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Universal law of gravitation and variation of g

Formulas and units, JEE Main. Status: Reviewed on 2026-11-20.

Result	Formula	Units or note
Law of gravitation	F = G m1 m2/r^2 Valid when: point masses or uniform spheres, r measured between centres	N
Gravitational constant	G = 6.67 x 10^-11	N m^2/kg^2
Surface gravity	g = G M/R^2 = (4/3) pi G rho R Valid when: spherical body, rotation ignored; (4/3) pi G rho R needs uniform density	m/s^2
g at height h	g_h = g R^2/(R + h)^2, about g (1 - 2h/R) for small h Valid when: spherical Earth, h above the surface; the (1 - 2h/R) form needs h much less than R	m/s^2
g at depth d	g_d = g (1 - d/R) Valid when: uniform sphere, d below the surface	m/s^2
g at distance r inside a uniform sphere	g r/R Valid when: uniform solid sphere, r less than R from the centre	m/s^2
Effective g at latitude lambda	g - omega^2 R cos^2(lambda) Valid when: spherical rotating Earth; approximate, omega^2 R much less than g	m/s^2
Equatorial weightlessness	omega = root(g/R), T = 2 pi root(R/g) = 84.6 min Valid when: hypothetical Earth spinning until effective g at the equator is zero	rad/s (s)
Useful substitution	G M = g R^2 Valid when: at or near the surface of a spherical body, rotation ignored	m^3/s^2

Full lesson with worked examples:
https://www.engineeringrise.in/learn/learn/jee-main/physics/gravitation/universal-law-of-gravitation-and-variation-of-g

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