JEE/NEET Physics · Gravitation series (9 parts)

Gravitation — Complete Formula Card

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- Gravitation is electrostatics' twin: same $1/r^2$ force shape, same $1/r$ potential shape — learn one, get the other
- Every satellite fact falls out of $v_o = \sqrt{GM/r}$ plus energy bookkeeping
- Inside a shell the field is zero; outside, the shell acts like a point mass at its centre

What	Formula	Remember
Newton's law	$F = Gm_1m_2/r^2$	$G = 6.67\times10^{-19}$; attraction always
Field (g)	$g = GM/R^2$	points to the centre
Escape velocity	$v_e = \sqrt{2GM/R} = \sqrt{2gR}$	surface launch; mass-independent
Orbital velocity	$v_o = \sqrt{GM/r} = \sqrt{gR}$	$r = R + h$; $v_e = \sqrt{2}\cdot v_o$
Kepler's third law	$T^2 = 4\pi^2r^3/GM$	same central body only
Angular momentum	$L = mvr = \text{constant}$	central force → $\tau = 0$
Gravitational PE	$U = -GMm/r$	$U = 0$ at infinity
Orbit energies	$KE = GMm/2r$; $E = -GMm/2r$	$\lvert PE\rvert = 2\lvert KE\rvert$
g with depth	$g' = g(1 - d/R)$	$g = 0$ at centre
g with height	$g' \approx g(1 - 2h/R)$	exact: $gR^2/(R+h)^2$
g with latitude	$g' = g - \omega^2R\cos^2\lambda$	max reduction at equator

Mistakes to avoid

- Mixing r (orbit radius) and R (planet radius): $r = R + h$ — check which one the question means
- Forgetting escape velocity ignores the launch direction: any direction works from the surface (energy-only result)
- PE zero-point drift: gravitational PE is negative and zero at infinity — don't mix conventions mid-problem
- g with height: the $(1 - 2h/R)$ form is an approximation for small h; use $gR^2/(R+h)^2$ when h is comparable to R