STEPPING STONE SCHOOL (HIGH)

CLASS – IX

PHYSICS

WORKSHEET- 14

Date – 1/07/2020, (Day- 14)

Chapter- LAWS OF MOTION (Pt. V)

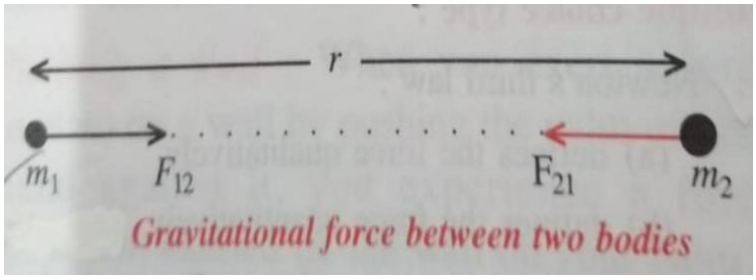
Topic- Gravitation (I)

Time limit: 30 minutes.

Please read the chapter from your text book and the attached notes. Then work out the exercise neatly in your notebook. Ensure neat and tidy work. Use black ink to solve the exercise.

Universal Law of Gravitation:

According to Newton, the force of attraction acting between two bodies is (i) directly proportional to the product of their masses and (ii) inversely proportional to the square of the distance between them.



Gravitational force between two bodies

Let there be two bodies of masses m_1 m_2 at a separation ‘d’. The magnitude of force of attraction F acting between them is

$$F \propto m_1 m_2$$

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

Combining, $$F \propto \frac{m_1 m_2}{d^2}$$

or $$F = G\frac{m_1 m_2}{d^2}$$

Where G is a universal gravitational constant.

The value of G remains same at all places and it is independent of the nature of the nature of particles, temperature etc.

<u>Unit and value of universal gravitational constant:</u>

$$G = \frac{F \times d^2}{m_1 \times m_2}$$

S.I. Unit of $G = \frac{\text{newton} \times \text{metre}^2}{\text{Kg} \times \text{Kg}}$

$= Nm^2 Kg^{-2}$

The value of G is $6.67 \times 10^{-11}\ Nm^2 Kg^{-2}$

If $m_1 = m_2 = 1$ Kg, $r = 1$ m then $G = F$

If $m_1 = m_2 = 1$ kg , r = 1 m then G = F

Thus,

Universal Gravitational constant is numerically equal to the magnitude of force of attraction between two masses each of 1kg placed at a separation of 1m.

Regarding the gravitational force it is important to note that the gravitational force between two masses;

(i) is directly attractive

(ii) directly proportional to the product of the masses

(iii) is inversely proportional to the square of the distance between them.

Importance of the law of gravitation:

Newton used this law to explain the motion of planets around the sun, the motion of moon around the earth and the motion of a freely falling body.

Force due to Gravity:

According to the law of gravitation, the earth attracts each object around it, towards its center. The force with which the earth attracts a body is called the force due to gravity on the body. It acts vertically downwards at the center of gravity of the body

Taking the mass of earth $M = 5.96 \times 10^{24}$ kg and the radius of earth $R = 6.37 \times 10^{6}$ m, the force of gravity on a body of mass m = 1kg

$$F = \frac{(6.67 \times 10^{-11}) \times (5.96 \times 10^{24}) \times 1}{(6.37 \times 10^{6})^2}$$

$$= 9.8\ N$$

Thus earth attracts a body of mass 1kg by a force of 9.8 N towards

Acceleration due to Gravity

The rate which the velocity of a freely falling body increased is called the acceleration due to gravity.

The acceleration due to gravity as denoted by letter ‘g’. Its S.I unit is ms^{-2}. It is a vector quantity directed vertically downwards towards the center of earth.

Relationship between g and G

Let g be acceleration due to gravity at a planet of mass M and radius R. By Newton's law of motion, the force due to gravity of mass m

$$F = mg$$

By Newton's gravitational law,

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

Therefore, $mg = \frac{GMm}{R^2}$

or $g = \frac{GM}{R^2}$

<u>Exercise:</u>

Answer the following questions:

(1) State whether the gravitational force between two masses is attractive or repulsive?

(2) How does the gravitational force of attraction between two masses depend on the distance between them?

(3) How is the gravitational force between two masses affected if the separation between them is doubled?

(4) What is the importance of the law of gravitation?

(5) What do you understand by the term force due to gravity?

(6) Write down the average value of g on the earth's surface.

(7) How are 'g' and G related?