

**Q.** If the law of gravitation, instead of being inverse square law, becomes an inverse cube law

- (a) planets will not have elliptic orbits
- (b) circular orbits of planets is not possible
- (c) projectile motion of a stone thrown by hand on the surface of the earth will be approximately parabolic
- (d) there will be no gravitational force inside a spherical shell of uniform density

**Ans. (a, c)**

If the law of gravitation becomes an inverse cube law, then we can write, for a planet of mass  $m$  revolving around the sun of mass  $M$ ,

$$F = \frac{GMm}{a^3} = \frac{mv^2}{a} \quad (\text{where } a \text{ is radius of orbiting planet})$$

$$\Rightarrow v = \text{orbital speed} = \frac{\sqrt{GM}}{a} \Rightarrow v \propto \frac{1}{a}$$

$$\text{Time period of revolution of a planet } T = \frac{2\pi a}{v} = \frac{2\pi a}{\frac{\sqrt{GM}}{a}} = \frac{2\pi a^2}{\sqrt{GM}}$$

$$\Rightarrow T^2 \propto a^4$$

Hence, orbit will not be elliptical. [for elliptical orbit  $T^2 \propto a^3$ ]

As force 
$$F = \left(\frac{GM}{a^3}\right)m = g'm$$

where, 
$$g' = \frac{GM}{a^3}$$

As  $g'$ , acceleration due to gravity is constant, hence path followed by a projectile will be approximately parabolic. (as  $T \propto a^2$ )