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Class 9 Science C10: Gravitation



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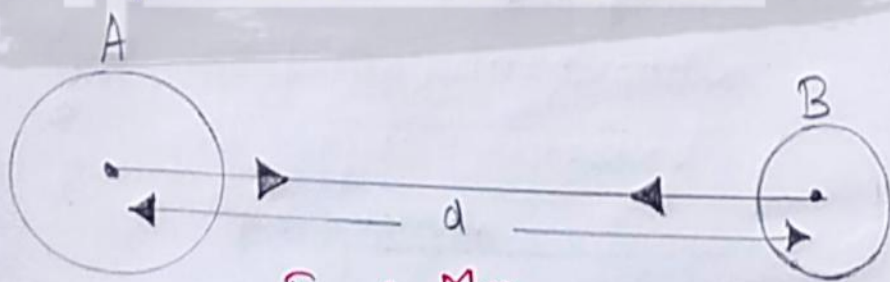
GRAVITATION

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- Universal law of gravitation :

- Every object in the universe attracts every other object with a force which is 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.



$$F = G \frac{Mm}{d^2}$$

- Let two objects 'A' and 'B' masses 'M' and 'm' lie at distance 'd' from each other as shown in the diagram drawn above.

- 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,

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

$$F \propto M \times m$$

(10.1)

Combining

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

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

(10.2)

Combining both the equations (10.1) and (10.2), we get

$$F \propto \frac{M \times m}{d^2}$$

(10.3)

$$\text{or, } F = G \frac{M \times m}{d^2}$$

(10.4)

- where G is the constant of proportionality and is called the universal gravitation constant.

- By multiplying crosswise, Eq. (10.4) gives

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

$$\text{or } G = \frac{F d^2}{M \times m}$$

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- SI unit of gravitation is $\text{Nm}^2 \text{kg}^{-2}$.
 - The accepted value of G is $6.673 \times 10^{-11} \text{Nm}^2 \text{kg}^{-2}$.
 - Free fall :
 - When an object falls down towards the earth under the gravitational force alone, we say the object is in the free fall.
 - The acceleration is called acceleration due to gravity, denoted by ' g '.
 - Unit is m/s^2 .

$$\begin{aligned} \text{As } F &= ma & (a=g) & \text{--- (i)} \\ F &= mg & & \text{--- (ii)} \end{aligned}$$

$$\text{and } F = G \frac{Mm}{d^2}$$

from (i) and (ii)

$$\therefore mg = G \frac{Mm}{d^2}$$

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

M = Mass of the earth.

d = Distance between the object and the earth⁴
 G = Gravitational constant

If the object is placed on the earth then
 $d = R$.

(R = radius of the earth)

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

Earth is not a sphere it is flattened at poles.

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