MULTIPLE CHOICE QUESTIONS

1. A bomb of mass 12 kg, initially at rest, explodes into two pieces of masses 4 kg and 8 kg. The speed of the 8 kg mass is 6 m/s. The kinetic energy of the 4 kg mass is **[MNR 85]**
   (*a*) 32 J (*b*) 48 J
   (*c*) 114 J (*d*) 288 J

2. A bomb of mass 9 kg, initially at rest, explodes into two pieces of masses 3 kg and 6 kg. The kinetic energy of the 3 kg mass is 216 J. The kinetic energy of the 6 kg mass is
   (*a*) 216 J (*b*) 108 J
   (*c*) 432 J (*d*) 54 J

3. A bomb of mass 1 kg, initially at rest, explodes into three fragments of masses in the ratio 1 : 1 : 3. The two pieces of equal mass fly off perpendicular to each other, each with a speed of 30 m/s. What is the velocity of the heavier fragment ? **[CBSE PMT 91]**
   (*a*) $10\sqrt{2}$ m/s at 45° with each of the other two fragments
   (*b*) $10\sqrt{2}$ m/s at 135° with each of the other two fragments
   (*c*) 20 m/s at 45° with each of the other two fragments
   (*d*) 20 m/s at 135° with each of the other two fragments

4. In an elastic collision **[DCE 93, 92]**
   (*a*) momentum is conserved but energy is not
   (*b*) energy is conserved but momentum is not
   (*c*) both momentum and energy are conserved
   (*d*) neither momentum nor energy is conserved

5. When two bodies stick together after the collision, the collision is said to be
   (*a*) perfectly elastic
   (*b*) partially elastic
   (*c*) completely inelastic
   (*d*) none of these

6. A moving particle of mass m makes a head-on elastic collision with a particle of mass $2m$ which is initially at rest. The fraction of the initial kinetic energy lost by the colliding particle is
   (*a*) 1/9 (*b*) 2/9
   (*c*) 4/9 (*d*) 8/9

7. When an explosive shell, travelling in a parabolic path under the effect of gravity explodes, the centre of mass of the fragments will move
   (*a*) first vertically upwards and then vertically downwards
   (*b*) vertically downwards
   (*c*) along the original parabolic path
   (*d*) first horizontally and then along a parabolic path

8. A bullet hits and gets embedded in a solid block resting on a horizontal frictionless table. What is conserved ? **[CPMT 1970]**
   (*a*) momentum and kinetic energy
   (*b*) momentum alone
   (*c*) kinetic energy alone
   (*d*) neither momentum nor kinetic energy.

9. A bag of mass M hangs by a long thread. A bullet of mass m comes horizontally with a velocity v and gets embedded in the bag. Then for the combined system, immediately after the collision, the
   (*a*) momentum is $\dfrac{mv\,M}{M+m}$
   (*b*) momentum is mv
   (*c*) kinetic energy is $\dfrac{m^2\,v^2}{2(M+m)}$
   (*d*) kinetic energy is $\dfrac{mv^2}{2}$

10. A shell is fired from a canon with a velocity v at an angle θ with the horizontal . At the highest point it explodes into two pieces of equal masses. One of the pieces retraces its path to the canon. The speed of the other piece immediately after the explosion is **[CBSE PMT 99, IIT 86]**

(a) $3v\cos\theta$ (b) $2v\cos\theta$

(c) $\frac{3}{2}v\cos\theta$ (d) $v\cos\theta$

11. A sphere has a perfectly elastic oplique collision with another identical sphere which is initially at rest. The angle between their velocities after the collision is **[DCE 92]**
(a) 30° (b) 45°
(c) 60° (d) 90°

12. In an inelastic collision **[DEC 93]**
(a) kinetic energy is more after the collision
(b) kinetic energy is less after the collision
(c) momentum is more after the collision
(d) momentum is less after the collision

13. Three particles *A*, *B* and *C* of equal masses, moving with the same speed v along the medians of an equilateral triangle, collide at the centroid of the triangle. After collision, *A* comes to rest and *B* retraces its path with speed v. The speed of *C* after the collision is
(a) zero (b) $v/2$
(c) v (d) $4v$

14. Two particles, each of mass *m*, moving in opposite directions with equal speeds along the same straight line strike elastically. If the velocities of the first and the second particle before collision are denoted by $+v$ and $-v$, respectively, then if there is no change in the line of motion of the two particles, their velocities after collision are, respectively, **[MNR 1980]**
(a) $-v$ and $+v$ (b) $+v$ and $-v$
(c) 0 and $2v$ (d) $2v$ and 0

15. A rocket works on the principle of conservation of **[CPMT 73]**
(a) mass
(b) linear momentum
(c) energy
(d) angular momentum

16. A particle of mass m moving with a velocity $\vec{v}$ makes a head-on elastic collision with another identical particle which is initially at rest. The velocity of the first particle after the collision is **[CPMT 78]**

(a) $-\vec{v}$ (b) $\vec{v}$

(c) $\frac{\vec{v}}{2}$ (d) zero

17. Two skaters *A* and *B*, having masses 50 kg and 70 kg respectively, stand facing each other 6 m apart on a horizontal smooth surface. They pull on a rope stretched between them. How far does each move before they meet ?
(a) both move 3 m
(b) A moves 2.5 m and *B* moves 3.5 m
(c) A moves 3.5 m and *B* moves 2.5 m
(d) none of the above

18. A metal ball and a rubber ball, both having the same mass, strike a wall normally with the same velocity. The rubber ball rebounds and the metal ball does not rebound. It can be concluded that
(a) the rubber ball suffers greater change in momentum
(b) the metal ball suffers greater change in momentum
(c) both suffer the same change in momentum
(d) the initial momentum of the rubber ball in greater than that of the metal ball

19. A canon ball is fired with a velocity of 300 m/s at an angle of 60° with the horizontal. At the highest point it explodes into three equal fragments. One goes vertically upwards with a velocity of 150 m/s, the second one falls vertically downwards with a velocity of 150 m/s. The third one moves with velocity of
(a) 150 m/s horizontally
(b) 300 m/s horizontally
(c) 450 m/s horizontally
(d) 300 m/s at 60° with the horizontal

20. Six identical steel balls are lined up in a straight frictionless groove made on a horizontal surface. Two similar balls moving with speed v collide elastically with the row of 6 balls from the left. Then

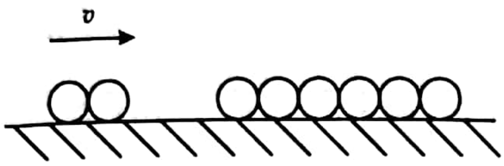


Fig. 7.18

(a) one ball from the row will move with a speed $2v$, other balls remaining at rest

(b) two balls from the row will move with a speed v other balls remaining are rest

(c) all the 6 balls in the row will move with a speed $v/6$ each and the two incident balls will come to rest

(d) all the 8 balls will move with a speed $v/8$ each

21. A steel ball of radius 1 cm is initially at rest on a horizontal frictionless surface. It is struck head-on and elastically by another steel ball of radius 2 cm moving with a speed of 81 cm/s. The speed of the two balls after the collision are, respectively,

(a) 63 cm/s; 144 cm/s

(b) 144 cm/s, 63 cm/s

(c) 126 cm/s; 72 cm/s

(d) 72 cm/s, 126 cm/s

22. An object, initially at rest, explodes into three fragments. The momenta of two parts are $2p\mathbf{i}$ and $p\mathbf{j}$ where p is a positive number. The momentum of the third part

(a) will have a magnitude $3p$

(b) will have a magnitude $\sqrt{5}p$

(c) will make an angle $\tan^{-1}\left(\frac{1}{2}\right)$ with the x-axis

(d) will make an angle of $\pi - \tan^{-1}\left(\frac{1}{2}\right)$ with the x-axis

23. A body of mass 2.9 kg is suspended from a string of length 2.5 m and is at rest. A bullet of mass 100 g, moving horizontally with a speed of 150 m/s, strikes and sticks to it. What is the maximum angle made by the string with the vertical after the impact ? (g = 10 m/s^2)

