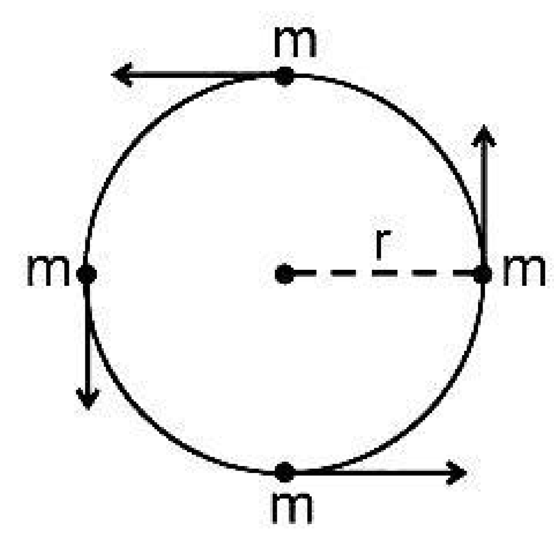
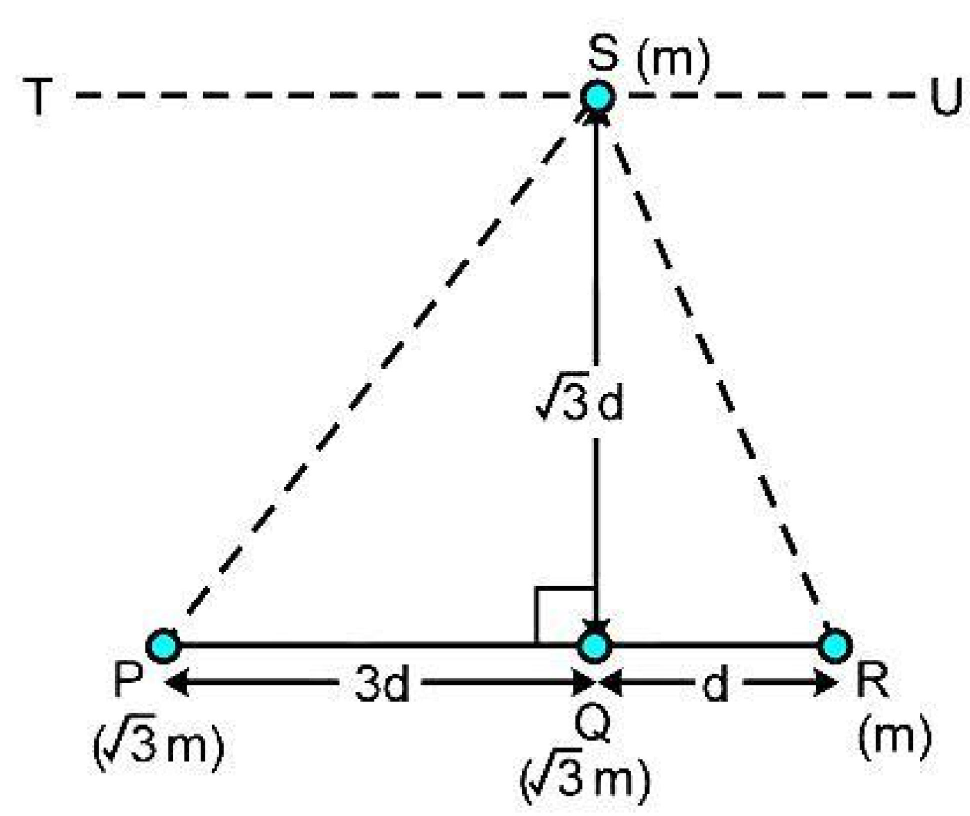
SYLLABUS : GRAVITATION

1. Four similar particles of mass m are orbiting in a circle of radius r in the same direction and same speed because of their mutual gravitational attractive force as shown in the figure. Speed of a particle is given by



