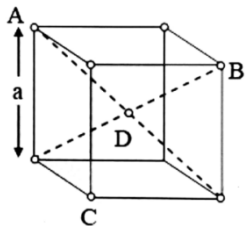


**GRAVITATION**

1. Four identical masses  $m$  each are kept at points A, B, C & D shown in figure. Gravitational force on mass at point D (body centre) is -



- (a)  $\frac{3Gm^2}{a^2}$  (b)  $\frac{12Gm^2}{a^2}$   
(c)  $\frac{4Gm^2}{a^2}$  (d)  $\frac{4Gm^2}{a^2}$

2. A planet has mass  $1/10$  of that of earth, while radius is  $1/3$  that of earth. If a person can throw a stone on earth surface to a height of 90m, then he will be able to throw the stone on that planet to a height-

- (a) 90m (b) 40 m  
(c) 100 m (d) 45 m

3. The height at which the acceleration due to gravity becomes  $\frac{g}{9}$  (where  $g$  = the acceleration due to gravity on the surface of the earth) in terms of  $R$ , the radius of the earth, is-

- (a)  $2R$  (b)  $\frac{R}{\sqrt{2}}$   
(c)  $R/2$  (d)  $\sqrt{2}R$

4. A body of mass  $m$  and radius  $r$  falls on earth from a great height. If  $M$  is mass and  $R$  is the radius of earth while  $r = \frac{R}{100}$  then the acceleration of the body when it hits the earth is: (acceleration due to gravity at earth surface is  $g$ )

- (a)  $g$  (b)  $0.98 g$   
(d)  $\frac{g}{0.98}$  (d)  $9.8 g$

5. Two bodies of masses 10 kg and 100 kg are separated by a distance of 2m. The gravitational potential at the mid-point of the line joining the two bodies is:

- (a)  $-7.3 \times 10^{-7} \text{ J/kg}$  (b)  $-7.3 \times 10^{-8} \text{ J/kg}$   
(c)  $-7.3 \times 10^{-9} \text{ J/kg}$  (d)  $-7.3 \times 10^{-6} \text{ J/kg}$

6. Suppose the gravitational force varies inversely as the  $n^{\text{th}}$  power of distance. Then the time period of a planet in circular orbit of radius  $R$  around the sun will be proportional to -

- (a)  $R^{\frac{(n+1)}{2}}$  (b)  $R^{\frac{(n-1)}{2}}$   
(c)  $R^n$  (d)  $R^{\frac{(n-2)}{2}}$

7. The distance of Neptune and Saturn from the Sun are nearly  $10^{13} \text{ m}$  and  $10^{12} \text{ m}$  respectively. Their periodic times will be in the ratio -

- (a) 10 (b) 100  
(c)  $10\sqrt{10}$  (d) 1000

8. What should be the angular speed of earth, so that bodies lying on the equator may appear weightless? ( $R = 6400$

km,  $g = 10 \text{ m/s}^2$ )-

- (a)  $1.25 \times 10^{-2} \text{ rad/s}$  (b)  $2.5 \times 10^{-3} \text{ rad/s}$   
(c)  $2.0 \times 10^{-3} \text{ rad/s}$  (d)  $3.0 \times 10^{-3} \text{ rad/s}$

9. **Statement - 1:** When a planet approaches the point which is farthest from the Sun, its orbital speed decreases.

**Statement - 2:** Work done on the planet by the gravitational force exerted by the Sun is negative.

- (a) Both Statement -1 and Statement - 2 are true  
(b) Statement -1 is true and Statement - 2 is false  
(c) Statement -1 is False and Statement - 2 is true  
(d) Both Statement -1 and Statement - 2 are False

10. A Geostationary satellite is revolving around the earth. To make it escape from gravitational field of earth, its velocity must be increased -

- (a) 100 % (b) 41.4%  
(c) 50% (d) 59.6%

11. A comet travels around the sun in elliptical orbit. Its mass is  $10^8 \text{ kg}$  when  $2.5 \times 10^{11} \text{ m}$  away its speed is  $2 \times 10^4 \text{ ms}^{-1}$ . Find the change in KE when it has reached  $5 \times 10^{10} \text{ m}$  away from the sun-

- (a)  $38 \times 10^8 \text{ J}$  (b)  $48 \times 10^{16} \text{ J}$   
(c)  $58 \times 10^8 \text{ J}$  (d)  $56 \times 10^8 \text{ J}$

