macro

Gravitational Field

Gravitational Potential Energy (units: Joules)

The **work done** by an external agent in bringing a body from infinity to that point. (without a change in KE).

Newton's Law of Gravitation

Two point masses attract each other with a force that is *proportional* to the **product of their masses** and *inversely proportional* to the **square of their separations.**

$$F_G(N) = \frac{GM_1m_2}{r^2}$$

Energy of an Object in Orbit
$$F_{G} = F_{C}$$

H2 PHYSICS

$$KE = \frac{1}{2}mv^2 = \frac{1}{2}\frac{GMm}{r}$$

 $\therefore Total Energy = GPE + KE$

 $TE = -\frac{GMm}{r} + \frac{1}{2}\frac{GMm}{r} = -\frac{1}{2}\frac{GMm}{r}$

Gravitational Potential

$$\phi = \frac{GPE}{m} = -\frac{GI}{r}$$

The work done **per unit mass** by an external agent in bringing a body from infinity to that point. (without a change in KE)

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Variation of Gravitational Field Strength g with distance r

Inside the Earth, at a distance of r_1 from the center of the circle, only the inner sphere contributes to g.

$$g = G \frac{M_1}{r_1^2} = G \frac{\rho V_1}{r_1^2} = G \frac{\rho \frac{4}{3}\pi r_1^3}{r_1^2} = \frac{4}{3}G\rho\pi r_1$$

And hence inside earth, $g \propto r$

The Gravitational Field

A region of space where a mass experiences a gravitational force.

<u>Gravitational Field Strength</u> (units: *Nkg*⁻¹)

The gravitational force acting per unit mass at that point.

$$g = \frac{F_G}{m} = \frac{GM}{r^2}$$



Field Lines

- Field lines point in the direction of the force acting on a small test mass. (resultant g-field lines)
- Field lines are always incident perpendicular to surfaces.
- Field lines never cross each other.





Variation of Gravitational Potential Between 2 Masses

Why is GPE & phegative?

- Potential at infinity is taken to be zero.
- **Negative work done** by the external agent the direction of the external force is opposite in direction to the displacement of the mass.



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Escape Speed

The minimum speed at which a body can be projected from the surface of a planet such that it reaches **an infinite distance** from the planet.



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