(A) $\left[\frac{Gm}{r}\left(\frac{1+2\sqrt{2}}{4}\right)\right]^{\frac{1}{2}}$ (B) $\sqrt[3]{\frac{Gm}{r}}$ (C) $\sqrt{\frac{Gm}{r}\left(1+2\sqrt{2}\right)}$ (D) zero

2. Three particles P, Q and R are placed as per given figure. Masses of P, Q and R are $\sqrt{3}$ m, $\sqrt{3}$ m and m respectively. The gravitational force on a fourth particle 'S' of mass m is equal to



(A) $\frac{\sqrt{3}\,GM^2}{2d^2}$ in ST direction only

(B) $\frac{\sqrt{3}\,Gm^2}{2d^2}$ in SQ direction and $\frac{\sqrt{3}\,Gm^2}{2d^2}$ in SU direction

(C) $\frac{\sqrt{3}\,Gm^2}{2d^2}$ in SQ direction only

(D) $\frac{\sqrt{3}\,Gm^2}{2d^2}$ in SQ direction and $\frac{\sqrt{3}\,Gm^2}{2d^2}$ in ST direction

3. A stone drop from height 'h' reaches to Earth surface in1 sec. If the same stone taken to Moon and drop freely then it will reaches from the surface of the Moon in the time (The 'g' of Moon is 1/6 times of Earth):–

(A) $\sqrt{6}$ second (B) 9 second (C) $\sqrt{3}$ second (D) 6 second

4. Two bodies of masses m and M are placed at distance d apart. The gravitational potential (V) at the position where the gravitational field due to them is zero V is :–

(A) $V = -\frac{G}{d}(m+M)$ (B) $V = -\frac{G}{d}$ (C) $V = -\frac{GM}{d}$ (D) $V = -\frac{G}{d}(\sqrt{m}+\sqrt{M})^2$

5. Let gravitation field in a space be given as E = – (k/r). If the reference point is at distance d_i where potential is V_i then relation for potential is :

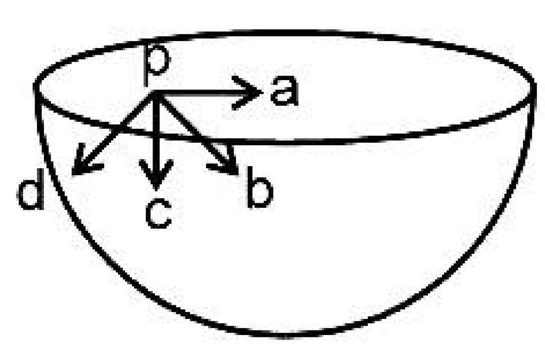
(A) $V = k\,\ell n\frac{1}{V_i} + 0$ (B) $V = k\,\ell n\frac{r}{d_i} + V_i$

(C) $V = \ell n\frac{r}{d_i} + kV_i$ (D) $V = \ell n\frac{r}{d_i} + \frac{V_i}{k}$

6. A very large number of particles of same mass m are kept at horizontal distances of 1m, 2m, 4m, 8m and so on from (0,0) point. The total gravitational potential at this point (0, 0) is:

(A) – 8G m (B) – 3G m (C) – 4G m (D) – 2G m

7. Figure show a hemispherical shell having uniform mass density. The direction of gravitational field intensity at point P will be along:



(A) a (B) b (C) c (D) d

8. A body starts from rest at a point, distance R_0 from the centre of the earth of mass M, radius R. The velocity acquired by the body when it reaches the surface of the earth will be

(A) $GM\left(\frac{1}{R}-\frac{1}{R_0}\right)$ (B) $2\,GM\left(\frac{1}{R}-\frac{1}{R_0}\right)$ (C) $\sqrt{2GM\left(\frac{1}{R}-\frac{1}{R_0}\right)}$ (D) $2GM\sqrt{\left(\frac{1}{R}-\frac{1}{R_0}\right)}$

9. Escape velocity of a body from the surface of Earth is 11.2 km/sec. from the Earth surface. If the mass of Earth becomes double of its present mass and radius becomes half of its present radius, then escape velocity will become