12. Three particles of equal mass  $m$  go round a circle of radius  $R$  under the action of their mutual gravitational attraction. The speed of each particle is -

- (a)  $v = \frac{1}{2R} \sqrt{\frac{1}{Gm}}$  (b)  $v = \sqrt{\frac{Gm}{2R}}$   
(c)  $v = \sqrt{\frac{Gm}{\sqrt{3}R}}$  (d)  $v = \sqrt{\frac{4Gm}{R}}$

13. The radii of two planets are respectively  $R_1$  &  $R_2$  and their densities are respectively  $\rho_1$  &  $\rho_2$ . The ratio of the acceleration due to gravity at their surface is

- (a)  $g_1:g_2 = \frac{\rho_1}{R_1^2} : \frac{\rho_2}{R_2^2}$  (b)  $g_1:g_2 = R_1R_2:\rho_1\rho_2$   
(c)  $g_1:g_2 = R_1\rho_2:R_2\rho_1$  (d)  $g_1:g_2 = R_1\rho_1:R_1\rho_2$

14. The moon's radius is  $1/4$  th that of the earth & its mass is  $\frac{1}{80}$  times that of earth, if  $g$  represents the acceleration due to gravity on the surface of earth, that on the surface of moon is-

- (a)  $\frac{g}{4}$  (b)  $\frac{g}{5}$

(c)  $\frac{g}{6}$  (d)  $\frac{g}{8}$

15. Consider a particle of mass  $m$  on the axis of a ring of mass  $M$  & radius  $r$ , at a distance  $r$  from the centre of ring, this particle moving under the gravitational attraction of the ring, reaches the centre of the ring. The velocity of the particle at the centre of the ring will be -

(a)  $\sqrt{\frac{GM}{r}}$  (b)  $\sqrt{\frac{2GM}{r}}$   
(c)  $\sqrt{\frac{2GM}{r(\sqrt{2}+1)}}$  (d)  $\sqrt{\frac{2GM}{r}\left(1 - \frac{1}{\sqrt{2}}\right)}$

16. A satellite is in a circular equatorial orbit of radius 7000 km around the Earth. If it is transferred to a circular orbit of double the radius

| Column I                                      | Column II          |
|-----------------------------------------------|--------------------|
| (A) Angular momentum                          | (p) Increases      |
| (B) Area of Earth covered by satellite signal | (q) Decreases      |
| (C) Potential energy                          | (r) Becomes double |
| (D) Kinetic energy                            | (s) Becomes half   |

- (a)  $a \rightarrow p; b \rightarrow p; c \rightarrow p, s; d \rightarrow q, s$   
(b)  $a \rightarrow q; b \rightarrow r; c \rightarrow r, s; d \rightarrow p, s$   
(c)  $a \rightarrow s; b \rightarrow p; c \rightarrow q, s; d \rightarrow p, q$   
(d)  $a \rightarrow r; b \rightarrow r; c \rightarrow p, r; d \rightarrow p, q$

17. A mass  $m$  is raised from a distance  $2R$  from surface of earth to  $3R$ . Work done to do so against gravity will-

(a)  $\frac{mgR}{10}$  (b)  $\frac{mgR}{11}$   
(c)  $\frac{mgR}{12}$  (d)  $\frac{mgR}{14}$

18. A satellite of the sun is in circular orbit around the sun, midway between the sun and the earth. Then:

- (a) The period of the satellite is nearly 229 days  
(b) The period of the satellite is nearly 129 days  
(c) The speed of the satellite equal the escape velocity of the earth  
(d) The acceleration of the satellite is four times the acceleration of the earth.

19. The mass of the moon is about 1.2% of the mass of the earth. Compared to the gravitational force the earth exerts on the moon, the gravitational force the moon exerts on earth

- (a) Is the same (b) Is smaller  
(c) Is greater (d) Varies with its phase

20. A weight is suspended from the V ceiling of a lift by a spring balance. When the lift is stationary the spring balance reads  $W$ . If the lift suddenly falls freely under gravity, the reading on the spring balance will be

- (a)  $W$  (b)  $2W$  (c)  $W/2$  (d)  $0$

21. A pendulum clock is set to give correct time at the sea level. This clock is moved to hill station at an altitude of 2500 m above the sea level. In order to keep correct time of the hill station, the length of the pendulum

- (a) Has to be reduced  
(b) Has to be increased  
(c) Needs no adjustment  
(d) Needs no adjustment but its mass has to be increased

22. **Statement - 1:** The acceleration of a particle near the Earth surface differs slightly from the gravitational acceleration.

