



BAL BHARATI PUBLIC SCHOOL, PITAMPURA, DELHI - 110034

**SUBJECT:-PHYSICS**  
**CLASS IX**

**TOPIC : GRAVITATION**

Week -5<sup>th</sup> October to 9<sup>th</sup> October, 2020.

**No of blocks: 1**

**GUIDELINES FOR STUDENTS:**

Dear Students

- There is only one assignment detailed as follows:
- Assignment1: Based on UNIVERSAL LAW OF GRAVITATION
- Solve the assignment in a separate notebook you have made for Physics
- Suitable video links have been provided for better understanding of the concept.
- Please read NCERT too for better understanding of these concepts

**SUBTOPICS:**

**Gravitation**

**Universal Law of Gravitation**

**Instructional aids /Resources:**

NCERT LINK FOR THE CHAPTER:

<https://ncert.nic.in/ncerts/l/iesc110.pdf>

(Page no 131 to 134)

**YouTube Links:**

<https://youtu.be/YeqQWJ74t-M>(Universal law of Gravitation) (3.26/39:42)

<https://youtu.be/euvXilLecUU> ( Importance of Universal law of Gravitation) (5.17/30:49)

## **Learning Outcomes:**

Each learner will be able to:

1. State Universal Law of Gravitation.
2. Calculate force of gravitation between two given objects
3. Write mathematical formula of Universal law of Gravitation.

## **Activities:**

You Tube links

<https://youtu.be/kHEvyeSKd6w>

## **Lesson Development:**

Let's begin the journey of learning:

### **Gravitation**

We have learnt about the motion of objects and force as the cause of motion in the previous chapters. We have learnt that a force is needed to change the speed or the direction of motion of an object. We have always seen that an object dropped from a height falls towards the earth. We know that all the planets go around the sun. The moon goes around the earth. In all these cases, there must be some force acting on the objects, the planets and on the moon. Isaac Newton could grasp that the same force is responsible for all these. This force is called the gravitational force.

### **Universal Law of Gravitation**

Every object in the universe attracts every other object with a force which is directly proportional to the product of their masses and inversely proportional to the square of the distance between them. The force is along the line joining the centres of two objects.

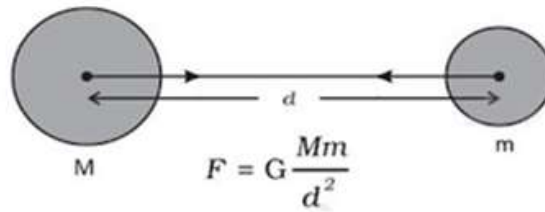


Fig.1

Let two objects A and B of masses  $M$  and  $m$  lie at a distance ' $d$ ' from each other as shown in Fig. 1. Let the force of attraction between two objects be  $F$ . According to the universal law of gravitation, the force between two objects is directly proportional to the product of their masses. That is,

$$F \propto M \times m \quad \text{----- (1)}$$

And the force between two objects is inversely proportional to the square of the distance between them, that is,

$$F \propto 1/d^2 \quad \text{----- (2)}$$

Combining equations. (1) and (2), we get

$$F \propto M \times m / d^2 \quad \text{----- (3)}$$

$$\text{or, } F = G ((M \times m) / d^2) \quad \text{----- (4)}$$

where  $G$  is the constant of proportionality and is called the universal gravitation constant. By multiplying crosswise, Eq. (4) gives

$$F \times d^2 = G M \times m$$

$$\text{or} \quad G = F d^2 / M m \quad \text{----- (5)}$$

The SI unit of  $G$  can be obtained by substituting the units of force, distance and mass in Eq. (5) as  $\text{N m}^2 \text{kg}^{-2}$ .

The value of G was found out by Henry Cavendish (1731 – 1810) by using a sensitive balance. The accepted value of

G is  $6.673 \times 10^{-11} \text{ N m}^2 \text{ kg}^{-2}$ .

We know that there exists a force of attraction between any two objects. Let us take few examples.

#### EXAMPLE-1

Calculate force of gravitation between two bodies of mass 50 kg separated by a distance of 1m.

\*M=m=50 kg      d=1m      G= $6.673 \times 10^{-11} \text{ N m}^2 \text{ kg}^{-2}$ .

So  $F = GMm/d^2$

$F = 6.673 \times 10^{-11} \times 50 \times 50 / 1 = 1.67 \times 10^{-7} \text{ N}$

#### EXAMPLE-2

Calculate force of gravitation between earth and a body of mass 50 kg on its surface.

M= $6 \times 10^{24} \text{ Kg}$       m=50 kg      d= $6.4 \times 10^6 \text{ m}$       G= $6.673 \times 10^{-11} \text{ N m}^2 \text{ kg}^{-2}$ .

So  $F = GMm/d^2$

$F = 6.673 \times 10^{-11} \times 6 \times 10^{24} \times 50 / (6.4 \times 10^6)^2 = 490 \text{ N}$

### **Importance of the Universal Law of Gravitation**

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 planets around the sun; and
4. the tides due to the moon and the sun.

**Relation between Newton's Third law of motion and Newton's law of Gravitation**

According to Newton's third law of motion, every object exerts equal and opposite force on other object but in opposite direction.

According to Newton's law of gravitation, every mass in the universe attracts the every other mass.

In case of freely falling stone and earth, stone is attracted towards earth means earth attracts the stone but according to Newton's third law of motion, the stone should also attract the earth and it is true that stone also attracts the earth with the same force  $F = m \times a$  but due to very less mass of the stone, the acceleration in its velocity is  $9.8\text{m/s}^2$  and acceleration of earth towards stone is  $1.65 \times 10^{24}\text{m/s}^2$  which is negligible and we cannot feel it.

### **Assignment**

Refer to example 10.1 on page 134 of NCERT.

Do Question 1 and 2 on page 134 (In text questions) and Question 1 to 7 on page 143 (Back exercises) of NCERT.