(A) 5.6 km/sec (B) 11.2 km/sec (C) 22.4 km/sec (D) 44.8km/sec

10. A body of mass m is situated at distance $4R_e$ above the Earth's surface, where R_e is the radius of Earth how much minimum energy be given to the body so that it may escape :–

(A) mgR_e (B) $2mgR_e$ (C) $\frac{mgR_e}{5}$ (D) $\frac{mgR_e}{16}$

11. Periodic-time of satellite revolving around the earth is - (ρ is density of earth)

(A) Proportional to $\frac{1}{\rho}$ (B) Proportional to $\frac{1}{\sqrt{\rho}}$ (C) Proportional ρ (D) does not depend on ρ.

12. An orbiting satellite will escape if :

(A) its speed is increased by $(\sqrt{2}-1)100\%$

(B) its speed in the orbit is made $\sqrt{1.5}$ times of its initial value

(C) it stops moving in the orbit

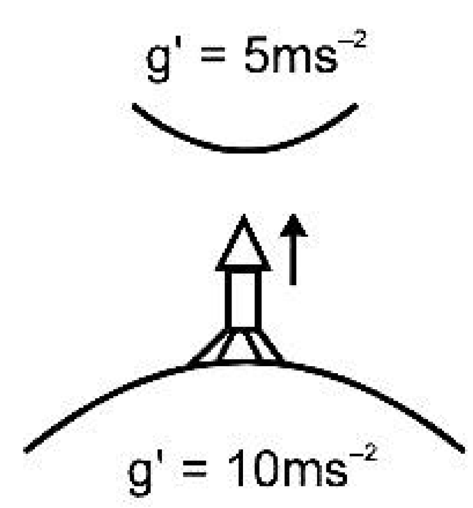
(D) None of these

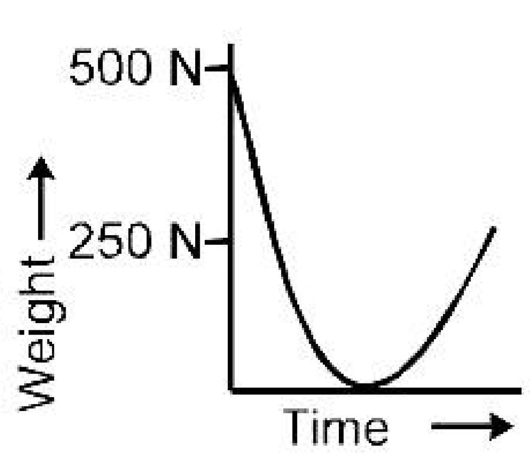
13. In case of an orbiting satellite if the radius of orbit is decreased :

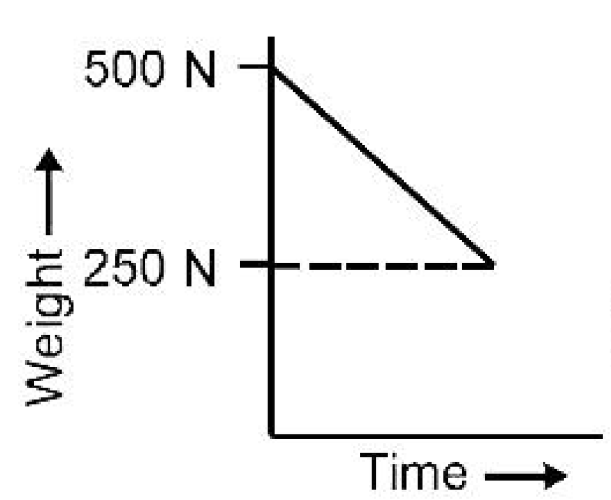
(A) its Kinetic Energy decreases (B) its Potential Energy decreases

