28.8.2021

Homework

Q1. How does the force of gravitation between two objects change when the distance between them is reduced to half?

Sol'n $F = \frac{GMm}{r^2} = \frac{Gm_1m_2}{r^2}$

$F' = \frac{Gm_1m_2}{\left(\frac{r}{2}\right)^2} = \frac{Gm_1m_2}{\frac{r^2}{4}} = \frac{4Gm_1m_2}{r^2}$

$\frac{F'}{F} = \frac{Gm_1m_2}{r^2} \times 4$

$\Rightarrow F' = 4F$

∴ The force becomes 4 times.

Q2. Gravitational force acts on all objects in proportion to their masses. Why then, a heavy object does not fall faster than a light object?

Ans:- Gravitational force acts on all objects in proportion to their mass. But a heavy object does not fall faster

of the body is the acceleration due to gravity, which does not depend upon the mass of the body.

than a light object. This is because during free-fall, the acc^{n}

Acceleration = $\frac{\text{Force}}{\text{Mass}}$

or Force = Mass × Acceleration

As force is directly proportional to mass, acceleration is constant for a body of any mass. This acceleration is acceleration due to gravity.

Q8. The earth and the moon are attracted to each other by gravitational force. Does the earth attract the moon with a force that is greater or smaller or the same as the force with which the moon attracts the earth? Why?

Ans:- According to the universal law of gravitation, two objects attract

Sol: Let M be the mass of the earth and m be the mass of the Moon.
Let the distance between them be r.

$$F_{EM} = \frac{GMm}{r^2} \qquad F_{ME} = \frac{GmM}{r^2}$$

Thus, earth attracts the moon with the same force by which moon attracts the earth, because gravitational force is a mutual force.

Q. What happens to the force between two objects, if
(i) the mass of one object is doubled?
(ii) the distance between the objects is doubled and tripled?
(iii) the masses of not both objects are doubled?

Sol: (i) $F = \frac{GMm_1m_2}{r^2}$

$$F' = \frac{G \times 2m_1 \times m_2}{r^2} = \frac{2Gm_1m_2}{r^2}$$

$$= 2F$$

∴ The force gets doubled.

(ii) When distance is doubled:-

$$F = \frac{G m_1 m_2}{r^2} \qquad F' = \frac{G m_1 m_2}{(2r)^2}$$

$$F' = \frac{G m_1 m_2}{4r^2} = \frac{F}{4}$$

∴ Force gets becomes one fourth.

(i) When distance is tripled:-

$$F = \frac{G m_1 m_2}{r^2} \qquad F' = \frac{G m_1 m_2}{(3r)^2}$$

$$F' = \frac{G m_1 m_2}{9r^2} = \frac{F}{9}$$

∴ Force becomes one ninth.

(iii) $$F = \frac{G m_1 m_2}{r^2} \qquad F' = \frac{G \times 2m_1 \times 2m_2}{r^2}$$

$$F' = \frac{4 G m_1 m_2}{r^2} = 4F$$

∴ Force becomes 4 times.

Q. ~~Assertion:~~ ~~statement 1:~~ When distance between two objects is doubled and also mass of each body is also doubled, gravitational force between them remains the same

Statement 2°. According to Newton's law of gravitation, force is directly proportional to mass of bodies and inversely proportional to the square of the distance between them.

Ans: (1) Statement-1 is True; Statement 2 is True; Statement-2 is a correct explanation for Statemen-1.

as Define acceleration due to gravity.

Ans: The acceleration produced in a freely falling body under the gravitational pull of the earth is called acceleration due to gravity. It is denoted by g.

Q: The earth attracts falling apple, but do you think that the apple also attracts the earth? If it is, why the earth does not move towards apple?

Ans: The Earth attracts an apple and so does the apple attract

the earth with an equal and opposite force. Mass of the earth is extremely massive as compared to that of the apple. So, the acceleration produced is very small as compared to that in the apple. Hence, the motion of the earth towards the apple is not noticeable.

Q8. What is the importance of universal law of gravitation?

Ans:- The universal law of gravitation successfully explained several phenomena which were believed to be unconnected:

1. the force that binds us to the earth.
2. the motion of the moon around the earth.
3. the motion of plants around the sun
4. the tides due to the moon and the sun.

Q4. At what height above the surface, the value of the gravity would be half of what it is on the surface of the earth. Take radius of the earth as $R_e = 6400$ km.

Ans: $g = \frac{GM_1M_2}{R^2} \quad \frac{GM}{R^2}$

$g_h = \frac{GM}{(R+h)^2} \qquad g_h = \frac{g}{2}$

$\Rightarrow \frac{g}{2} = \frac{GM}{(R+h)^2}$

$\frac{g}{g} = \frac{GM}{R^2} \times R+h$

$\frac{g}{2} \times \frac{1}{g} = \frac{GM}{(R+h)^2} \times \frac{R^2}{GM}$

$\Rightarrow \frac{1}{2} = \frac{R^2}{(R+h)^2} \Rightarrow R+h = \sqrt{2}R$

$\Rightarrow 6400 + h = 6400\sqrt{2}$

$\Rightarrow h = 2650$ km

$\therefore$ Height $= 2650$ km

Q1. The value of the universal gravitational constant—

Ans (b) Does not change from place to place

Q2. The radius of the earth is about 6400 km and that of the Mars is about 3200 km. The mass of earth is about 10 times the mass of Mars. An object weighs 200N on earth's surface. Then its weight on the surface of Mars will be

Sol: $g_m = \frac{GM}{R^2}$

Let the mass of ~~Moon~~ Mars = M

$g_e = \frac{G \times 10M}{R_e^2} \Rightarrow g_e = \frac{10GM}{6400 \times 6400}$

$g_m = \frac{GM}{3200 \times 3200}$

$\frac{g_e}{g_m} = \frac{10GM}{6400 \times 6400} \times \frac{3200 \times 3200}{GM}$

$g_e = \frac{10}{4} g_m \Rightarrow g_m = \frac{4}{10} g_e$

$W = mg$

$\Rightarrow 200 = m_e \times g_e \Rightarrow m_e = \frac{200}{g_e}$

$W_m = m_m \times g_m$

$\Rightarrow W_m =$

Q. Statement 1: The value of acceleration due to gravity does not depend upon mass of the body.

Statement 2: Acceleration due to gravity is a constant quantity.

Ans (3) Statement – 1 is True; statement – 2 is false.