**Statement - 2:** The Earth is not a uniform sphere and because the Earth rotates.

- (a) Both Statement - 1 and Statement - 2 are true  
(b) Statement - 1 is true and Statement - 2 is false  
(c) Statement - 1 is False and Statement - 2 is true  
(d) Both Statement - 1 and Statement - 2 are False

23. The ratio of the radius of the earth to that of the moon is 10. The ratio of acceleration due to gravity on the earth and on the moon is 6. The ratio of the escape velocity from the earth's surface to that from the moon is

- (a) 10 (b) 6  
(c) Nearly 8 (d) 1.66

24. Two identical satellites A and B are circulating round the earth at the height of  $R$  and  $2R$  respectively, (where  $R$  is radius of the earth). The ratio of kinetic energy of A to that of B is

- (a)  $\frac{1}{2}$  (b)  $\frac{2}{3}$  (c) 2 (d)  $\frac{3}{2}$

25. In elliptical orbit of a planet, as the planet moves from apogee position to perigee position,

| Column-I                                  | Column-II        |
|-------------------------------------------|------------------|
| (A) Speed of planet                       | (p) Remains same |
| (B) Distance of planet from centre of Sun | (q) Decreases    |
| (C) Potential energy                      | (r) Increases    |
| (D) Angular momentum about centre of Sun  | (s) Cannot say   |

- (a)  $A \rightarrow r, B \rightarrow q, C \rightarrow q, D \rightarrow p$   
(b)  $A \rightarrow q, B \rightarrow r, C \rightarrow s, D \rightarrow p$   
(c)  $A \rightarrow p, B \rightarrow s, C \rightarrow q, D \rightarrow r$   
(d)  $A \rightarrow s, B \rightarrow p, C \rightarrow q, D \rightarrow r$

26. A geostationary satellite is orbiting the earth at a height of  $5R$  above that surface of the earth,  $R$  being the radius of the earth. The time period of another satellite in hours at a height of  $2R$  from the surface of the earth is:

- (a) 5 (b) 10 (c)  $6\sqrt{2}$  (d)  $\frac{6}{\sqrt{2}}$

27. Infinite number of bodies, each of mass 2 kg are situated on x- axis at distances  $1m, 2m, 4m, 8m \dots$

Respectively, from the origin. The resulting gravitational potential due to this system at the origin will be:

- (a)  $-\frac{8}{3}G$  (b)  $-\frac{4}{3}G$   
(c)  $-4G$  (d)  $-G$

28. A black hole is an object whose gravitational field is so strong that even light cannot escape from it. To what approximate radius would earth (mass =  $5.98 \times 10^{24}$  kg) have to be compressed to be a black hole?

- (a)  $10^{-9}$  m (b)  $10^{-6}$  m  
(c)  $10^{-2}$  m (d) 100 m

29. The gravitational field in a region is  $10 \text{ N/kg } (\hat{i} - \hat{j})$ . Then the work done by gravitational force to shift slowly a particle of mass 1kg from point (1m, 1m) to a point (2m, -2m) is-

- (a) 10 J (b) -10J  
(c) -40J (d) + 40J

30. A body is projected from the surface of earth with a velocity  $2v_e$  where  $v_e$  is the escape velocity. The velocity of the body when it escapes the gravitational field of the earth is:

- (a)  $\sqrt{2} v_e$  (b)  $\sqrt{3} v_e$   
(c)  $\sqrt{7} v_e$  (d)  $\sqrt{11} v_e$

31. **Statement - 1:** Two satellites A & B are in the same orbit If around the Earth, B being behind A. B cannot overtake A by increasing its speed.

**Statement - 2:** It will then go into a different orbit.

- (a) Both Statement -1 and Statement - 2 are true  
(b) Statement -1 is true and Statement - 2 is false  
(c) Statement -1 is False and Statement - 2 is true  
(d) Both Statement -1 and Statement - 2 are False

32. Acceleration due to gravity at earth's surface is  $10 \text{ ms}^{-2}$ . The value of acceleration due to gravity at the surface of a planet of mass  $\frac{1}{5}$ th and radius  $\frac{1}{2}$  of the earth is -

- (a)  $4 \text{ ms}^{-2}$  (b)  $6 \text{ ms}^{-2}$   
(c)  $8 \text{ ms}^{-2}$  (d)  $12 \text{ ms}^{-2}$