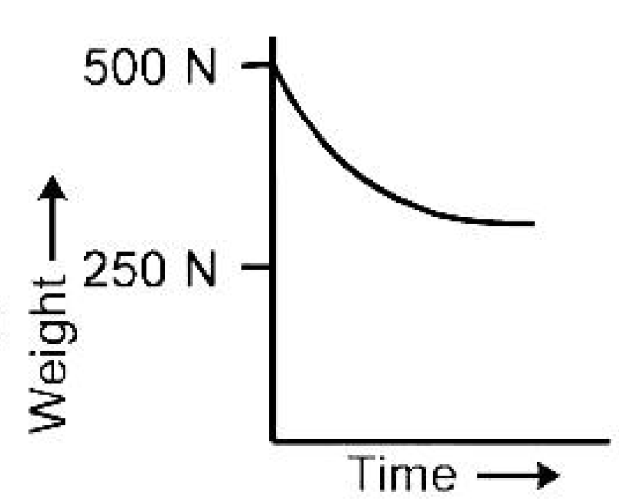
(C) its speed decreases (D) None of these

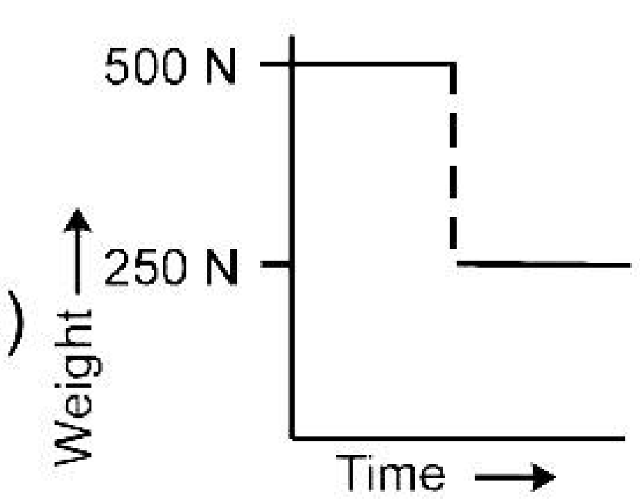
14. If acceleration due to gravity on the surface of earth is 10 ms^{-2} and let acceleration due to gravitational acceleration at surface of another planet of our solar system be 5 ms^{-2}. An astronaut weighing 50 kg on earth goes to this planet in a spaceship with a constant velocity. The weight of the astronaut with time of flight is roughly given by



(A)


(B)


(C)


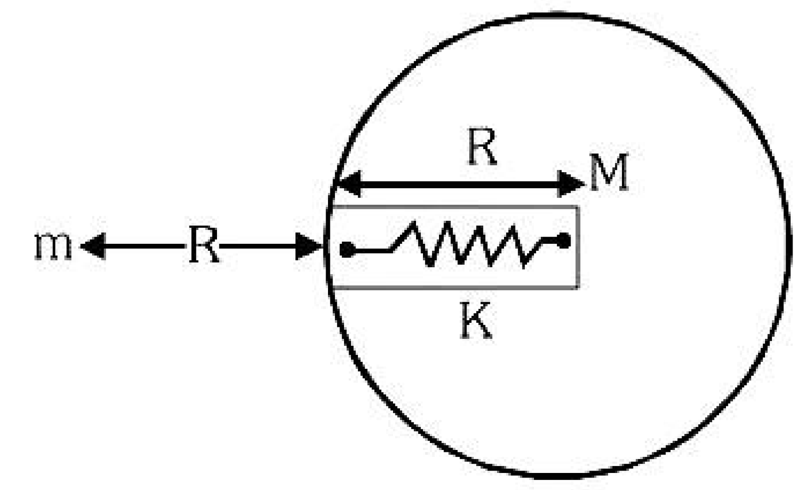
(D)


15. The acceleration due to gravity at a height (1/20)th the radius of the earth above earth's surface is 9 m/s^2. Find out its approximate value at a point at an equal distance below the surface of the earth.

