01. The moment of inertia of a flywheel having kinetic energy 360 J and angular speed of 20 rad/s is:
(a) 18 kg-m$^2$ (b) 1.8 kg-m$^2$
(c) 2.5 kg-m$^2$ (d) 9 kg-m$^2$

02. The radius of gyration of a rod of length $L$ and mass $M$ about an axis perpendicular to its length and passing through a point at a distance $L/3$ from one of its ends is:
(a) $\frac{\sqrt{7}}{6}L$ (b) $\frac{L}{9}$ (c) $\frac{L}{3}$ (d) $\frac{\sqrt{5}}{2}L$

03. The moment of inertia about an axis of a body which is rotating with angular velocity 1 radian per second is numerically equal to:
(a) one-fourth of its rotational kinetic energy
(b) half of the rotational kinetic energy
(c) rotational kinetic energy
(d) twice the rotational kinetic energy

04. The moment of inertia of a circular disc of radius 2 m and mass 1 kg about an axis passing through its centre of mass is 2 kg-m$^2$. Its moment of inertia about an axis parallel to this axis and passing through its edge (in kg-m$^2$) is:
(a) 10 (b) 8 (c) 6 (d) 4

05. A solid sphere rolls down two different inclined planes of same height, but of different inclinations. In both cases:
(a) speed and time of descent will be same
(b) speed will be same, but time of descent will be different
(c) speed will be different, but time of descent will be same
(d) speed and time of descent both are different

06. Two blocks of masses 6 kg and 4 kg are placed on a frictionless surface and connected by a spring. If the heavier mass is given a velocity of 14 m/s in the direction of lighter one, then the velocity gained by the centre of mass will be:
(a) 7.4 m/s (b) 14 m/s
(c) 8.4 m/s (d) 10 m/s

07. A door 1.6 m wide requires a force of 1 N to be applied at the free end to open or close it. The force that is required at a point 0.4 m distant from the hinges for opening or closing the door is:
(a) 1.2 N (b) 3.6 N
(c) 2.4 N (d) 4 N

08. If $\vec{F}$ is the force acting on a particle having position vector $\vec{r}$ and $\vec{\tau}$ be the torque of this force about the origin, then:
(a) $\vec{r}\cdot\vec{\tau} > 0$ and $\vec{F}\cdot\vec{\tau} < 0$
(b) $\vec{r}\cdot\vec{\tau} = 0$ and $\vec{F}\cdot\vec{\tau} = 0$
(c) $\vec{r}\cdot\vec{\tau} = 0$ and $\vec{F}\cdot\vec{\tau} \neq 0$
(d) $\vec{r}\cdot\vec{\tau} \neq 0$ and $\vec{F}\cdot\vec{\tau} = 0$

09. Four identical thin rods each of mass $M$ and length $l$, form a square frame. Moment of inertia of this frame about an axis through the centre of the square and perpendicular to its plane is:
(a) $\frac{2}{3}Ml^2$ (b) $\frac{13}{3}Ml^2$
(c) $\frac{1}{3}Ml^2$ (d) $\frac{4}{3}Ml^2$

10. A child stands at one end of a boat moving with a speed $v$ in still water. If the child starts running towards the other end of the boat with a speed $u$, the centre of mass of the system (boat and child) will move with a speed:
(a) $v-u$ (b) $v$ (c) $u$ (d) $v+u$

11. Two particles $A$ and $B$, initially at rest, move towards each other under a mutual force of attraction. At the instant when the speed of $A$ is $v$ and that of $B$ is $2v$, the speed of the centre of mass of the system is:
(a) 0 (b) $v$ (c) $1.5v$ (d) $3v$

12. From a circular disc of radius $R$ and mass $9M$, a small disc of mass $M$ and radius $\frac{R}{3}$ is removed concentrically. The moment of inertia of the remaining disc about an axis perpendicular to the plane of the disc and passing through its centre is:
(a) $\frac{40}{9}MR^2$ (b) $MR^2$
(c) $4MR^2$ (d) $\frac{4}{9}MR^2$

13. A circular disc of moment of inertia $I_t$ is rotating in a horizontal plane, about its symmetry axis, with a constant angular speed $\omega_i$. Another disc of moment of inertia $I_b$ is dropped coaxially onto the rotating disc. Initially the second disc

has zero angular speed. Eventually both the discs rotate with a constant angular speed $\omega_f$. The energy lost by the initially rotating disc to friction is:

(a) $\frac{1}{2}\frac{I_b^2}{(I_t + I_b)}\omega_i^2$ (b) $\frac{1}{2}\frac{I_t^2}{(I_t + I_b)}\omega_i^2$

(c) $\frac{I_b - I_t}{(I_t + I_b)}\omega_i^2$ (d) $\frac{1}{2}\frac{I_b I_t}{(I_t + I_b)}\omega_i^2$

14. A wire of mass $m$ and length $l$ is bent in the form of a circular ring, the moment of inertia of the ring about its axis is:

(a) $\left(\frac{1}{8\pi^2}\right)ml^2$ (b) $\left(\frac{1}{2\pi^2}\right)ml^2$

(c) $\left(\frac{1}{4\pi^2}\right)ml^2$ (d) $ml^2$

15. A mass $m$ hangs with the help of a string wrapped around a pulley on a frictionless bearing. The pulley has mass $m$ and radius $R$. Assuming pulley to be a perfect uniform circular disc, the acceleration of the mass $m$, if the string does not slip on the pulley, is :

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

16. A small mass attached to a string rotates on a frictionless table top as shown. If the tension in the string is increased by pulling the string causing the radius of the circular motion to decrease by a factor of 2, the kinetic energy of the mass will:

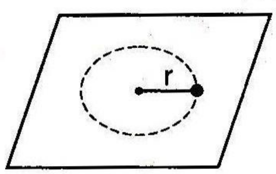


**Fig. 6.17**

(a) decrease by a factor of 2
(b) remain constant
(c) increase by a factor of 2
(d) increase by a factor of 4

17. A solid cylinder of mass 3 kg is rolling on a horizontal surface with velocity 4 $ms^{-1}$. It collides with horizontal spring of force constant 200 $Nm^{-1}$. The maximum compression produced in the spring will be :

(a) 0.7 m (b) 0.2 m
(c) 0.5 m (d) 0.6 m

18. Two persons of masses 55 kg and 65 kg respectively, are at the opposite ends of a boat. The length of the boat is 3.0 m and weighs 100 kg. The 55 kg man walks upto the 65 kg man and sits with him. If the boat is in still water, the centre of mass of the system shifts by :

(a) zero (b) 0.75 m (c) 3.0 m
(d) 2.3 m

19. $ABC$ is an equilateral triangle with $O$ as its centre. $\vec{F_1}, \vec{F_2}$ and $\vec{F_3}$ represent three forces acting along the sides $AB, BC$ and $AC$ respectively. If the total torque about $O$ is zero then the magnitude of $\vec{F_3}$ is :

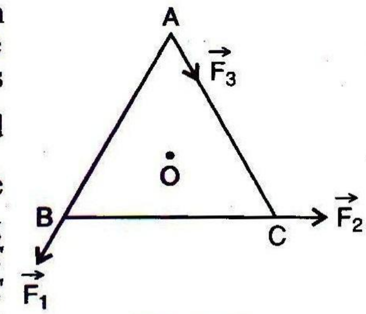


**Fig. 6.18**

(a) $\frac{F_1 + F_2}{2}$ (b) $2(F_1 + F_2)$

(c) $F_1 + F_2$ (d) $F_1 - F_2$

20. When a mass is rotating in a plane about a fixed points, its angular momentum is directed along :

(a) the radius
(b) the tangent to the orbit
(c) a line perpendicular to the plane of rotation
(d) the line making an angle of 45° to the plane of rotation

21. A rod $PQ$ of mass $M$ and length $L$ is hinged at end $P$. The rod is kept horizontal by a massless string tied to point $Q$ as shown in figure. When string is cut, the initial angular acceleration of the rod is :

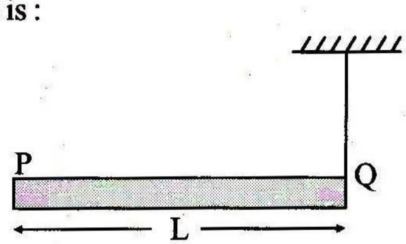


**Fig. 6.19**

(a) $g/L$ (b) $2g/L$ (c) $\frac{2g}{3L}$ (d) $\frac{3g}{2L}$

22. A solid cylinder of mass 50 kg and radius 0.5 m is free to rotate about the horizontal axis. A massless string is wound round the cylinder with one end attached to it and other hanging freely. Tension in the string required to produce an angular acceleration of 2 revolutions $s^{-2}$ is :