33. A projectile is fired vertically upwards from the surface of the earth with a velocity  $kv_e$ , where  $v_e$  is the escape velocity and  $k < 1$ . If R is the radius of the earth, the maximum height to which it will rise measured from the centre of earth will be- (Neglect air resistance)

- (a)  $\frac{1-k^2}{R}$  (b)  $\frac{R}{1-k^2}$   
(c)  $R(1-k^2)$  (d)  $\frac{R}{1+k^2}$

34. Three particles each of mass M are situated at the vertices of an equilateral triangle of side length a. The only forces acting on the particles are their mutual gravitational forces. It is desired a that each particle moves in a circle while maintaining the original mutual

separation a. What is the net gravitational force on one of the particles?

- (a)  $\frac{GM^2}{a^2}$  (b)  $\sqrt{2} \frac{GM^2}{a^2}$   
(c)  $\sqrt{3} \frac{GM^2}{a^2}$  (d)  $\frac{2GM^2}{a^2}$

35. A, B, C and D are four masses each of mass M lying on the vertices of a square of side 'a'. They always move along a common circle with velocity v. Find v so that they always remain on the vertices of the square -

- (a)  $\sqrt{\frac{GM(2\sqrt{2}+1)}{2\sqrt{2}a}}$  (b)  $\sqrt{\frac{GM(\sqrt{2}+1)}{2a}}$   
(c)  $\sqrt{\frac{GM\sqrt{2}(2+1)}{a}}$  (d) none

36. Two concentric spherical shells are as shown in figure.:

| Column-I                     | Column-II                         |
|------------------------------|-----------------------------------|
| (A) Potential at A           | (p) greater than B                |
| (B) Gravitational field at A | (q) less than B                   |
| (C) As one moves from C to D | (r) potential remains constant    |
| (D) As one moves from D to A | (s) gravitational field decreases |
|                              | (t) None                          |

- (a) A→q, B→t, C→r, D→s  
(b) A→r, B→q, C→p, D→t  
(c) A→s, B→p, C→q, D→r  
(d) A→t, B→r, C→p, D→s

37. A projectile is fired from the surface of earth of radius R with a velocity  $\eta v_e$  where  $v_e$  is the escape velocity and  $\eta < 1$ . Neglecting air resistance, the orbital velocity of projectile is-

- (a)  $v_e \sqrt{1-\eta^2}$  (b)  $v_e \sqrt{\frac{\eta^2}{5}}$   
(c)  $\frac{2}{5} v_e \sqrt{\eta}$  (d)  $\frac{2\eta}{5} v_e$

38. The gravitational potential of two homogeneous spherical shells A and B of same surface density at their respective centres are in the ratio 3:4. If the two shells coalesce into single one such that surface charge density remains same, then the ratio of potential at an internal point of the new shell to shell A is equal to-

- (a) 3 : 2 (b) 4 : 3  
(c) 5 : 3 (d) 5 : 6

39. **Statement-1:** A person feels weightlessness in an artificial satellite of the Earth. However a person on the Moon (natural satellite) feels his weight.

**Statement-2:** Artificial, satellite is a freely falling body and on the Moon surface, the weight is mainly due to Moon's gravitational attraction.

- (a) Both Statement - 1 and Statement - 2 are true  
(b) Statement -1 is true and Statement - 2 is false  
(c) Statement -1 is False and Statement - 2 is true

(d) Both Statement - 1 and Statement - 2 are False

40. What should be the angular velocity of earth about its own axis so that the weight of the body at equator would become  $\frac{3}{4}$ th of its present value-

- (a)  $\frac{1}{400}$  rad/s (b)  $\frac{1}{800}$  rad/s  
(c)  $\frac{1}{1600}$  rad/s (d)  $\frac{1}{3200}$  rad/s

41. Two satellites  $S_1$  and  $S_2$  revolve round a planet in coplanar circular orbits in the same sense. Their periods of revolution are 1 hour and 8 hour respectively. The radius of the orbit of  $S_1$  is  $10^4$  km. The speed of  $S_2$  relative to  $S_1$  when they are closet (in  $\text{kmh}^{-1}$ ) is

- (a)  $-10^4\pi$  (b)  $2 \times 10^4\pi$   
(c)  $\frac{1}{2} \times 10^4\pi$  (d)  $4 \times 10^4\pi$