(A) $\frac{12}{2}$ m/s^2 = 9.5 m/s^2 (B) $\frac{15}{2}$ m/s^2 = 5.5 m/s^2

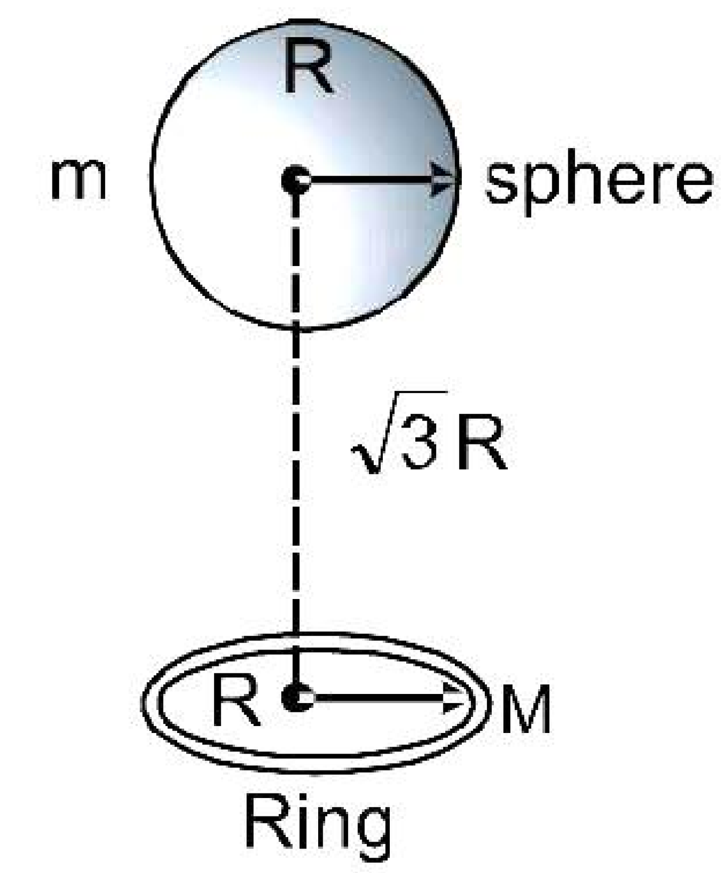
(C) $\frac{19}{2}$ m/s^2 = 9.5 m/s^2 (D) $\frac{17}{2}$ m/s^2 = 7.5 m/s^2

16. A small ball of mass 'm' is released at a height 'R' above the Earth surface, as shown in the figure. If the maximum depth of the ball to which it goes is R/2 inside the Earth through a narrow grove before coming to rest momentarily. The grove, contain an ideal spring of spring constant K and natural length R, the value of K is (R is radius of Earth and M mass of Earth)



(A) $\frac{3GMm}{R^3}$ (B) $\frac{6GMm}{R^3}$ (C) $\frac{9GMm}{R^3}$ (D) $\frac{7GMm}{R^3}$

17. A uniform ring of mass M is lying at a distance $\sqrt{3}$ R from the centre of a uniform sphere of mass m just below the sphere as shown in the figure where R is the radius of the ring as well as that of the sphere. Then gravitational force exerted by the ring on the sphere is :



(A) $\frac{GMm}{8R^2}$ (B) $\frac{GMm}{3R^2}$

(C) $\sqrt{3}\frac{GMm}{R^2}$ (D) $\sqrt{3}\frac{GMm}{8R^2}$

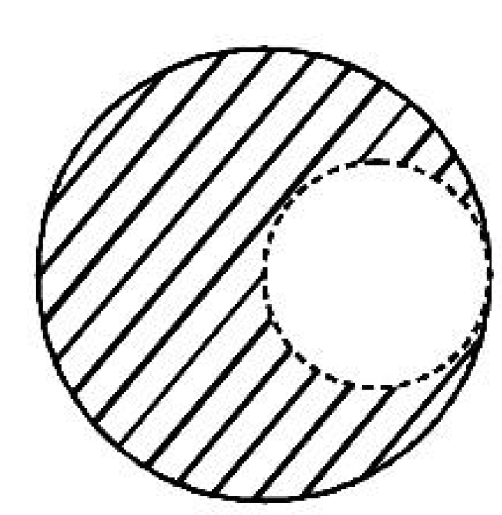
18. A projectile is fired from the surface of earth of radius R with a speed $k\nu_e$ in radially outward direction (where ν_e is the escape velocity and k < 1). Neglecting air resistance, the maximum height from centre of earth is