(a) 25 N (b) 50 N
(c) 78.5 N (d) 157 N

23. The ratio of the accelerations for a solid sphere (mass $m$ and radius $R$) rolling down an incline of angle $\theta$ without slipping and slipping down the incline without rolling is :

(a) 5 : 7 (b) 2 : 3
(c) 2 : 5 (d) 7 : 5

24. A mass $m$ moves in a circle on a smooth horizontal plane with velocity $v_0$ at a radius $R_0$. The mass is attached to a string which passes through a smooth hole in the plane as shown. The tension in the string is increased gradually and finally $m$ moves in a circle of radius $(R_0/2)$. The final value of the kinetic energy is :

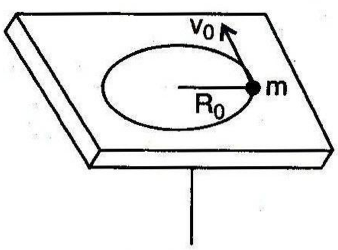


Fig. 6.20

(a) $\frac{1}{4}mv_0^2$ (b) $2mv_0^2$
(c) $\frac{1}{2}mv_0^2$ (d) $mv_0^2$

25. A rod of weight $W$ is supported by two parallel knife edges $A$ and $B$ and is in equilibrium in a horizontal position. The knives are at a distance $d$ from each other. The centre of mass of the rod is at distance $x$ from $A$. The normal reaction on $A$ is :

(a) $\frac{Wd}{x}$ (b) $\frac{W(d-x)}{x}$
(c) $\frac{W(d-x)}{d}$ (d) $\frac{Wx}{d}$

26. Three identical spherical shells, each of mass $M$ and radius $r$ are placed as shown in figure. Consider an axis $XX'$ which is touching to low shells and passing through diameter of third shell. Moment of inertia of the system consisting of these spherical shells about $XX'$ axis is :

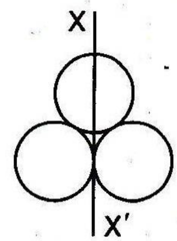


Fig. 6.21

(a) $3Mr^2$ (b) $\frac{16}{5}Mr^2$
(c) $4Mr^2$ (d) $\frac{11}{5}Mr^2$

27. A disc and a sphere of same radius but different masses roll off on two inclined planes of the same altitude and length. Which one of the two objects gets to the bottom of the plane first ?

(a) Disc
(b) Sphere
(c) Both reach at the same time
(d) Depends on their masses

28. A uniform circular disc of radius 50 cm at rest is free to turn about an axis which is perpendicular to its plane and passes through its centre. It is subjected to a torque which produces a constant angular acceleration of 2.0 rad $s^{-2}$. Its net acceleration in $ms^{-2}$ at the end of 2.0 s is approximately :

(a) 8.0 (b) 7.0 (c) 6.0 (d) 3.0

29. From a disc of radius $R$ and mass $M$, a circular hole of diameter $R$, whose rim passes through the centre is cut. What is the moment of inertia of the remaining part of the disc about a perpendicular axis, passing through the centre ?

(a) $15MR^2/32$ (b) $13MR^2/32$
(c) $11MR^2/32$ (d) $9MR^2/32$

30. Radius of orbit of satellite of the earth is $R$. Its kinetic energy is proportional to:

(a) $1/R$ (b) $-1/R$ (c) $R$ (d) $1/R^{3/2}$

31. A particle of mass $m$ is thrown upwards from the surface of the earth, with a velocity $u$. The mass and the radius of the earth are, respectively, $M$ and $R$. $G$ is gravitational constant and $g$ is acceleration due to gravity on the surface of the earth. The minimum value of $u$ so that the particle does not return back to the earth, is:

(a) $\sqrt{\frac{2GM}{R^2}}$ (b) $\sqrt{\frac{2GM}{R}}$

(c) $\sqrt{\frac{2gM}{R^2}}$ (d) $\sqrt{2gR^2}$

32. If distance between the earth and the sun become four times, then time period becomes:

(a) 4 times (b) 8 times

(c) 1/4 times (d) 1/8 times

33. Find ratio of acceleration due to gravity $g$ at depth $d$ and at height $h$, where $d = 2h$.

(a) 1 : 1 (b) 1 : 2 (c) 2 : 1 (d) 1 : 4

34. If the earth were to suddenly contract to $\frac{1}{n}th$ of its present radius without any change in its mass, the duration of the new day will be nearly:

(a) $\frac{24}{n^2}$ hr (b) $24n$ hr

(c) $\frac{24}{n}$ hr (d) $24n^2$ hr

35. A body is orbiting around the earth at a mean radius which is two times as greater as the parking orbit of a satellite, the period of body is:

(a) 4 days (b) 16 days

(c) $2\sqrt{2}$ days (d) 64 days

36. Two identical solid copper spheres of radius $R$ are placed in contact with each other. The gravitational attraction between them is proportional to:

(a) $R^2$ (b) $R^{-2}$ (c) $R^4$ (d) $R^{-4}$

37. A cosmonaut is orbiting the earth in a space-craft at an altitude $h = 630$ km with a speed of 8 km/s. If the radius of the earth is 6400 km, the acceleration of the cosmonaut is:

(a) $9.10\ m/s^2$ (b) $9.80\ m/s^2$

(c) $10.0\ m/s^2$ (d) $9.88\ m/s^2$

38. Two satellites $A$ and $B$ go around a planet $P$ in circular orbits having radius $4R$ and $R$ respectively. If the speed of satellite $A$ is $3v$, then the speed of satellite $B$ will be:

(a) $6v$ (b) $9v$

(c) $3v$ (d) none of these

39. The motion of planets in the solar system is an example of conservation of:

(a) mass (b) momentum

(c) angular momentum (d) kinetic energy

40. A body is thrown upward from the earth surface with velocity 5 m/s and from a planet surface with velocity 3 m/s. Both follow the same path. What is the projectile acceleration due to gravity on the planet?

(a) $2\ m/s^2$ (b) $3.5\ m/s^2$

(c) $4\ m/s^2$ (d) $5 m/s^2$

41. Two point objects of masses 1.5 g and 2.5 g respectively are at a distance of 16 cm apart, the centre of gravity is at a distance $x$ from the object of mass 1.5 g where $x$ is:

(a) 10 cm (b) 6 cm

(c) 13 cm (d) 3 cm

42. If the earth shrinks such that its mass does not change but radius decreases to one quarter of its original value, then one complete day will take:

(a) 96 hrs (b) 48 hrs

(c) 6 hrs (d) 1.5 hrs

43. If there were a reduction in gravitational effect, which of the following forces do you think would change in some respect?

(a) Magnetic force
(b) Electrostatic force
(c) Viscous force
(d) Archimedes' uplift

44. A solid sphere of mass $M$ and radius $R$ has a spherical cavity of radius $\frac{R}{2}$ such that the centre of cavity is at a distance $R/2$ from the

centre of the sphere. A point mass $m$ is placed inside the cavity at a distance $R/4$ from the centre of the sphere. The gravitational pull between the sphere and the point mass $m$ is:

(a) $11GMm/R^2$ (b) $14\,GMm/R^2$

(c) $GMm/2R^2$ (d) $GMm/R^2$

45. The largest and the shortest distances of the earth from the sun are $r_1$ and $r_2$. Its distance from the sun when it is at the perpendicular to the major axis of the orbit drawn from the sun, is:

(a) $\dfrac{r_1 + r_2}{4}$ (b) $\dfrac{r_1 r_2}{r_1 + r_2}$

(c) $\dfrac{2 r_1 r_2}{r_1 + r_2}$ (d) $\dfrac{r_1 + r_2}{3}$

46. A satellite moving around the earth in a circular orbit of radius $r$ and speed $v$ suddenly loses some of its energy. Then:

(a) $r$ will increase and $v$ will decrease
(b) both $r$ and $v$ will decrease
(c) $r$ will decrease and $v$ will increase
(d) none of the above

47. A body is projected up from the surface of the earth with a velocity equal to $\dfrac{3}{4}$ th of its escape velocity. If $R$ be the radius of the earth, the height it reaches is:

(a) $\dfrac{3R}{10}$ (b) $\dfrac{9R}{7}$

(c) $\dfrac{8R}{5}$ (d) $\dfrac{9R}{5}$

48. The additional kinetic energy to be provided to a satellite of mass $m$ revolving around a planet of mass $M$, to transfer it from a circular orbit of radius $R_1$ to another of radius $R_2\,(R_2 > R_1)$ is:

(a) $GmM\left(\dfrac{1}{R_1^2} - \dfrac{1}{R_2^2}\right)$

(b) $GmM\left(\dfrac{1}{R_1} - \dfrac{1}{R_2}\right)$

(c) $2GmM\left(\dfrac{1}{R_1} - \dfrac{1}{R_2}\right)$

(d) $\dfrac{1}{2}GmM\left(\dfrac{1}{R_1} - \dfrac{1}{R_2}\right)$

49. If the earth were to cease rotating about its own axis. The increase in the value of $g$ in CGS system at a place of latitude of 45° will be:

(a) 2.68 (b) 1.68

(c) 3.36 (d) 0.34

50. Two bodies of masses $m$ and $4\,m$ are placed at a distance $r$. The gravitational potential at a point on the line joining them where the gravitational field is zero is:

(a) zero (b) $-\dfrac{4Gm}{r}$

(c) $-\dfrac{6Gm}{n}$ (d) $-\dfrac{9Gm}{r}$

51. A spherical planet has a mass $M_p$ and diameter $D_p$. A particle of mass $m$ falling freely near the surface of this planet will experience an acceleration due to gravity, equal to :

(a) $\dfrac{GM_p}{D_p^2}$ (b) $\dfrac{4GM_p m}{D_p^2}$

(c) $\dfrac{4GM_p}{D_p^2}$ (d) $\dfrac{GM_p m}{D_p^2}$

52. A geostationary satellite is orbiting the earth at a height of $5R$ above the 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 earth is :

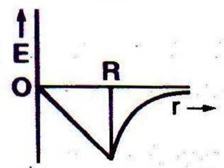
(a) $6\sqrt{2}$ (b) $\dfrac{6}{\sqrt{2}}$ (c) 5 (d) 10

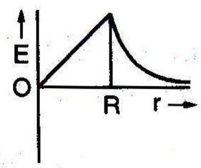
53. A black hole is an object whose gravitational field is so strong that even light cannot escape from it. To what approximate radius would earth (mass $= 5.98 \times 10^{24}$ kg) have to be compressed to be a black hole ?

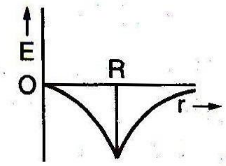
(a) $10^{-9}$ m (b) $10^{-6}$ m

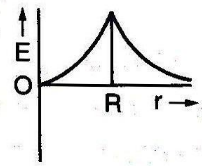
(c) $10^{-2}$ m (d) 100 m

54. Dependence of intensity of gravitational field $(E)$ of earth with distance $(r)$ from centre of earth is correctly represented by :

(a) 


(b) 


(c) 


(d) 


55 . Kepler's third law states the square of period of revolution ($T$) of a planet around the sun, is proportional to third power of average distance $r$ between sun and planet, *i.e.*, $T^2 = Kr^3$, here $K$ is constant. If the masses of sun and planet are $M$ and $m$ respectively, then as per Newton's law of gravitation, force of attraction between them, is :

$$F = \frac{GMm}{r^2}$$

Here, $G$ is gravitational constant. The relation between $G$ and $K$ is described as :

(a) $GMK = 4\pi^2$ (b) $K = G$

(c) $K = \frac{1}{G}$ (d) $GK = 4\pi^2$

56 . Two spherical bodies of mass $M$ and $5M$ and radii $R$ and $2R$ released in free space with initial separation between their centres equal to $12R$. If they attract each other due to gravitational force only, then the distance covered by the smaller body before collision is :

(a) 4.5 $R$ (b) 7.5 $R$

(c) 1.5 $R$ (d) 2.5 $R$

57 . The ratio of escape velocity at earth ($V_e$) to the escape velocity at a planet ($V_p$) whose radius and mean density are twice as that of earth is :

(a) 1 : 2 (b) $1 : 2\sqrt{2}$

(c) 1 : 4 (d) $1 : \sqrt{2}$

58. At what height from the surface of earth the gravitation potential and the value of $g$ are $-5.4 \times 10^7$ J kg$^{-2}$ and 6.0 ms$^{-2}$ respectively ? Take the radius of earth as 6400 km :

(a) 2600 km (b) 1600 km

(c) 1400 km (d) 2000 km