HW 17/8/21

ODM CONNECT APP HOMEWORK

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

Ans) we know that Gravitational force between 2 objects is

$$F = \frac{GMm}{r^2}, \text{ where}$$

G = Gravitational constant
M = Mass of object 1
m = Mass of object 2
r = Distance between the two objects
When distance is reduced to half,
Distance = $\frac{r}{2}$, & everything else remains same.
Thus,

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

$$= \frac{GMm}{r^2/4} = \frac{4GMm}{r^2} = 4 \times \text{old Force}$$

∴ when the distance is reduced to half, force becomes four 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) 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.

Q3. 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 equal force but in opposite direction.
Therefore, the earth attracts the moon with an equal force with which the moon attracts the earth but these forces are in opposite directions.

Q4. 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 both objects are doubled?

Ans) we know that $F = \frac{GMm}{r^2}$, where
G = Gravitational constant
M = Mass of object 1
m = Mass of object 2
r = Distance between the two objects

(i) Let Mass of object 1 be doubled

New Mass of object 1 = $2M$

Thus,

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

$$= 2 \times \text{old Force}$$

∴ If mass of one object is doubled, the force is also doubled.

(ii)

Distance is doubled	Distance is tripled
So, New distance = $2r$	So, New Distance = $3r$
New Force = $\frac{GMm}{(2r)^2} = \frac{GMm}{4r^2}$	New Force = $\frac{GMm}{(3r)^2}$
$= \frac{1}{4} \times$ old Force	$= \frac{GMm}{9r^2}$
	$= \frac{1}{9} \times$ old Force

∴ 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) New Mass of object 1 = $2M$

New Mass of object 2 = $2m$

Thus,

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

$$= 4 \times \text{old Force}$$

∴ If mass of both objects are double, force becomes four times.

Q5. 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'.

Q6. The earth attracts falling apple, but do you think that the apple also attract the earth? If it is, why the earth does not move towards apple?

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.

Q7. 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 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 the moon and the sun

on the surface of water).

Q8. 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 Here $g_h = g/2$

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

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

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

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

Q9. The value of the universal gravitational constant –

a) changes with change of place

b) Does not change from place to place ✓

c) Becomes more at night

d) Becomes more during day

Q10. 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 20N on earth's surface. Then its weight on the surface of Mars will be

a) 8N b) 20N c) 40N d) 80N ✓

Ans) Radius of earth (R_e) = 6400 km ; Radius of mars (R_m) = 3200 km ; Mass of earth (M_e) = $10 M_m$ and weight of the object on earth (w_e) = 900 N

$$\frac{w_m}{w_e} = \frac{mg_m}{mg_e} = \frac{M_m}{M_e} \times \left[\frac{R_e}{R_m}\right]^2$$

$$= \frac{1}{10} \times (2)^2 = \frac{2}{5}$$

or $w_m = w_e \times \frac{2}{5} = 900 \times 0.4 = 80\ N$

Q11. 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.

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).