

Question 37229

Find the percentage decrease in weight of body when taken to a height of 32 km above the surface of earth. Radius of earth is given as 6400 km.

Weight is defined as $P = mg = G \frac{Mm}{d^2}$, where G is the gravitational constant, M is the mass of the Earth, and d is the distance from the object to the Earth's center of the core.

When the object is at the Earth's surface,

$$P_0 = G \frac{Mm}{R^2},$$

where R is the radius of the Earth.

When the object is taken to a height h above the Earth's surface,

$$P_h = G \frac{Mm}{(R+h)^2}.$$

The percentage difference of the new weight with respect to the original one is

$$p.d. = \frac{P_h - P_0}{P_0} \times 100\% = \frac{\frac{1}{(R+h)^2} - \frac{1}{R^2}}{\frac{1}{R^2}} \times 100\% = \left(\frac{R^2}{(R+h)^2} - 1 \right) \times 100\%.$$

Using the numerical values, $R = 6400$ km, and $h = 32$ km, we substitute

$$p.d. = \left(\frac{6400^2}{6432^2} - 1 \right) \times 100\% \approx -0.9925\%.$$

Answer: the weight is about 0.9925% less.