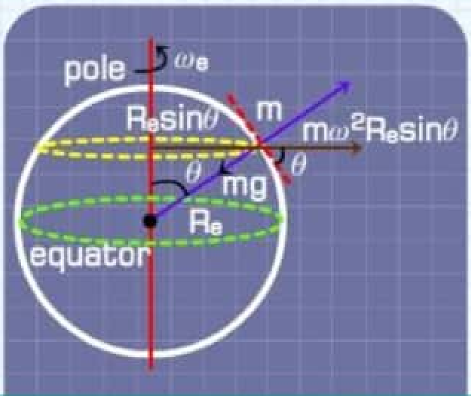
$$g = \frac{GM}{R^2} = 9.81\,ms^{-2}$$

At height h from the surface of earth



$$g' = \frac{g}{\left(1+\frac{h}{R}\right)^2} = g\left(1-\frac{2h}{R}\right) \text{ if } h << R$$

Effect of rotation of earth at latitude

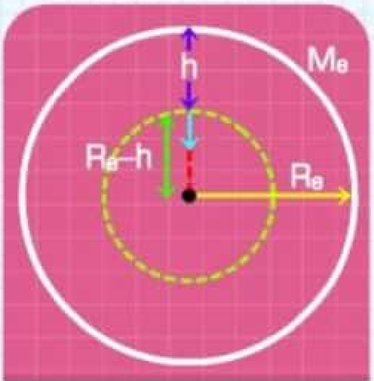


$$g' = g - R\omega^2\sin^2\phi$$

At equator, $\phi = 90°$, $g' - R\omega^2 = 9.78 m/s^2$

At poles, $\phi = 0$, $g' = g = 9.83\ m/s^2$

At depth d from the surface of earth



$$g' = g\left(1-\frac{d}{R}\right)$$

$g' = 0$ if $d = R$ i.e., at centre of earth

- At equator, effect of rotation of earth is maximum and value of g is minimum.
- At poles, effect of rotation of earth is zero and value of g is maximum.

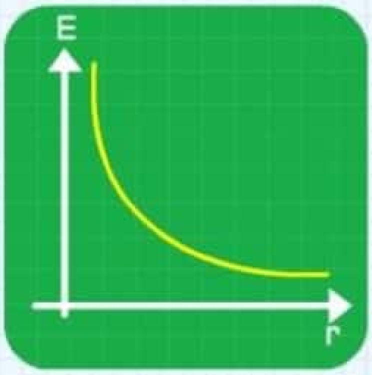
Gravitation Field Strength

Part III

Gravitation field strength at a point in gravitational field is defined as:

$\vec{E} = \frac{\vec{F}}{m}$ = Gravitational force per unit mass.

Due to a point mass

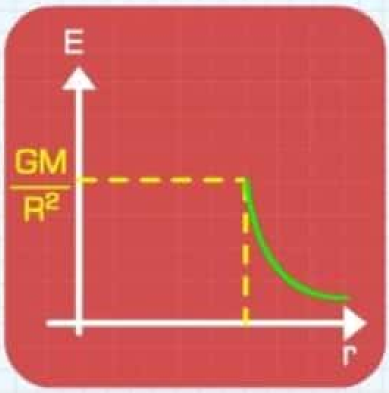


$E = \frac{GM}{r^2}$ (towards the mass)

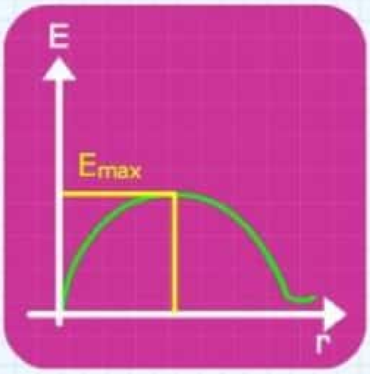
or $E \propto \frac{1}{r^2}$

Due to spherical shell

- Inside points, $E_i = 0$
- Just outside the surface, $E = \frac{GM}{R^2}$; **R - Radius of Sphere**
- Outside Point, $E_o = \frac{GM}{r^3}$; **r - Distance of centre from an external point**
- On the surface E-r graph is discontinuous.



On the axis of a ring



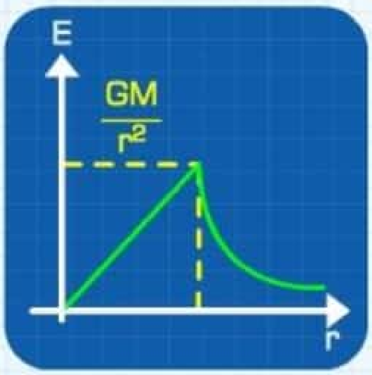
$E_{ix} = \frac{GMx}{(R^2+x^2)^{3/2}}$; At $x = 0$, $E = 0$ i.e., at centre

If $x >> R$, $E = \frac{GM}{x^2}$ i.e., ring behaves as a point mass

At $x \to \infty, E \to 0$; $E_{max} = \frac{2GM}{3\sqrt{3}R^2}$ at $x = \frac{R}{\sqrt{2}}$

Due to a solid sphere

- Inside points $E_i = \frac{GM}{R^3} r$
- At $r = 0$, $E = 0$ i.e. at centre
- At $r = R$, $E = \frac{GM}{R^2}$ i.e., on surface
- Outside points $E_o = \frac{GM}{R^2}$ or $E_o \propto \frac{1}{r^2}$
- At $r \to \infty, E \to 0$

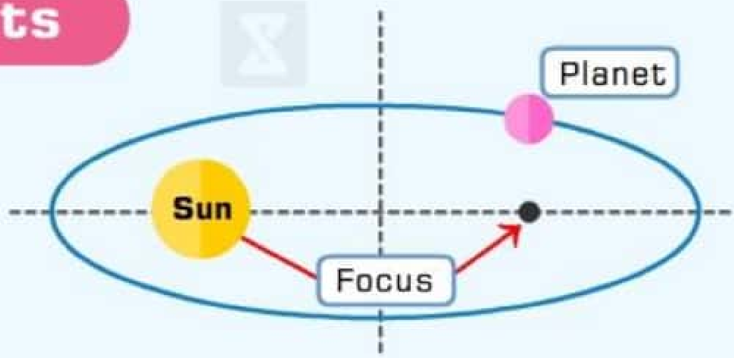


Kepler's law of Planetary Motion

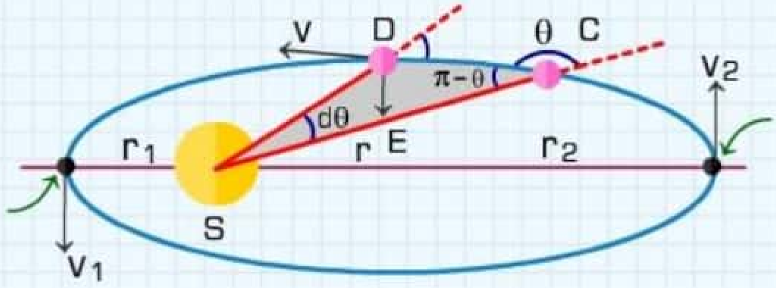
Part IV

1st Law The Law of Orbits

All the planets move around the sun in elliptical orbits with sun at one of the focus, not at centre of orbit.



The Law of Areas 2nd Law



The line joining the sun and planet sweeps out equal areas in equal time.

$$\frac{dA}{dt} = \frac{L}{2m} = \text{Constant}$$

3rd Law The Law of Periods

The time period of revolution of a planet in its orbit around the sun is directly proportionally to the cube of semi - major axis of the elliptical path around the sun.

$$T^2 \propto a^3$$