(a) 30° (b) 45°

(c) 60° (d) 90°

24. A ball, moving with a speed of 3 m/s, strikes an identical stationary ball such that after the collision, the direction of each ball makes an angle of 30° with the original line of motion. The speeds of the two balls after the collision are, respectively,

(a) $\sqrt{3}$ m/s; 3 m/s

(b) 3 m/s; $\sqrt{3}$ m/s

(c) 3 m/s; 3 m/s

(d) $\sqrt{3}$ m/s, $\sqrt{3}$ m/s

25. A ball A, moving with a speed u, collides directly with another similar ball B moving with a sped v in the opposite direction. A comes to rest after the collision. If the coefficient of restitution is e then u/v is

(a) $\frac{1+e}{1-e}$ (b) $\frac{1-e}{1+e}$

(c) $\frac{e}{1-e}$ (d) $\frac{e}{1+e}$

26. A sphere A impinges directly on an identical sphere B at rest. If e is the coefficient of restitution then the ratio of the velocities of A and B after impact is

(a) $\frac{1+e}{1-e}$ (b) $\frac{1-e}{1+e}$

(c) $\frac{e}{1-e}$ (d) $\frac{e}{1+e}$

27. When a ball collides head-on and elastically with an identical ball on a horizontal frictionless surface, the first one comes to rest while the second one moves with the same velocity as that of the first ball before collision. This result

[AIIMS 92]

(a) can be derived by using momentum conservation alone

(b) can be derived by using energy conservation alone

(c) cannot be derived by using any of the two conservation principles

(d) can be derived by using both conservation of energy and momentum.

28. A bomb explodes in air when it has a horizontal speed of 100 km/h. It breaks into two pieces A, B of mass ratio 1 : 2. If A goes vertically up at a speed of 400 km/h, the speed of B is

(a) 200 km/h (b) 250 km/h
(c) 300 km/h (d) 500 km/h

29. A space craft of mass M is moving in free space with velocity V. It explodes and breaks into two. One part, which has mass m is left stationary The velocity of the other part is

(a) $\frac{MV}{M+m}$ (b) $\frac{mV}{M+m}$
(c) $\frac{MV}{M-m}$ (d) $\frac{mV}{M-m}$

30. A ball A of mass 1 kg, moving with a speed of 12 m/s, collides obliquely and elastically with another ball B which was initially at rest. Ball A then moves off at right angles to its initial direction with a speed of 5 m/s. The momentum of ball B after collision is

(a) 5 kg m/s (b) 11 kg m/s
(c) 13 kg m/s (d) 17 kg m/s

31. A uniform wooden plank of mass 400 kg and length 10 m is floating on still water with a man of 100 kg at one end of it. The man walks to the other end of the plank and stops. The distance moved by the man relative to water is

(a) 10 m (b) 8 m
(c) 5 m (d) zero

32. A 6 kg box sled is travelling on ice at a speed of 9 m/s when a 12 kg packet is dropped into it vertically. The velocity of the sled will now be

(a) 3 m/s (b) 4 m/s
(c) 6 m/s (d) 8 m/s

33. A body of mass 2 kg makes an elastic collision with another body at rest and then continues to move in the original direction with one-fourth of its initial speed. The mass of the struck body is

(a) 0.6 kg (b) 1 kg
(c) 1.2 kg (d) 2 kg

34. 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 **[IIT 82]**

(a) zero (b) v
(c) $1.5\,v$ (d) $2v$

35. Two blocks m_1 and m_2, having masses 10 kg and 5 kg respectively, are placed on a frictionless horizontal surface and are connected by a light spring of force constant 5 N/m. m_1 is in contact with a rigid wall. m_2 is pushed through a distance of 4 cm towards m_1 and then released. The velocity of the centre of mass of the system when m_1 breaks off the wall is

(a) 2/3 cm/s (b) 4/3 cm/s
(c) 2 cm/s (d) 4 cm/s

36. A ball is dropped from a height of 1 m. If the coefficient of restitution between the surface and the ball is 0.6, the ball rebounds to a height of **[CPMT 93]**

(a) 0.6 m (b) 0.4 m
(c) 0.16 m (d) 0.36 m.

37. A bomb of mass M at rest explodes into three pieces, two of which of mass M/4 each, are thrown off in perpendicular directions with speeds of 3 m/s and 4 m/s. The third piece is thrown off with a speed **[CPMT 90]**

(a) 1.5 m/s (b) 2.0 m/s
(c) 2.5 m/s (d) 3.0 m/s

38. A block of mass 1kg, moving with a speed of 4 m/s, collides with another block of mass 2 kg which is at rest. The lighter block comes to rest after collision. The loss in the kinetic energy of the system is **[Bihar 93]**

(*a*) 8 J (*b*) 4×10^{-7} J
(*c*) 4 J (*d*) none of these

39. A ball, moving with a speed v towards north, collides with an identical ball, moving with a speed v towards east. After collision the two balls stick together and move towards north-east. The speed of the combination is **[DPMT 2005, MP CET 99]**

(*a*) v (*b*) $v\sqrt{2}$
(*c*) $v/\sqrt{2}$ (*d*) $v/2$

40. A radioactive nucleus of mass number A, initially at rest, emits an α particle with speed v. The recoil speed of the daughter nucleus is **[AIIMS 2004]**

(*a*) $\frac{4v}{A-4}$ (*b*) $\frac{4v}{A}$
(*c*) $\frac{(A-4)v}{A}$ (*d*) $\frac{(A-4)v}{4}$

41. A neutron collides head-on and elastically with an atom of mass number A, which is initially at rest. The fraction of kinetic energy retained by the neutron is

(*a*) $\left(\frac{A}{A+1}\right)^2$ (*b*) $\left(\frac{A-1}{A+1}\right)^2$
(*c*) $\left(\frac{A-1}{A}\right)^2$ (*d*) $\frac{A-1}{A+1}$

42. A ball of mass m_1 collides head-on and elastically with an identical ball of mass m_2 initially at rest. The transfer of energy will be maximum when
(*a*) $m_1 = m_2$ (*b*) $m_1 = m_2/2$
(*c*) $m_1 = 2m_2$
(*d*) none of the above.

43. A ball moving horizontally with speed v strikes the bob of a simple pendulum at rest. The mass of the bob is equal to that of the ball. If the collision is elastic the bob will rise to a height

(*a*) $\frac{v^2}{g}$ (*b*) $\frac{v^2}{2g}$
(*c*) $\frac{v^2}{4g}$ (*d*) $\frac{v^2}{8g}$

44. In Q. 43, if the collision is completely inelastic, the height to which the ball-bob system will rise is

(*a*) $\frac{v^2}{g}$ (*b*) $\frac{v^2}{2g}$
(*c*) $\frac{v^2}{4g}$ (*d*) $\frac{v^2}{8g}$

45. A bullet of mass 0.01 kg, travelling at a speed of 500 m/s, strikes a block of mass 2 kg, which is suspended by a string of length 5 m, and emerges out. The block rises by a vertical distance of 0.1m. The speed of the bullet after it emerges from the block is
(*a*) 55 m/s (*b*) 110 m/s
(*c*) 220 m/s (*d*) 440 m/s

46. A rocket of initial mass 5000 kg ejects gas at a constant rate of 15 kg/s with a relative speed of 10 km/s. Neglecting gravity, the acceleration of the rocket one minute after the blast is
(*a*) 9.2 m/s^2 (*b*) 18.3 m/s^2
(*c*) 27.5 m/s^2 (*d*) 36.6 m/s^2

47. A 6000 kg rocket is set for vertical firing. If the exhaust speed is 1000 m/s, the amount of gas that must be ejected per second to supply the thrust needed to overcome the weight of the rocket is (g = 10 m/s^2)
(*a*) 30 kg (*b*) 60 kg
(*c*) 75 kg (*d*) 90 kg

48. In Q. 47, the amount of gas that must be ejected per second to give the rocket an initial upward acceleration of 10 m/s is
(*a*) 90 kg (*b*) 120 kg
(*c*) 150 kg (*d*) 180 kg

49. Two spheres of masses M and $2M$ are initially at rest at a distance R apart. Due to mutual force of attraction they approach each other. When they are at separation $R/2$, the acceleration of their center of mass would be **[CPMT 93]**