42. At a given place where acceleration due to gravity is 'g'  $\text{m/sec}^2$ , a sphere of lead of density 'd'  $\text{kg/m}^3$  is gently released in a column of liquid of density ' $\rho$ '  $\text{kg/m}^3$ . If  $d > \rho$ , the sphere will

- (a) Fall vertically with an acceleration 'g'  $\text{m/sec}^2$   
(b) Fall vertically with no acceleration  
(c) Fall vertically with an acceleration  $g\left(\frac{d-\rho}{d}\right)$   
(d) Fall vertically with an acceleration  $g\left(\frac{\rho}{d}\right)$

43. The mean radius of the earth's orbit around the sun is  $1.5 \times 10^{11}$  m. The mean radius of the orbit of mercury round the sun is  $6 \times 10^{10}$  m. The mercury will rotate around the sun in

- (a) A year (b) Nearly 4 years  
(c) Nearly  $\frac{1}{4}$  year (d) 2.5 years

44. Match the following

| Column-I                                                                 | Column-II                                               |
|--------------------------------------------------------------------------|---------------------------------------------------------|
| (A) Kinetic energy of a particle in gravitational field is increasing    | (p) work done by gravitational force should be positive |
| (B) Potential energy of a particle in gravitational field is increasing  | (q) work done by external force should be non-zero      |
| (C) Mechanical energy of a particle in gravitational field is increasing | (r) work done by gravitational force should be negative |
|                                                                          | (s) cannot say anything                                 |

- (a)  $A \rightarrow s, B \rightarrow r, C \rightarrow q$  (b)  $A \rightarrow p, B \rightarrow p, C \rightarrow r$   
(c)  $A \rightarrow q, B \rightarrow s, C \rightarrow p$  (d)  $A \rightarrow p, B \rightarrow q, C \rightarrow r$

45. A satellite is moving round the earth. In order to make it move to infinity, its velocity must be increased by

- (a) 20% (b) it is impossible to do so  
(c) 82.8% (d) 41.4%

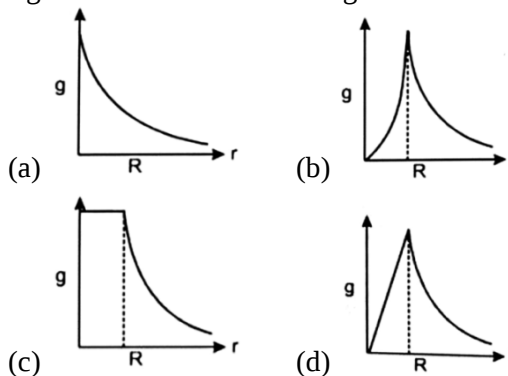
46. A particle of mass M is situated at the center of a spherical shell of same mass and radius a. The gravitational potential at a point situated at distance  $a/2$  from the centre, will be

- (a)  $-\frac{3GM}{a}$  (b)  $-\frac{2GM}{a}$   
(c)  $-\frac{GM}{a}$  (d)  $-\frac{4GM}{a}$

47. The radii of circular orbits of two satellites A and B of the earth, are  $4R$  and  $R$ , respectively. If the speed of satellite A is  $3V$ , then the speed of satellite B will be

- (a)  $\frac{3V}{4}$  (b)  $6V$   
(c)  $12V$  (d)  $\frac{3V}{2}$

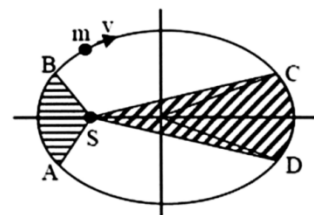
48. The dependence of acceleration due to gravity g on the distance r from the centre of the earth, assumed to be a sphere of radius R of uniform density is as shown in figures below. The correct figure is.



49. Suppose a tunnel is dug along the diameter of the earth. A particle is dropped from a point directly above the tunnel. If the earth's density is assumed to be uniform and the friction is neglected, then wrong statement is

- (a) particle will have maximum speed when passing through the centre of the earth.  
(b) Acceleration of particle will be the maximum just at the point of release  
(c) Particle will have harmonic oscillation  
(d) Particle will drop to the centre of the earth

50. The figure shows elliptical orbit of a planet m about the sun S. The shaded area SCD is twice the shaded area SAB. If  $t_1$  is the time for the planet to move from C to D and  $t_2$  is the time to move from A to B then



- (a)  $t_1 = 4t_2$  (b)  $t_1 = 2t_2$   
(c)  $t_1 = t_2$  (d)  $t_1 > t_2$