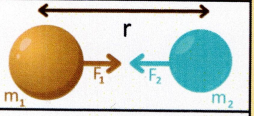
GRAVITATION

Newton's Gravitational Law

$F_1 = -F_2 = G\frac{m_1 m_2}{r^2}$ G = universal gravitational constant (It's value is $6.67 \times 10^{-11}\ Nm^2kg^{-2}$)	
Acceleration due to gravity(g)	$g = \frac{GM}{R^2}$

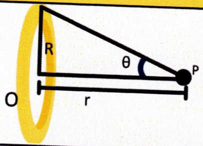
Factors affecting g

Effect of altitude	$g' = \frac{g}{\left(1 + \frac{h}{R}\right)^2}$
Effect of altitude (for h>>R)	$g' = g\left[1 - \frac{2h}{R}\right]$
Effect of depth	$g' = g\left(1 - \frac{d}{R}\right)$
Variation with latitude	$g_{net} = g - a_R \cos\phi$
	$g_{net} = g - R\omega^2 \cos\phi$
g at surface of a planet	$g = \frac{4\pi G}{3} r\rho$
g at 'r' from center of Earth	$g' = \frac{g_e}{R_e} r$

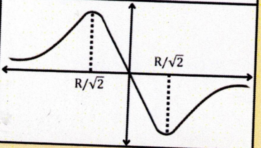
Intensity of Gravitational Field

Due to a uniform circular ring

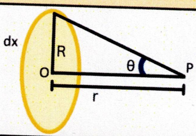
$$E = \frac{GMr}{(r^2 + R^2)^{3/2}} \text{ along } \overrightarrow{PO}$$



Variation of gravitational field due to a ring as a function of its axial distance



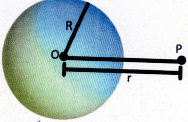
Due to a uniform disc at a point and its axis



$$E_T = \frac{2GxM}{R^2}\left[\frac{1}{x} - \frac{1}{\sqrt{R^2 + x^2}}\right]$$

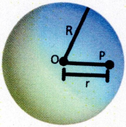
Due to a uniform solid sphere

Case I At an external point



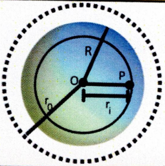
$$E = \frac{Gm}{r^2}$$

Case II At an internal point



$$E = \frac{Gm}{R^3} r$$

Gravitational Potential on Solid Sphere



$$V_{out} = -\frac{GM}{2R^3}[3R^2 - r_0^2]$$

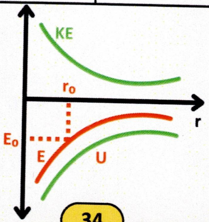
$$V_{in} = -\frac{GM}{R} - \frac{GM}{2R^3}[R^2 - r_i^2]$$

Satellite motion in Circular Motion

Orbital Speed	Time Period
$v = \sqrt{\frac{GM}{r}}$	$T^2 = \frac{4\pi^2}{GM} r^3$

Energy of Satellite

$K.E. = \frac{GMm}{2r}$	$P.E. = -\frac{GMm}{r}$
$T.E. = -\frac{GMm}{2r}$	$\text{Binding energy} = \frac{GMm}{2r}$



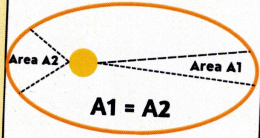
Satellite

$\omega = \sqrt{\dfrac{GM}{(R+h)^3}}$	$L = m\sqrt{GMr}$	$T = 2\pi\sqrt{\dfrac{r^3}{GM}}$

Escape Velocity

$V_E = \sqrt{\dfrac{2GM_E}{R_E}}$	$v_e = \sqrt{2gR}$

Kepler's Law of Planetary Motion

Law of Orbit	Every planet revolves around the sun in an elliptical orbit and sun is at its one focus
Law of Area	$\dfrac{dA}{dt} = \dfrac{L}{2m} = \text{constant}$
	The radius vector drawn from the sun to a planet sweeps equal areas in equal intervals of time, i.e. the arial velocity of the planet around the sun is constant.

Law of Period

The square of time period of revolution of a planet around the sun is directly proportional to the cube of the semi major axis of its ellipti… it.	$\left(\dfrac{T_1}{T_2}\right)^2 = \left(\dfrac{a_1}{a_2}\right)^3$ $T^2 \propto a^3$