(a) 0 (b) g m/s^2

(c) $3g$ m/s^2 (d) $12g$ m/s^2

50. A bullet of mass m and velocity a is fired into a large block of wood of mass M. The final velocity of the system is **[AFMC 94]**

(a) $\frac{M}{m+M}a$ (b) $\frac{m+M}{m}a$

(c) $\frac{m+M}{M}a$ (d) $\frac{m}{m+M}a$

51. A 50 g bullet moving with velocity of 10 m/s strikes a block of mass 950 g at rest and gets embedded in it. The loss in kinetic energy is **[MP PET 94]**

(a) 100% (b) 95%

(c) 5% (d) 50%

52. In an elastic collision of two particles the following is conserved: **[MP PET 94]**

(a) Momentum of each particle

(b) Speed of each particle

(c) Kinetic energy of each particle

(d) Total kinetic energy of both the particles

53. A 1 kg ball, moving at 12 m/s, collides head-on with a 2 kg ball moving in the opposite direction at 24 m/s. If the coefficient of restitution is 2/3, then the energy lost in the collision is

(a) 60 J (b) 120 J

(c) 140 J (d) 480 J

54. The coefficient of restitution for a perfectly elastic collision is **[CBSE PMT 88]**

(a) 1 (b) 0

(c) ∞ (d) – 1

55. The coefficient of restitution for a completely inelastic collision is

(a) 1 (b) 0

(c) ∞ (d) – 1

56. A railway truck of mass 2×10^4 kg travelling at 0.5 m/s, collides with another truck of half its mass, moving in the opposite direction at 0.4 m/s. If the trucks couple automatically on collision, their common velocity after collision is **[EAMCET 92]**

(a) 0.2 m/s (b) 0.47 m/s

(c) 0.1 m/s (d) 0.3 m/s

57. A ball of mass m collides head-on and elastically with a ball of mass nm, initially at rest. The fraction of the incident energy transferred to the heavier ball is

(a) $\frac{n}{n+1}$ (b) $\frac{n}{(n+1)^2}$

(c) $\frac{2n}{(n+1)^2}$ (d) $\frac{4n}{(n+1)^2}$

58. In carbon monoxid molecules, the carbon and the oxygen atoms are separated by a distance of 1.2×10^{-10}m. The distance of the centre of mass, from the carbon atom is **[CBSE PMT 97]**

(a) 0.48×10^{-10} m

(b) $0.51\ 10^{-10}$ m

(c) 0.69×10^{-10} m

(d) $0.56\ 10^{-10}$ m

59. A metal ball of mass 2 kg, moving with speed of 36 km/h , has a head-on collision with a stationary ball of mass 3 kg. If, after the collision, the two balls move together, the loss in K.E. due to collision is **[CBSE PMT 97]**

(a) 40 J (b) 60 J

(c) 100 J (d) 140 J

60. Which of the following works on the conservation of linear momentum ? **[AFMC 97]**

(a) jet (b) aeroplane

(c) rocket (d) all of these

61. A ball of mass 100 g falls from a height of 5 m on a massive floor. At each bounce the speed of the ball is halved. Total momentum imparted by the ball to the floor, in kg m/s, is (g = 10 m/s^2) **[DPMT 97]**

(a) 3 (b) 2

(c) 1 (d) 0

62. A neutron, moving with a velocity v, collides head-on with a stationary α-particle. After collision the neutron moves with a velocity **[DCE 97, DPMT 99]**

(a) $v/5$ (b) $v/4$

(c) $3v/4$ (d) $3v/5$

63. An isolated particle of mass m is moving in a horizental plane $(x - y)$, along the x-axis, at a certain height above the ground. It suddenly explodes into two fragments ot masses $m/4$ and $3m/4$. An instant later, the smaller fragment is at $y = +15$ cm. The larger fragment at this instant is at **[IIT may 97]**

(a) $y = -5$ cm (b) $y = +20$ cm

(c) $y = +5$ cm (d) $y = -20$ cm

64. Two equal masses m_1 and m_2 moving along the same straight line with velocities +3 m/s and – 5 m/s respectively collide elastically. Their velocities after the collision will be respectively **[CBSE PMT 98]**

(a) + 4 m/s for both

(b) – 4m/s and + 4 m/s

(c) –3 m/s and + 4 m/s

(d) – 5 m/s and + 3 m/s

65. A 5000 kg rocket is set for vertical firing. The exhaust speed is 800 ms^{-1}. To give an initial upward acceleration of 20 ms^{-2}, the amount of gas ejected per second to supply the needed thrust will be ($g = 10$ m/s^2) **[CBSE PMT 98]**

(a) 127.5 kg s^{-1} (b) 137.5 kg s^{-1}

(c) 187.5 kg s^{-1} (d) 185.5 kg s^{-1}

66. Which of the following is *not* a completely inelastic collision ? **[BHU PMT 98]**

(a) Striking of two glass balls

(b) A bullet striking a bag of sand

(c) An electron captured by a proton

(d) A man jumping onto a moving cart

67. Two bodies of masses 2 kg and 4 kg, initially at rest ,start moving towards each other due to mutual gravitational attraction. At a certain instant their speeds are 2 m/s and 1 m/s respectively. The speed of their centre of mass at that instant is **[BHU PMT 98]**

(a) 5 m/s (b) 6 m/s

(c) 8 m/s (d) zero

68. A particle of mass m, moving with velocity v, strikes a stationary particle of mass $2m$ and sticks to it. The speed of the system will be **[MP CET 98]**

(a) $v/2$ (b) $2v$

(c) $v/3$ (d) $3v$

69. A moving neutron collides with a stationary α-particle. The fraction of the kinetic energy lost by the neutron is **[DCE 99]**

(a) $\frac{1}{4}$ (b) $\frac{1}{16}$

(c) $\frac{9}{25}$ (d) $\frac{16}{25}$

70. A spacecraft, moving with a speed v, explodes into two parts, One of the parts, having mass 1/4 times that of the spacecraft, is left stationary. The speed of the other part will be **[DCE 99]**

(a) $4v$ (b) $4v/3$

(c) $4v/5$ (d) $v/5$

71. A bomb of mass 1 kg is thrown vertically upwards with a speed of 100 m/s. After 5 seconds it explodes into two fragments. One fragment of mass 400 gm is found to go down with a speed of 25 m/s. What will happen to the second fragment just after the explosion ? ($g = 10$ m/s^2) **[CBSE PMT 2000]**

(a) It will go upward with speed 40 m/s

(b) It will go upward with speed 100 m/s

(c) It will go upward with speed 60 m/s

(d) It will go downward with speed 40 m/s

72. A body of mass m_1 moving with a velocity 3ms^{-1} collides with another body at rest of mass m_2. After collision the velocities of the two bodies are 2ms^{-1} and 5 ms^{-1} respectively along the direction of motion of m_1. The ratio m_1/m_2 is **[EAMCET Engg. 2000]**

(a) $\frac{5}{12}$ (b) 5

(c) $\frac{1}{5}$ (d) $\frac{12}{5}$

73. A particle falls from a height h upon a fixed horizontal plane and rebounds. If e is the coefficient of restitution, the total distance travelled before rebounding has stopped is : **[EAMCET Engg. 2001]**

(a) $h\left(\frac{1+e^2}{1-e^2}\right)$ (b) $h\left(\frac{1-e^2}{1+e^2}\right)$

(c) $\frac{h}{2}\left(\frac{1-e^2}{1+e^2}\right)$ (d) $\frac{h}{2}\left(\frac{1+e^2}{1-e^2}\right)$

74. The velocities of three particles of masses 20 g, 30 g and 50 g are 10**i**, 10**j** and 10**k** respectively, the velocity of the centre of mass of the three particles is

[EAMCET Engg. 2001]

(a) 2**i** + 3**j** + 5**k** (b) 10 (**i** + **j** + **k**)

(c) 20**i** + 30**j** + 5**k** (d) 2**i** + 30**j** + 50**k**

75. The distance between the carbon atom and the oxygen atom in a carbon monoxide molecule is 1.1 Å. Given, mass of carbon atom is 12 a.m.u. and mass of oxygen atom is 16 a.m.u., calculate the position of the center of mass of the carbon monoxide molecule.