(A) $\frac{R}{k^2+1}$ (B) k^2 R (C) $\frac{R}{1-k^2}$ (D) kR

19. Four particles, each of mass M and equidistant from each other, move along a circle of radius R under the action of their mutual gravitational attration. the speed of each particle is :

(A) $\sqrt{\frac{GM}{R}}$ (B) $\sqrt{2\sqrt{2}\frac{GM}{R}}$ (C) $\sqrt{\frac{GM}{R}\left(1+2\sqrt{2}\right)}$ (D) $\frac{1}{2}\sqrt{\frac{GM}{R}\left(1+2\sqrt{2}\right)}$

20. From a solid sphere of mass M and radius R, a spherical portion of radius R/2 is removed , as shown in the figure. Taking gravitational potential V = 0 at r = ∞, the potential at the centre of the cavity thus formed is :(G = gravitational constant)



(A) $\frac{-GM}{2R}$ (B) $\frac{-GM}{R}$ (C) $\frac{-2GM}{3R}$ (D) $\frac{-2GM}{R}$

21. A satellite is moving with a constant speed v in circular orbit around the earth. An object of mass 'm' is ejected from the satellite such that it just escapes from the gravitational pull of the earth. At the time of ejection, the kinetic energy of the object is :

(A) $\frac{3}{2}mv^2$ (B) $\frac{1}{2}mv^2$ (C) $2mv^2$ (D) mv^2

22. Two satellites, A and B, have masses m and 2m respectively. A is in a circular orbit of radius R, and B is in a circular orbit of radius 2R around the earth. The ratio of their kinetic energies, $\frac{T_A}{T_B}$, is :

(A) 1 (B) $\sqrt{\frac{1}{2}}$ (C) 2 (D) $\frac{1}{2}$

23. Planet A has mass M and radius R. Planet B has half the mass and half the radius of Planet A. If the escape velocities from the Planets A and B are v_A and v_B, respectively, then $\frac{v_A}{v_B} = \frac{n}{4}$. The value of n is

(A) 1 (B) 4 (C) 3 (D) 2

24. On the x-axis and at a distance x from the origin, the gravitational field due to a mass distribution is given by $\frac{Ax}{(x^2+a^2)^{3/2}}$ in the x-direction. The magnitude of gravitational potential on the x-axis at a distance x, taking its value to be zero at infinity, is

(A) $A(x^2+a^2)^{3/2}$ (B) $\frac{A}{(x^2+a^2)^{3/2}}$ (C) $\frac{A}{(x^2+a^2)^{1/2}}$ (D) $A(x^2+a^2)^{1/2}$

25. Two stars of masses m and 2m at a distance d rotate about their common centre of mass in free space. The period of revolution is :

(A) $\frac{1}{2\pi}\sqrt{\frac{d^3}{3Gm}}$ (B) $2\pi\sqrt{\frac{d^3}{3Gm}}$ (C) $\frac{1}{2\pi}\sqrt{\frac{3Gm}{d^3}}$ (D) $2\pi\sqrt{\frac{3Gm}{d^3}}$

ANSWER KEY

1.	(A)	**2.**	(C)	**3.**	(A)	**4.**	(D)	**5.**	(B)
6.	(D)	**7.**	(C)	**8.**	(C)	**9.**	(C)	**10.**	(C)
11.	(B)	**12.**	(A)	**13.**	(B)	**14.**	(A)	**15.**	(C)
16.	(D)	**17.**	(D)	**18.**	(C)	**19.**	(D)	**20.**	(B)
21.	(D)	**22.**	(A)	**23.**	(B)	**24.**	(C)	**25.**	(B)