

17/8/21

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

Ans) case: 1 :- (Original)

$$F_1 = \frac{GMm}{d^2} \text{ --- (1)}$$

Case: 2 :- (change)

$$F_2 = \frac{GMm}{d^2} = \frac{GMm}{\frac{1}{4}d^2} = \frac{4GMm}{d^2} \text{ --- (2)}$$

Dividing equation (2) by (1) we get,

$$\frac{F_2}{F_1} = \frac{4GMm}{d^2} \times \frac{d^2}{GMm} = 4 \Rightarrow F_2 = 4F_1$$

2. 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) when an object falls on earth, it falls with constant acceleration known as acceleration due to gravity. Since acceleration is constant, therefore, it does not depend upon mass. Thus, heavy and lighter objects will fall at the same speed.

3. 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 each other with the equal force but in opposite direction. The earth attracts the moon with an equal force with which the moon attracts the earth but these forces are in opposite directions. Therefore, the earth attracts the moon with the same force as the moon attracts the earth.

4. 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 and tripled? (iii) the masses of both objects are doubled?

Ans) We know that the gravitational force between two objects is given by,

$$F = \frac{GMm}{r^2}$$

where,

$G$  = Gravitational constant

$M$  = Mass of object 1

$m$  = mass of object-2

$r$  = Distance between the two objects

(i) When mass of one object is doubled

Let Mass of object 1 be doubled



New mass of object 1 =  $2M$

Thus,

$$\text{New force} = \frac{G \times 2M \times m}{r^2}$$

$$= \frac{2GMm}{r^2} = 2 \times \text{old force}$$

$\therefore$  If mass of one object is doubled, the force is also doubled  
(ii) Distance between the objects is doubled and tripled

Distance is doubled

$\therefore$ , New Distance =  $2r$

$$\text{New force} = \frac{GMm}{(2r)^2}$$

$$= \frac{GMm}{4r^2}$$

$$= \frac{1}{4} \times \text{old force}$$

Distance is tripled

$\therefore$ , New Distance =  $3r$

$$\text{New force} = \frac{GMm}{(3r)^2}$$

$$= \frac{GMm}{9r^2}$$

$$= \frac{1}{9} \times \text{old force}$$

Therefore,

when distance is doubled, force becomes  $\frac{1}{4}$  times of old force

when distance is tripled, force becomes  $\frac{1}{9}$  times of old force

(iii) when mass of both objects is doubled

New mass of object 1 =  $2M$

New mass of object 2 =  $2m$

Thus

$$\text{New force} = \frac{G \times 2M \times 2m}{r^2} = \frac{4GMm}{r^2} = 4 \times \text{old force}$$

i.e. If mass of both objects is doubled,  
the force becomes 4 times

① 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  $g$ .

② 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 apples?

Ans) According to Newton's third law of motion, action and reaction are equal and opposite. It means that the force on the apple due to earth's attraction is equal to that on the earth due to apple's attraction. But we know, acceleration  $\propto 1/m$ .

As the mass of the earth is very large as compared to that of the apple, the acceleration experienced by the earth will be so small that it will not be noticeable.

③ What is the importance of universal law of gravitation?

Ans) Universal law is important because it explained several phenomena which were believed to be unconnected. Like



- \* It explained how objects are bound to the earth.
  - \* It explained why the moon revolves ~~the~~ around the earth.
  - \* It explained why the planets revolve around the sun.
  - \* It explained how high tides and low tides are formed (due to gravitational force of moon and the sun on the surface of water).
4. 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  $R_e = 6400 \text{ km}$

Ans) Here  $g_h = g/2$

But,

$$g_h = g \left( \frac{R}{R+h} \right)^2$$

$$\therefore \frac{g}{2} = g \left( \frac{R}{R+h} \right)^2 \text{ or } \left( \frac{R}{R+h} \right)^2 = \frac{1}{2}$$

$$\text{or, } \frac{R+h}{R} = \sqrt{2}$$

$$\text{or, } h = (\sqrt{2} - 1)R = 0.414R = 0.414 \times 6400 = 2649.6 \text{ km}$$

1. The value of the universal gravitational constant:

b. does not change from place to place

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

Mass will be

412) Radius of earth ( $R_e$ ) = 6400 km; Radius of moon ( $R_m$ ) = 1600 km;

Mass of earth ( $M_e$ ) = 10  $M_m$  and weight of the object on earth ( $w_e$ ) = 200 N.

$$\frac{w_m}{w_e} = \frac{m g_m}{m g_e} = \frac{M_m}{M_e} \times \left[ \frac{R_e}{R_m} \right]^2 = \frac{1}{10} \times (2)^2 = \frac{2}{5}$$

or  $w_m = w_e \times \frac{2}{5} = 200 \times 0.4 = 80 \text{ N}$ .

Each questions contain STATEMENT-1 [Assertion] and STATEMENT-2 [Reason]. Each question has 5 choices (1), (2), (3), (4) and (5) out of which only one is correct.

(1) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.

(2) Statement-1 is True, Statement-2 is True, statement-2 is not a correct explanation for Statement-1.

(3) Statement-1 is True, Statement-2 is false.

(4) Statement-1 is False, statement-2 is True

(5) Statement-1 is false, statement-2 is false

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.

prob) 3

Acceleration due to gravity is given by  $g = \frac{GM}{R^2}$ .

Thus it does not depend on mass of body on which it is acting. Also it is not a constant quantity it changes with change in value of both  $M$  and  $R$  (distance between two bodies).