[Kerala Engg. 2001]

(a) 6.3 Å from the carbon atom

(b) 1 Å from the oxygen atom

(c) 0.63 Å from the carbon atom

(d) 0.12 Å from the oxygen atom

(e) 0.16 Å from the carbon atom

76. A heavy nucleus at rest breaks into two fragments which fly off with velocities in the ratio 8 : 1. The ratio of the radii of the fragments is:

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

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

ANSWERS

1. *d*	**2.** *b*	**3.** *b*	**4.** *c*	**5.** *c*	**6.** *d*	**7.** *c*	**8.** *b*
9. *b, c*	**10.** *a*	**11.** *d*	**12.** *b*	**13.** *c*	**14.** *a*	**15.** *b*	**16.** *d*
17. *c*	**18.** *a*	**19.** *c*	**20.** *b*	**21.** *b*	**22.** *b, d*	**23.** *c*	**24.** *d*
25. *a*	**26.** *b*	**27.** *d*	**28.** *b*	**29.** *c*	**30.** *c*	**31.** *b*	**32.** *a*
33. *c*	**34.** *a*	**35.** *b*	**36.** *d*	**37.** *c*	**38.** *c*	**39.** *c*	**40.** *a*
41. *b*	**42.** *a*	**43.** *b*	**44.** *d*	**45.** *c*	**46.** *d*	**47.** *b*	**48.** *b*
49. *a*	**50.** *d*	**51.** *b*	**52.** *d*	**53.** *c*	**54.** *a*	**55.** *b*	**56.** *a*
57. *d*	**58.** *c*	**59.** *b*	**60.** *c*	**61.** *c*	**62.** *d*	**63.** *a*	**64** *d*
65. *c*	**66.** *a*	**67.** *d*	**68.** *c*	**69.** *d*	**70.** *b*	**71.** *b*	**72.** *b*
73. *a*	**74.** *a*	**75.** *c*	**76.** *a*				

The particle leaves the surface when $N = 0$

or $$3\cos\theta - 2 = 0$$

or $$\cos\theta = 2/3$$

or $$\theta = \cos^{-1}(2/3)$$

EXAMPLE 18. *A tube of length L is filled completely with an incompressible liquid of mass M and closed at both ends. The tube is then rotated in a horizontal plane about one of its ends with uniform angular velocity ω. Find the force exerted by the liquid at the other end.*

Solution. Consider a small element dl at a distance l from the axis. Mass of the element is $\frac{M}{L}dl$.

Centrifugal force on this element

$$= \left(\frac{M\,dl}{L}\right)(\omega^2 l)$$

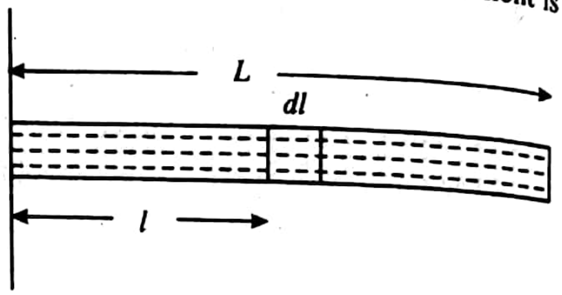


Fig. 8.17

$$\text{Total force} = \frac{M}{L}\omega^2 \int_0^L l\,dl = \frac{ML\omega^2}{2}$$

This is the force exerted by the liquid at the other end.

MULTIPLE CHOICE QUESTIONS

1. Two racing cars of masses m_1 and m_2 are moving in circles of radii r_1 and r_2 respectively. Their speeds are such that each makes a complete circle in the same length of time. The ratio of the angular speed of the first car to that of the second car is
   (*a*) $m_1 : m_2$ (*b*) $r_1 : r_2$
   (*c*) $1 : 1$ (*d*) $m_1 r_1 : m_2 r_2$
2. A cyclist moves in a circular track of radius 100 m. If the coefficient of friction is 0.2, then the maximum speed with which the cyclist can take a turn without leaning inwards, in m/s, is
   (*a*) 9.8 (*b*) 1.4
   (*c*) 14 (*d*) 1.0
3. A 4 kg stone tied at the end of a 1 m long string is whirled in a vertical circle. At the instant when the string makes an angle θ with the vertical, the linear speed of the stone is 4 m/s and the tension in the string is 103.2 N. Then the value of θ is
   (*a*) 0° (*b*) 30°
   (*c*) 60° (*d*) 90°
4. A bottle of sodawater is grasped by the neck and swung briskly in a circle. Near which portion of the bottle do the bubbles collect?
   (*a*) Near the bottom
   (*b*) Near the neck
   (*c*) In the middle of the bottle
   (*d*) Bubbles remain distributed uniformly throughout the volume of the bottle
5. A cyclist moves around a circular path of radius $39.2 \times \sqrt{3}$ metres with a speed of 19.6 m/s. He must lean inwards at an angle θ with the vertical such that $\tan\theta$ is equal to
   (*a*) 1 (*b*) $\sqrt{3}$
   (*c*) $1/\sqrt{3}$ (*d*) 2
6. A motorcyclist is moving inside a spherical cage of radius 5 m. The minimum speed with which he must pass the highest point without losing contact is (g = 10 m/s2)
   (*a*) 5 m/s (*b*) $5\sqrt{2}$ m/s
   (*c*) 10 m/s (*d*) $10\sqrt{2}$ m/s

7. The string of a pendulum, having bob of mass m, is displaced through 90° from the vertical and then released. The minimum strength of the string in order to withstand the tension as the pendulum passes through the mean position is **[M.P. 86]**
(a) mg (b) $3mg$
(c) $5mg$ (d) $6mg$

8. On a dry road, the maximum permissible speed of a car in a circular path is 10 m/s. If the road becomes wet, the maximum speed is $5\sqrt{2}$ m/s. If the coefficient of friction for dry road is μ, then that for the wet road is
(a) $\frac{\mu}{2}$ (b) $\frac{\mu}{3}$
(c) $\frac{2\mu}{3}$ (d) $\frac{3\mu}{4}$

9. A heavy small sphere is suspended by a string of length l. The sphere revolves uniformly in a horizontal circle with the string making an angle θ with the vertical. The time period of revolution is
(a) $2\pi\sqrt{\frac{l}{g}}$ (b) $2\pi\sqrt{\frac{l\sin\theta}{g}}$
(c) $2\pi\sqrt{\frac{l\cos\theta}{g}}$ (d) $2\pi\sqrt{\frac{l\tan\theta}{g}}$

10. A pendulum consisting of a small sphere of mass m, suspended by an inextensible and massless string of length l, is made to swing in a vertical plane. If the breaking strength of the string is $2mg$ then the maximum angular amplitude of the displacement from the vertical can be
(a) 0° (b) 30°
(c) 60° (d) 90°

11. A motor car of mass m travels with a uniform speed v on a circular bridge of radius r. When the car is at the highest point of the bridge, then the force exerted by the car on the bridge is **[AFMC 97]**
(a) mg (b) $mg+\frac{mv^2}{r}$
(c) $mg-\frac{mv^2}{r}$ (d) $\frac{mv^2}{r}$

12. The bridge over a canal is in the form of a circular arc of radius 10 m. The maximum speed with which a motor cycle can cross the bridge without leaving the ground at the highest point is ($g = 10$ m/s^2)
(a) 10 m/s (b) 50 m/s
(c) 10 m/s (d) 1 m/s

13. A particle of mass 0.1 kg is whirled at the end of a string in a vertical circle of radius 1.0 m at a constant speed of 5 m/s. The tension in the string at the highest point of its path is ($g = 10$ m/s^2)
(a) 0.5 N (b) 1.0 N
(c) 1.5 N (d) 2.0 N

14. A particle is acted upon by a force of constant magnitude which is always perpendicular to the velocity of the particle. The motion takes place in a plane. It follows that **[IIT 87]**
(a) its velocity is constant
(b) its acceleration is constant
(c) its kinetic energy is constant
(d) it moves in a circular path

