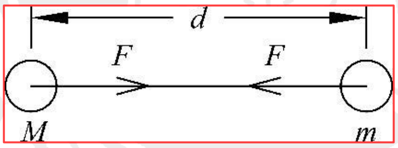
CHAPTER 8
GRAVITATION

NOTES

- **Gravitation or gravitational force:** It is the force of attraction between any two objects having masses. It is an unbalanced force and has acceleration.
- **An object moving along a circular path:** When an object moves in a circular path with a certain speed and changes its direction of motion continuously at every point of the path then, the change in direction involves a change in velocity which is called acceleration. This acceleration is towards the center and caused by a force which keeps the body moving along the orbit. This force must be acting towards the center and is called the centripetal force.
- **Gravity:** It is the force of attraction between any object and the earth.
- **Universal law of gravitation:** The universal law of gravitation states that" every object in the universe attracts every other object with a force which is directly proportional to product of the masses and inversely proportional to the square of the distance between them.
- **Mathematical form of the universal law of gravitation:**



According to the universal law of gravitation, the force *F* between the two objects is directly proportional to the product of the two masses and inversely proportional to the square of the distance between them. That is,

$$F \propto Mm, \qquad (8.1)$$

$$F \propto \frac{1}{d^2}, \qquad (8.2)$$

Where, *M* and *m* are the masses of the two bodies and *d* is the distance between the centers of the two bodies.

Combining relations (8.1) and (8.2) provides

$$F \propto \frac{Mm}{d^2}. \qquad (8.3)$$

$$\text{or} \quad F = G\frac{Mm}{d^2}, \qquad (8.4)$$

where, *G* is called universal gravitation constant or universal constant of gravitation.

- The SI unit of G is $\mathbf{Nm^2kg^{-2}}$. The value of G is $\mathbf{6.673 \times 10^{-11}\ Nm^2kg^{-2}}$.
- **Free fall:** The downward journey of an object under the gravitational force (*F*) alone is called free fall. While falling, there is no change in the direction of motion of the object but there will be a change in the magnitude of the velocity.
- **Acceleration due to gravity:** When an object falls towards the earth, an acceleration is involved. This acceleration is called acceleration due to gravity. It is denoted by g. The SI unit of g is ms^{-2}.
- **Mathematical expression for g:**

  The acceleration due to gravity is given by

  $$\text{or} \quad g = \frac{GM}{R^2}, \qquad (8.5)$$

  where, *G* is the universal gravitation constant

  M is the mass of the earth and

  R is the radius of the earth
- The value of g on the surface of the earth is $\mathbf{9.8\ ms^{-2}}$. The value of g is greater at the poles than that at the equator. The value of g decreases on going upward from the surface of the earth.
- **Mass:** The mass of an object is the measure of its inertia. Mass of an object does not change from place to place. i.e., mass remains constant.
- **Weight:** The force with which the earth attracts the body is called the weight of the body on the earth. The weight of a body of mass (*m*). Hence,

  $$W = F = \frac{GMm}{R^2} = mg. \qquad (8.6)$$
- The weight of an object varies with place. The SI unit of weight is **newton (N).**
- Weight of an object on the moon $= \frac{1}{6} \times$ **its weight on the earth.**

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