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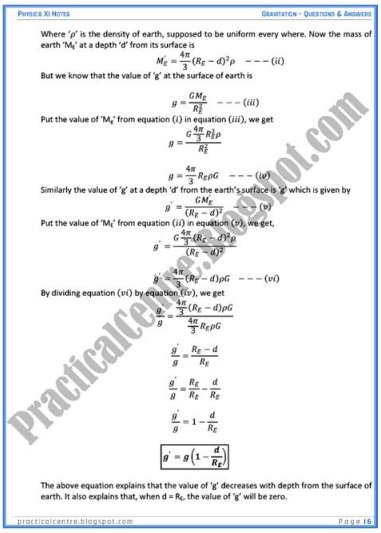

Physics XI Notes — Gravitation - Questions & Answers

Where 'ρ' is the density of earth, supposed to be uniform every where. Now the mass of earth 'M_E' at a depth 'd' from its surface is

$$M_E = \frac{4\pi}{3}(R_E - d)^3\rho \quad ---(ii)$$

But we know that the value of 'g' at the surface of earth is

$$g = \frac{GM_E}{R_E^2} \quad ---(iii)$$

Put the value of 'M_E' from equation (i) in equation (iii), we get

$$g = \frac{G\frac{4\pi}{3}R_E^3\rho}{R_E^2}$$

$$g = \frac{4\pi}{3}R_E\rho G \quad ---(iv)$$

Similarly the value of 'g' at a depth 'd' from the earth's surface is '$g^{'}$' which is given by

$$g^{'} = \frac{GM_E}{(R_E - d)^2} \quad ---(v)$$

Put the value of 'M_E' from equation (ii) in equation (v), we get,

$$g^{'} = \frac{G\frac{4\pi}{3}(R_E - d)^3\rho}{(R_E - d)^2}$$

$$g^{'} = \frac{4\pi}{3}(R_E - d)\rho G \quad ---(vi)$$

By dividing equation (vi) by equation (iv), we get

$$\frac{g^{'}}{g} = \frac{\frac{4\pi}{3}(R_E - d)\rho G}{\frac{4\pi}{3}R_E\rho G}$$

$$\frac{g^{'}}{g} = \frac{R_E - d}{R_E}$$

$$\frac{g^{'}}{g} = \frac{R_E}{R_E} - \frac{d}{R_E}$$

$$\frac{g^{'}}{g} = 1 - \frac{d}{R_E}$$

$$\boxed{g^{'} = g\left(1 - \frac{d}{R_E}\right)}$$

The above equation explains that the value of 'g' decreases with depth from the surface of earth. It also explains that, when d = R_E, the value of 'g' will be zero.

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