15. A 1 kg stone at the end of a 1 m long string is whirled in a vertical circle with a constant speed of 4 m/s. The tension in the string is 6 N when the stone is ($g = 10$ m/s^2)
(a) at the top of the circle
(b) at the bottom of the circle
(c) half way down
(d) at none of the above positions

16. A particle revolves round a circular path with a constant speed. The acceleration of the particle is **[MNR 86]**
(a) along the circumference of the circle
(b) along the tangent
(c) along the radius
(d) zero

17. If a body moves with a constant speed in a circle
(a) no work is done on it
(b) no force acts on it

(c) no acceleration is produced in it

(d) its velocity remains constant

18. A string can withstand a tension of 100 N. The greatest speed with which a body of mass 1 kg can be whirled in a horizontal circle using 1 m length of the string is

(a) 5 m/s (b) 7.5 m/s
(c) 10 m/s (d) 20 m/s

19. A car is moving on a circular road of radius 500 m. At some instant its speed is 30 m/s and is increasing at the rate of 2 m/s^2. The magnitude of its acceleration is

(a) 2 m/s^2 (b) 2.7 m/s^2
(c) 4 m/s^2 (d) 4.8 m/s

20. An inclined track ends in a circular loop of radius r as shown. From what height

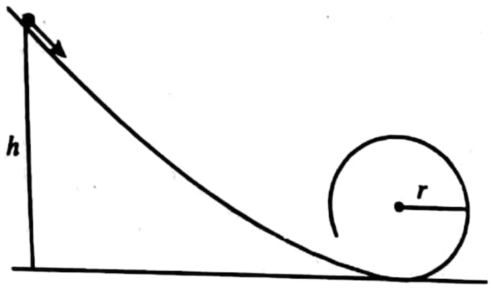


Fig. 8.18

on the track a particle should be release so that it completes the loop, assuming that there is no friction?

(a) $r/2$ (b) $3r/2$
(c) $2r$ (d) $5r/2$

21. A particle is placed at the highest pint of a frictionless hemispherical surface. If the

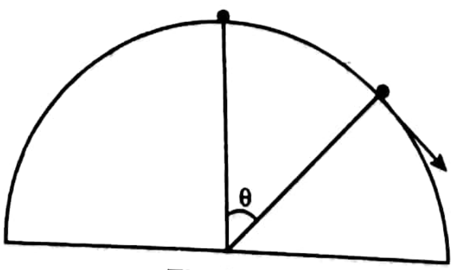


Fig. 8.18

particle is allowed to slide down, the angular displacement θ at which it will leave the surface is

(a) $\cos^{-1}\left(\frac{1}{3}\right)$ (b) $\cos^{-1}\left(\frac{1}{2}\right)$

(c) $\cos^{-1}\left(\frac{2}{3}\right)$ (d) $\cos^{-1}\left(\frac{3}{4}\right)$

22. In Q. 21, if r is the radius of the surface then the particle will leave the surface of a vertical distance below the highest point equal to **[BHU Med. 2003]**

(a) $r/3$ (b) $r/2$
(c) $2r/3$ (d) $3r/4$

23. Two masses m and M are connected by a light string that passes through a smooth hole O at the centre of a table. Mass m lies on the table and M hangs vertically,

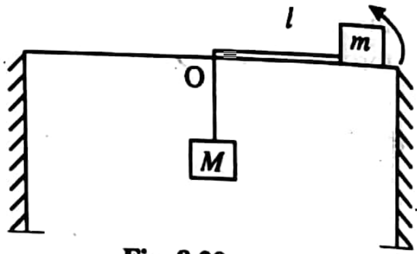


Fig. 8.20

m is moved round in a horizontal circle with O as the centre. If l is the length of the string from O to m then the frequency with which m should revolve so that M remains stationary is

(a) $\frac{1}{2\pi}\sqrt{\frac{Mg}{ml}}$ (b) $\frac{1}{\pi}\sqrt{\frac{Mg}{ml}}$

(c) $\frac{1}{2\pi}\sqrt{\frac{ml}{Mg}}$ (d) $\frac{1}{\pi}\sqrt{\frac{ml}{Mg}}$

24. Two masses M and m hang at the two ends of a string that passes through a

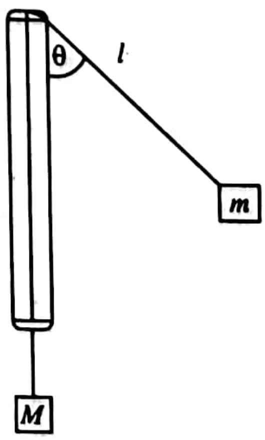


Fig. 8.21

smooth tube as shown. The mass m moves in a circular path which lies in a horizontal plane. The length of the string from m to the top of the tube is l and θ is the angle this length makes with the vertical. What should be the frequency of revolution of m so that M remains stationary?

(*a*) $\frac{1}{2\pi}\sqrt{\frac{Mg}{ml}}$ (*b*) $\frac{1}{2\pi}\sqrt{\frac{Mg}{ml\cos\theta}}$

(*c*) $\frac{1}{2\pi}\sqrt{\frac{ml\cos\theta}{Mg}}$ (*d*) $\frac{1}{\pi}\sqrt{\frac{ml}{Mg}}$

25. Two identical particles are attached at the ends of a light string which passes through a hole at the centre of a table. One of the particles is made to move in a circle on the table with angular velocity ω_1 and the other is made to move in a

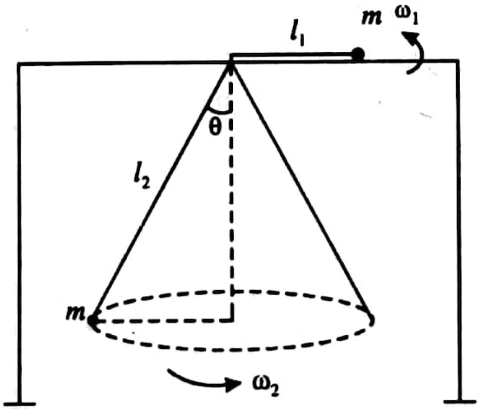


Fig. 8.22

horizontal circle as a conical pendulum with angular velocity ω_2. If l_1 and l_2 are the lengths of the string over and under the table, then in order that the particle under the table neither moves down nor moves up, the ratio l_1/l_2 is

(*a*) ω_1/ω_2 (*b*) ω_2/ω_1

(*c*) ω_1^2/ω_2^2 (*d*) ω_2^2/ω_1^2

26. For a particle moving in uniform circular motion

(*a*) velocity is transverse and acceleration is radial

(*b*) velocity is radial and acceleration is transverse

(*c*) both velocity and acceleration are radial

(*d*) both velocity and acceleration are transverse.

27. A wheel rotates about an axis passing through the centre and perpendicular to the plane with slowly increasing angular speed. Thus it has **[DPMT 92]**

(*a*) radial velocity and radial acceleration

(*b*) tangential velocity and radial acceleration

(*c*) tangential velocity and trangential acceleration

(*d*) tangential velocity but acceleration having both components.

28. A nail is located at a certain distance vertically below the point of suspension of a simple pendulum of length 1 m. The bob is released from the position where the string makes an angle of 60° with the vertical. What should be the distance of the nail from the point of suspension so that the bob just performs revolution with the nail as centre?

