H.W
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Gravitation

Q1. State the universal law of gravitation ?

Q2. Write the formula to find the magnitude of the gravitational force between the earth and an object on the surface of the earth ?

Q3. ~~Differentiate between mass and weight.~~

Q3. Define free fall.

Q4. Differentiate between mass and weight.

Q5. Why is the weight of an object on the moon 1/6 its weight on the Earth?

1. Answer- The universal law of gravitation state, that the force between two object is directly proportional to the product of their masses and inversely proportional to square of the distance between them.

Mathematically

$$F \propto m \times m$$

and $F \propto \frac{1}{d^2}$

$$\therefore \boxed{F = G\frac{M \times m}{d^2}}$$

G, is called universal gravitational constent.

2. Answer- We know

~~XX~~ $F = m \times g$

OR $m \times g = G \cdot \frac{m \times m}{d^2}$ (From universal law of gravitation)

OR $g = \frac{G \cdot M}{d^2}$

Where M = Mass of the earth

d = Distance between object and earth.

3. Answer- The earth attracts objects towards it. This is due to the gravitational force. Whenever objects fall towards the earth under this force alone, we say that the objects are in free fall.

4. Answer- Mass of an object is the measure of its inertia.

→ The weight of a body is the force with which the earth attracts it.

→ The weight is equal to the product of mass and acceleration due to gravity.

→ The law of gravitation states that the force of attraction between any two objects is proportional to the product of their masses and inversely proportional to the square of the distance between them. The law

applies to objects anywhere in the universe. Such a law is said to be universal.

5. Answer- The weight of an object on the earth is the force with the which the earth attracts the object. In the same way, the weight of an object on the moon is the force with which the moon attracts that object. The mass of the moon is less than that of the earth. Due to this the moon exerts lesser force of attraction on objects.

Let the mass of an object be m. Let its weight on the moon be Wm. Let the mass of the moon be Mm and its radius be Rm.

By applying the universal law of gravitation, the weight of the object on the moon will be

$$Wm = G\frac{Mm \times m}{Rm^2}$$

Let the weight of the same object on the earth be We. The mass of the earth is M and its radius is R.

From Eqs. (10.9) and (10.15) we have,

$$We = G\frac{M \times m}{R^2}$$

Substituting the values from Table 10.1 in Eqs. (10.16 and (10.17) we get:

$$W_m = G\,\frac{7.36\times10^{22}\ kg\times m}{(1.74\times10^{6}\ m)^2}$$

$$W_m = 1.431\times10^{10}\,G\times m$$

Dividing Eq. (10.18a) by Eq. (10.18b), we get

$$\frac{W_m}{W_e} = \frac{1.431\times10^{10}}{1.474\times10^{11}}$$

$$\frac{W_m}{W_e} = 0.165 \simeq \frac{1}{6}$$

Weight of the object on the moon $\simeq \frac{1}{6}$ Weight of the object on the earth

Weight of the object on the moon

= (1/6) x its weight on the earth.