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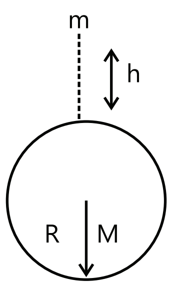
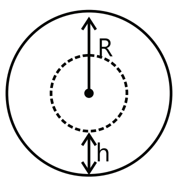
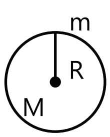
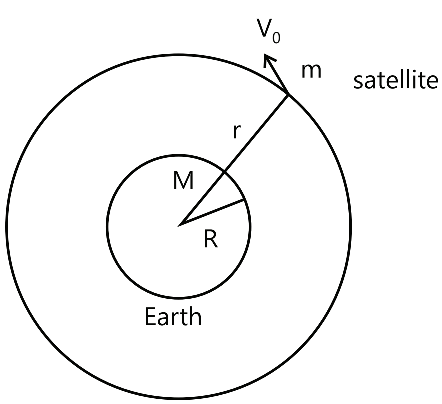
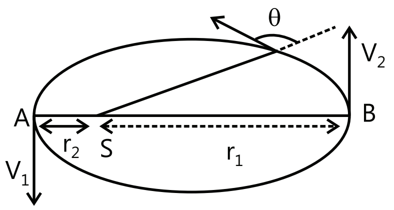
PROBLEM-SOLVING TACTICS

1. Most of the problems are easy, as gravitation and electrostatics are analogous to each other. Just be careful that gravitational force is always attractive, whereas electrostatic force can be attractive as well as repulsive and make changes as necessary.
2. Assumptions are appreciated in real cases of satellites and planetary motion.
3. Ideas and concepts of circular motion must be strong because they are generally applied here.
4. While dealing practical cases on Earth, be careful about Earth's rotation on its own axis.
5. Most questions are solved with ease by using work-energy theorem and laws of motion

FORMULAE SHEET

S. No.	Description	Formulae	
1	Magnitude of gravitational force between two particles of mass m_1 & m_2 placed at a distance r is	$F = \frac{Gm_1m_2}{r^2}$ $G = 6.67 \times 10^{-11} N - m^2 / kg^2$ Note: It acts along the line joining two particles.	
2	Acceleration due to gravity (g)	$g = \frac{GM}{R^2}$ SI units:- m/s^2 M is the mass of the earth and its radius R.	
3		Gravitational force $= \frac{GMm}{(R+h)^2}$ Acceleration due to gravity $= g' = F/m = \frac{GM}{(R+h)^2}$ If $h << R$ $g' = g\left(1 - \frac{2h}{R}\right)$	
4		At a certain, Depth H, acceleration due to gravity g' is $g' = g\left(1 - \frac{h}{R}\right)$ g is acceleration due to gravity at surface of earth.	
5	Effect of g due to axial rotation of earth	$g' = g - R\omega^2 \cos^2 \phi$ g' is the acceleration due to gravity on the particle on the earth surface in latitude ϕ.	
6	Gravitational field strength	$\vec{E} = \frac{\vec{F}}{m}$ SI unit is N/kg.	
		Gravitational Field	**Gravitational Potential**
7	Point Mass	$\frac{GM}{r^2}$	$-\frac{GM}{r}$
8	Uniform ring at point on its axis	$\frac{GMr}{(a^2+r^2)^{3/2}}$ (towards center of ring)	$-\frac{GM}{\sqrt{a^2+r^2}}$
9	Uniform thin spherical shell	Inside θ Outside $\frac{GM}{r^2}$	Inside $-\frac{GM}{a}$ Outside $-\frac{GM}{r}$

10	Uniform solid sphere	Inside $\frac{GMr}{a^3}$ Outside $\frac{GM}{r^2}$	Inside $-GMr^2/a^3$ Outside $-\frac{GM}{2a^2}\left(3a^2-r^2\right)$ Here, a is the radius and r is the location of point mass.
11	Gravitational potential	Note: It is a scalar; SI unit is J/kg.	
12		$\vec{E}=-\left[\frac{\partial y}{\partial x}\hat{i}+\frac{\partial V}{\partial y}\hat{j}+\frac{\partial V}{\partial z}\hat{k}\right]$ Note: It is partial derivative $dV=-\vec{E}.\vec{dr}$.	
13	Gravitational potential energy	$U=-\frac{Gm_1m_2}{r}$ System of particle $\left(m_1\,m_2\,m_3\,m_4\right)$ $U=-G\left[\frac{m_4m_3}{r_{43}}+\frac{m_4m_2}{r_{42}}+\frac{m_4m_1}{r_{41}}+\frac{m_3m_2}{r_{32}}+\frac{m_3m_1}{r_{31}}+\frac{m_2m_1}{r_{21}}\right]$ They are $\frac{4\left(4-1\right)}{2}=6$ Pairs	
14	For an n particle system, no. of pairs would be	$\frac{n\left(n-1\right)}{2}$ Pairs	
15	Binding Energy 	$E=\frac{GMm}{R}$ It is due to this energy particle is bound to earth.	
16	Escape Velocity	$v_e=\sqrt{2gR}$	
17	Motion of Satellites 	Orbital Speed $v_o=\sqrt{\frac{GM}{r}}$ Time period: $T=\frac{2\pi r}{v_o}=2\pi\sqrt{\frac{r^3}{GM}}$ Energy of satellite: $U=-\frac{GMm}{r};K=\frac{GMm}{2r}$ U is The potential energy Total Energy "E" K is The kinetic energy $E=K+U=-\frac{GMm}{2r}=-K$	

18	Kepler's Laws  	1[st] Law:- Law of elliptical orbits 2[nd] Law:- Law of conservation of angular momentum 3[rd] Law:- Harmonic law $\left(T^2 \propto r^3\right)$ $v_1r_1 = v_2r_2$ $v_1 = a\left(1+e\right)$ $r_2 = a\left(1-e\right)$ $V_{min} = V_1 = \sqrt{\frac{GM}{a}\left(\frac{1-e}{1+e}\right)}$ $V_{max} = V_2 = \sqrt{\frac{GM}{a}\left(\frac{1+e}{1-e}\right)}$