(*a*) 0.2 m (*b*) 0.4 m

(*c*) 0.6 m (*d*) 0.8 m

29. A circular railway track of radius 400 m is to be made so that a train can move with a speed of 10 m/s without friction. If the distance between the two rails is 1 m, by how much the outer rail should be raised? ($g = 10\ m/s^2$)

(*a*) 2.5 cm (*b*) 5 cm

(*c*) 7.5 cm (*d*) 10 cm

30. A smooth circular tube is kept in a vertical plane. A particle of mass m, which can slide freely inside the tube, is placed at the highest point in the tube. If the particle is displaced slightly from rest, the force exerted by it on the wall of the tube at angular displacement θ is

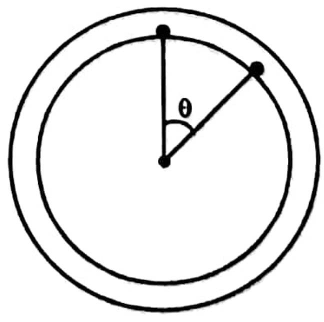


Fig. 8.23

(*a*) $mg(3-2\cos\theta)$

(*b*) $mg(3\cos\theta-2)$

(*c*) $mg(4\cos\theta-3)$

(*d*) $mg(4-3\cos\theta)$

31. For traffic moving at 60 km/h along a circular track of radius 0.1 km, the correct angle of banking is **[MNR 93]**

(*a*) $\tan^{-1}\left[\frac{(60)^2}{0.1}\right]$

(*b*) $\tan^{-1}\left[\frac{(50/3)^2}{100\times9.8}\right]$

(*c*) $\tan^{-1}\left[\frac{100\times9.8}{(50/3)^2}\right]$

(*d*) $\tan^{-1}\left[\sqrt{60\times0.1\times9.8}\right]$

32. Keeping the banking angle same, to increase the maximum speed with which a vehicle can travel on a circular road by 10%, the radius of curvature of the road has to be changed from 20 m to **[EAMCET 91]**

(*a*) 16 m (*b*) 18 m

(*c*) 24.2 m (*d*) 30. 5 m

33. A can filled with water is revolved in a vertical circle of radius 4 m so that the water does not fall down. The maximum possible period of revolution is **[CPMT 85]**

(*a*) 1 s (*b*) 2 s

(*c*) 3 s (*d*) 4 s

34. A particle moves in a circle of radius r. In half the period of revolution, its displacement and distance covered are **[IIT 83]**

(*a*) $2r$, $2\pi r$ (*b*) $r\sqrt{2}$, πr

(*c*) $2r$, πr (*d*) r, πr

35. The radius of the blade of a fan is 0.30 m. It is making 1200 rev/min. The acceleration of a particle at the tip of the blade is

(*a*) 1600 m/s^2 (*b*) 4740 m/s^2

(*c*) 2370 m/s^2 (*d*) 5055 m/s^2

36. A stone of mass 1 kg tied to a light inextensible string of length $L = (10/3)$ m is whirling in a circular path of radius L in a vertical plane. If the ratio of the maximum to the minimum tension in the string is 4 and g = 10 m/s^2, the speed of the stone at the highest point of the circle **[CBSE PMT 90]**

(*a*) 20 m/s (*b*) $10\sqrt{3}$ m/s

(*c*) $5\sqrt{2}$ m/s (*d*) 10 m/s

37. A particle of mass M is moving in a horizontal circle of radius R with a uniform speed V. When it moves from one point to a diametrically opposite point, its **[CBSE PMT92]**

(*a*) kinetic energy changes by $MV^2/4$

(*b*) momentum does not change

(*c*) momentum changes by $2MV$

(*d*) kinetic energy changes by MV^2

38. A vehicle is moving with a velocity v on a curved road of width b and radius of curvature R. For counteracting the centrifugal force on the vehicle, the difference in elevation required in between the outer and the inner edges of the road is **[EAMCET 83]**

(*a*) $\frac{v^2b}{Rg}$ (*b*) $\frac{vb}{Rg}$

(*c*) $\frac{vb^2}{Rg}$ (*d*) $\frac{vb}{R^2g}$

39. A body is moving in a circle with a constant speed. It has

(*a*) a constant valocity

(*b*) a constant acceleration

(*c*) a velocity of constant magnitude

(*d*) an acceleration of constant magnitude.

40. A body of mass m is moving in a circle of radius r with a constant speed v. The work done by the centripetal force in moving the body over half the circumference of the circle is

(*a*) $m\frac{v^2}{r}\times2r$ (*b*) $\frac{mv^2}{r}\times\pi r$

(c) $\frac{mv^2}{r} \times r$ (d) zero

41. A simple pendulum is oscillating with an angular amplitude of 90° as shown in the figure. The value of θ for which the resultant acceleration of the bob is directed horizontally is

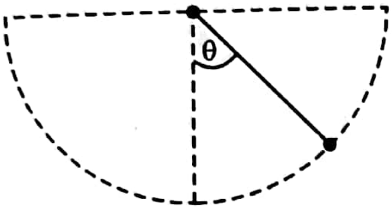


Fig. 8.24

(a) 0° (b) 90°

(c) $\sin^{-1}\left(\frac{1}{\sqrt{3}}\right)$ (d) $\cos^{-1}\left(\frac{1}{\sqrt{3}}\right)$

42. A car of mass 1000 kg moves on a circular road with a speed of 20 m/s. Its direction changes by 90° after travelling 628 m on the road. The centripetal force acting on the car is
(a) 500 N (b) 750 N
(c) 1000 N (d) 1500 N

43. A motor car moves with the same speed on (i) a horizontal level bridge, (ii) a concave bridge, and (iii) a convex bridge. The force exerted by the car on the bridge when it is at the centre of the bridge is
(a) maximum in case (i)
(b) maximum in case (ii)
(c) maximum in case (iii)
(d) the same in all the three cases.

44. A hollow cylinder of radius 10 cm rotates about its axis which is vertical. A small body remains in contact with the inner wall if the frequency of rotation is 200 per minute but falls at lower frequencies. The coefficient of friction between the body and the cylinder is
(a) 0.112 (b) 0.225
(c) 0.34 (d) 0.45

45. A stone is moved in a horizontal circle of radius 1.5 m by means of a string at a height of 2 m above the ground. The string breaks and the particle flies off horizontally, striking the ground 10 m away. Find the centripetal acceleration during circular motion ($g = 10\ m/s^2$)
(a) 83.3 m/s^2 (b) 166.6 m/s^2
(c) 249.9 m/s^2 (d) 333.2 m/s^2

46. A car is moving in a circular track of radius r with a constant speed v. A plumb bob is suspended from the roof of the car by a light string of length l. The angle made by the string with the vertical is

(a) $\tan^{-1}\left(\frac{v^2}{rg}\right)$ (b) $\tan^{-1}\left(\frac{v^2}{lg}\right)$

(c) $\tan^{-1}\left(\frac{rg}{v^2}\right)$ (d) $\tan^{-1}\left(\frac{lg}{v^2}\right)$

47. The work done by the centripetal force F when a body completes one revolution around a circle of radius R is **[MP PMT 93]**
(a) $2\pi RF$ (b) $2RF$
(c) RF (d) zero

48. A mass m slides, from rest, down the surface of a frictionless hemispherical bowl of radius r from the highest point A (see figure). The velocity of the mass when it reaches the bottom is **[MP PMT 93]**

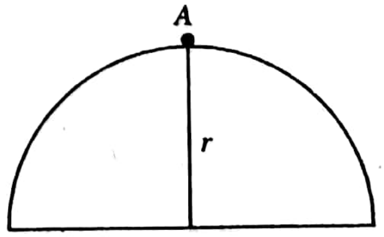


Fig. 8.25

(a) $\sqrt{2gr}$ (b) $\sqrt{mgr}$
(c) $2mgr$ (d) gr

49. A small sphere is suspended by a thread of length L. The horizontal velocity that should be given to it so that it may just reach the same height as the point of suspension is **[ISM Dhanbad 94]**
(a) $\sqrt{gL}$ (b) $\sqrt{5gL}$
(c) $2gL$ (d) $\sqrt{2gL}$

50. A stone of mass 16 kg is attached to a string 144 m long and is whirled in a

horizontal circle. The maximum tension the string can stand is 16 N. The maximum velocity of revolution that can be given to the stone without breaking the string is [SCRA 94]

(*a*) 20 m/s (*b*) 16 m/s
(*c*) 14 m/s (*d*) 12 m/s

51. A particle moves in a circle of radius 25 cm at two revolutions per second. The acceleration of the particle in m/s^2 is [MNR 91]

(*a*) π^2 (*b*) $8\pi^2$
(*c*) $4\pi^2$ (*d*) $2\pi^2$

52. The kinetic energy *K* of a particle moving along a circle of radius *R* depends on the distance covered *s* as $K = as^2$. The force acting on the particle is [MNR 92]

(*a*) $\frac{2as^2}{R}$ (*b*) $2as\left(1+\frac{s^2}{R^2}\right)^{1/2}$
(*c*) $2as$ (*d*) $\frac{2aR^2}{s}$

53. A car moving on a horizontal road may be thrown out of the road in taking a turn
(*a*) by the gravitational force
(*b*) due to the lack of proper centripetal force
(*c*) due to the rolling frictional force between the tyre and the road
(*d*) by the reaction of the ground

54. A body is moving in a vertical circle of radius *r* such that the string is just taut at its highest point. The speed of the particle when the string is horizontal is

(*a*) $\sqrt{gr}$ (*b*) $\sqrt{2gr}$
(*c*) $\sqrt{3gr}$ (*d*) $\sqrt{5gr}$

55. A particle of mass *m* is executing uniform circular motion on a path of radius *r*. If *p* is the magnitude of its linear momentum, them the radial force acting on the particle is [MP PET 94]

(*a*) pmr (*b*) $\frac{rm}{p}$
(*c*) $\frac{mp^2}{r}$ (*d*) $\frac{p^2}{rm}$

56. A particle of mass *m* is moving in a circular path of constant radius *r* such that its centripetal acceleration a_c is varying with time *t* as $a_c = k^2rt^2$, where *k* is a constant. The power delivered to the particle by the force acting on it is [IIT 94]

(*a*) $2\pi mk^2r^2t$ (*b*) mk^2r^2t
(*c*) $(mk^4r^2t^5)/3$ (*d*) zero

57. The bob of a simple pendulum has mass. It is released from the horizontal position as shown. The tension in the string at the lowest point is [DPMT 97]

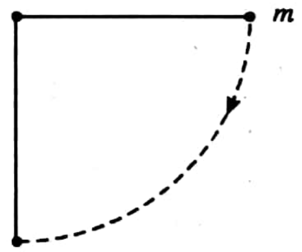


Fig. 8.26

(*a*) mg (*b*) $2mg$
(*c*) $3mg$ (*d*) $6mg$

58. A ball of mass 0.25 kg attached to the end of string of length 1.96 m is moving in a horizontal circle. The string will break if the tension is more than 25 N. What is the maximum speed with which the particle can be moved? [CBSE 98]

(*a*) 5 m/s (*b*) 3.92 m/s
(*c*) 3 m/s (*d*) 14 m/s

59. A body of mass 100 gm is rotating in a circular path of radius r metres with a constant speed. The work done in one complete revolution is [AFMC PMT 98]

(*a*) 100*r* J (*b*) (*r*/100) J
(*c*) (100/*r*) J (*d*) zero

60. A weightless thread can bear tension upto 3.7 kg wt. A stone of mass 500 g is tied to it and revolved in a circular path of radius 4 m in a vertical plane. If $g = 10$ ms^{-2}, then the maximum angular velocity of the stone will be [MP CET 98]

(a) 4 radians/sec
(b) 16 radians/sec
(c) $\sqrt{21}$ radians/sec
(d) 2 radians/sec

61. A mass of 2 kg is whirled in a horizontal circle by means of a string at an initial speed of 5 revolutions per minute. Keeping the radius constant the tension in the string is doubled. The new speed is nearly **[MP CET 98]**

(a) 14 rpm (b) 10 rpm
(c) 2.25 rpm (d) 7 rpm

62. A stone of mass 1 kg tied to the end of a string of length 1 m, is whirled in a horizontal circle, with a uniform angular velocity of 2 radian/sec. The tension of the string is (N) **[Karnataka CET 98]**

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

63. A stone tied to a string of length L is whirled in a vertical circle with the other end of the string at the centre. At a certain instant of time, the stone is at its lowest position, and has a speed u. The magnitude of the change in its velocity as it reaches a position where the string is horizontal is **[IIT 98]**

(a) $\sqrt{u^2 - 2gL}$ (b) $\sqrt{2gL}$
(c) $\sqrt{u^2 - gL}$ (d) $\sqrt{2(u^2 - gL)}$

64. A tube one metre long is filled with liquid of mass 1 kg. The tube is closed at both the ends and is revolved about one end in a horizontal plane at 2 rev/sec. The force experienced by the lid at the other end is **[NSEP 99]**

(a) $4\pi^2$ N (b) $8\pi^2$ N
(c) $16\pi^2$ N (d) 9.8 N

65. A small sphere is attached to a cord and rotates in a vertical circle about a point O. If the average speed of the sphere is increased, the cord is most likely to break at the orientation when the mass is at the **[CBSE PMT 2000]**

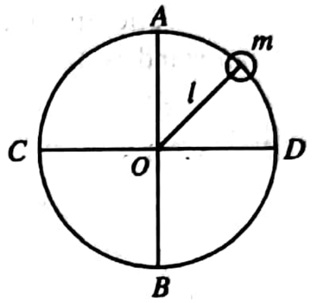


Fig. 8.27

(a) bottom point B
(b) point C
(c) point D
(d) top point A

66. For a body moving with constant speed in a horizontal circle, which of the following remains constant? **[MP PMT 2000]**

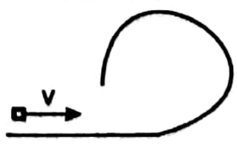
(a) Velocity
(b) Acceleration
(c) Centripetal force
(d) Kinetic energy

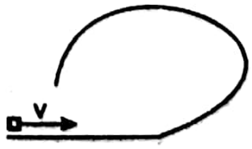
67. Roadways are banked on curves so that **[CPMT 2000]**

(a) the speeding vehicles may not fall inwards
(b) the frictional force between the road and vehicle may be decreased
(c) the wear and teat of tyre may be avoided
(d) the weight of the vehicle may be decreased

68. A small block is shot into each of the four tracks as shown below. Each of the tracks rises to the same height. The speed with which the block enters the track is the same in all cases. At the highest point of the track, the normal reaction is maximum in **[IIT 2001]**

(a) 

(b) 

(c) 

(d) 

Fig. 8.28

69. A stone of mass m is tied to a string and is moved in a vertical circle of radius r making n revolutions per minute. The total tension in the string when the stone is at its lowest point is **[Kerla Engg. 2001]**

(a) mg (b) $m(g+\pi nr^2)$

(c) $m(g+\pi nr)$ (d) $m(g+n^2 r^2)$

(e) $m\{g+(\pi^2 n^2 r)/900\}$

70. A cyclist riding the bicycle at a speed of $14\sqrt{3}$ ms^{-1} takes a turn around a circular road of radius $20\sqrt{3}$ m without skidding. Given, $g = 9.8$ ms^{-2}, what is inclination to the vertical? **[Kerala Engg. 2001]**

(a) 30° (b) 90°

(c) 45° (d) 60°

(e) 0°

ANSWERS

1. c	2. c	3. a	4. b	5. c	6. b	7. b	8. a
9. c	10. c	11. c	12. a	13. c	14. c, d	15. a	16. c
17. a	18. c	19. b	20. d	21. c	22. a	23. a	24. a
25. d	26. a	27. d	28. d	29. a	30. b	31. b	32. c
33. d	34. c	35. b	36. d	37. c	38. a	39. c, d	40. d
41. d	42. c	43. c	44. b	45. b	46. a	47. d	48. a
49. d	50. d	51. c	52. b	53. b	54. c	55. d	56. b
57. c	58. d	59. d	60. a	61. d	62. a	63. d	64. b
65. a	66. d	67. c	68. a	69. e	70. d		

MULTIPLE CHOICE QUESTIONS

1. Three points masses, each of mass m, are placed at the corners of an equilateral triangle of side l. The moment of inertia of this system about an axis along one side of the triangle is

(a) ml^2 (b) $\frac{3}{4}ml^2$

(c) $3ml^2$ (d) $\frac{3}{2}ml^2$

2. Which of the following has the highest moment of inertia if each has the same mass and the same radius? **[CPMT 83]**

(a) A ring about its axis perpendicular to the plane of the ring

(b) A solid sphere about one of its diameters

(c) A spherical shell about one of its diameters

(d) A disc about its axis perpendicular to the plane of its disc.

3. A mass M is moving with a constant velocity parallel to the x-axis. Its angular momentum with respect to the origin **[IIT 85]**

(a) is zero

(b) remains constant

(c) goes on increasing

(d) goes on decreasing

4. The ratio of the moment of inertia of a ring about an axis passing through its rim and perpendicular to its plane and that about a diameter is

(a) 1 : 4 (b) 4 : 1

(c) 1 : 2 (d) 2 : 1

5. The moments of inertia of two spheres of equal masses about their respective diameters are same. One of them is solid and the other is hollow. The ratio of the diameter of the solid sphere to that of the hollow sphere is :

(a) $\sqrt{3} : \sqrt{5}$ (b) $\sqrt{5} : \sqrt{3}$

(c) 5 : 3 (d) 3 : 5

6. Two discs have the same mass and thickness. Their materials are of densities d_1 and d_2. The ratio of their moments of inertia about an axis passing through the centre and perpendicular to the plane is

(a) $d_1 : d_2$ (b) $d_2 : d_1$

(c) $1 : d_1d_2$ (d) $d_1d_2 : 1$

7. A playground merry-go-round is at rest, pivoted about a frictionless axis. A child of mass m runs along a path tangential to the rim with speed v and jumps on to the merry-go-round. If R is the radius of the merry-go-round and I is its moment of inertia, then the angular velocity of the merry-go-round and the child is

(a) $\frac{mvR}{mR^2+I}$ (b) $\frac{mv}{I}$

(c) $\frac{mR^2+I}{mvR}$ (d) $\frac{I}{mvR}$

8. A thin circular ring of mass M is rotating about its axis with a constant angular velocity ω. Two objects, each of mass m, are attached gently to the opposite ends of a diameter of the ring. The ring now rotates with an angular velocity. **[IIT 83; MP CET 99, 98; CBSE PMT 98]**

(a) $\frac{\omega M}{M+m}$ (b) $\frac{\omega(M-2m)}{M+2m}$

(c) $\frac{\omega M}{M+2m}$ (d) $\frac{\omega(M+2m)}{M}$

9. A thin uniform circular disc of mass M and radius R is rotating in a horizontal plane about an axis passing through its centre and perpendicular to its plane with an angular velocity ω. Another disc of same dimensions but of mass $M/4$ is placed gently on the first disc co-axially. The angular velocity of the system is now

(a) $\sqrt{2}\,\omega$ (b) $4\omega/5$

(c) $3\omega/4$ (d) $\omega/3$

10. A spherical ball rolls on a table without slipping. Then the fraction of its total kinetic energy associated with rotation is

(a) 2/5 (b) 2/7

(c) 5/7 (d) 3/5

11. The ratio of the time taken by a solid sphere and that taken by a disc of the same mass and radius to roll down a smooth inclined plane from rest from the same height is

(a) 15 : 14 (b) $\sqrt{15} : \sqrt{14}$

(c) 14 : 15 (d) $\sqrt{14} : \sqrt{15}$

12. A solid cylinder of mass M and radius R rolls on a flat surface. Its moment of inertia about the line of contact is

(a) $\frac{1}{2}MR^2$ (b) MR^2

(c) $\frac{3}{2}MR^2$ (d) $2MR^2$

13. A solid cylinder (*i*) rolls (*ii*) slides down an inclined plane. The ratio of the accelerations in the two cases is

(a) 1 : 2 (b) 2 : 3

(c) 3 : 4 (d) $1:\sqrt{2}$

14. A rod of length l, hinged at the bottom, is held vertically and then allowed to fall. The linear velocity of its top when it hits the floor is

(a) $\sqrt{2gl}$ (b) $\sqrt{2g/l}$

(c) $\sqrt{3gl}$ (d) $\sqrt{3g/l}$

15. If a gymnast, standing on a rotating stool with his arms outstretched, suddenly lowers his arms.

(a) His angular velocity decreases

(b) His moment of inertia decreases

(c) His angular velocity increases

(d) His moment of inertia increases

16. Moment of inertia of a ring of mass m and radius R about an axis passing through the centre and perpendicular to the plane is [CPMT 82]

(a) $\frac{1}{4}mR^2$ (b) $\frac{1}{2}mR^2$

(c) $\frac{3}{4}mR^2$ (d) mR^2

17. When a mass is rotated in a plane about a fixed point, its angular momentum is directed along [MP PMT 86]

(a) the radius

(b) the tangent to the orbit

(c) a lines at an angle of 45° to the plane of rotation

(d) the axis of rotation

18. A hollow sphere and a solid sphere, having the same mass, are released from rest simultaneously from the top of an inclined plane. Which of the two will reach the bottom first? [CPMT 79]

(a) Solid sphere.

(b) Hollow sphere

(c) The one which has the greater density

(d) Both will reach the bottom simultaneously.

19. Angular momentum of a body is defined as the product of [CPMT 75]

(a) mass and angular velocity

(b) centripetal force and radius

(c) linear velocity and angular velocity

(d) moment of inertia and angular velocity.

20. A constant torque acting on a uniform circular wheel changes its angular momentum from A_0 to $4A_0$ in 4 seconds. The magnitude of this torque is [MP PMT 87]

(a) $\frac{3A_0}{4}$ (b) A_0

(c) $4A_0$ (d) $12A_0$

21. A solid cylinder of mass M and radius R rolls down an inclined plane from height h without slipping. The speed of its centre of mass when it reaches the bottom is [MP PMT 85]

(a) $\sqrt{2gh}$ (b) $\sqrt{\frac{4}{3}gh}$

(c) $\sqrt{\frac{3}{4}gh}$ (d) $\sqrt{\frac{4g}{h}}$

22. A mass is rotating in a plane about a fixed point. Its angular momentum is directed along [MNR 87, MP PMT 86]

(a) the radius

(b) the tangent to the orbit

(c) a line perpendicular to the plane of rotation
(d) none of these

23. The moment of inertia of a thin uniform circular disc about one of its diameters is I. The moment of inertia about an axis perpendicular to the circular surface and passing through its centre is
(a) $I/2$ (b) $I/\sqrt{2}$
(c) $2I$ (d) $\sqrt{2}I$

24. A solid sphere rolls down without slipping from rest on a 30° incline. Its linear acceleration is
(a) $5g/7$ (b) $5g/14$
(c) $2g/3$ (d) $g/3$

25. Two bodies with moments of inertia I_1 and I_2 ($I_1 > I_2$) have equal angular momenta. If E_1 and E_2 are their rotational kinetic energies respectively, then
(a) $E_1 > E_2$
(b) $E_1 = E_1$
(c) $E_1 < E_2$
(d) the one which has larger mass has larger kinetic energy

26. A ring, a disc and a solid sphere, all having the same mass and radius, roll down an inclined plane from the same height. Which of the three will reach the bottom first?
(a) Ring
(b) Disc
(c) Solid sphere
(d) All of them will reach simultaneously

27. A solid cylinder of radius R is free to rotate about its axis which is horizontal. A string is wound around it and a mass m is attached to its free end. When m falls through a distance h, its speed at that instant is

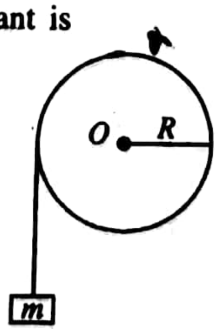


Fig. 9.16

(a) proportional to R
(b) proportional to $1/R$
(c) proportional to $1/R^2$
(d) independent of R

28. A thin hoop of diameter 0.5 m and mass 2 kg rolls down an inclined plane from rest. If its linear speed on reaching the foot of the plane is 2 m/s, its rotational kinetic energy at that instant is
(a) 2 J (b) 3 J
(c) 4 J (d) 6 J

29. A solid sphere of mass 2 kg rolls down an inclined plane from rest from a height of 7 m. Its rotational kinetic energy on reaching the foot of the plane is ($g = 10 m/s^2$)
(a) 10 J (b) 20 J
(c) 40 J (d) 100 J

30. A particle of mass m is projected with a velocity v making an angle of 45° with the horizontal. The magnitude of the angular momentum of the projectile about the point of projection when the particle is at its maximum height h is **[IIT 90]**
(a) zero (b) $\frac{mv^3}{4\sqrt{2}g}$
(c) $\frac{mv^3}{\sqrt{2}g}$ (d) $m\sqrt{2gh^3}$

31. A wheel of mass 40 kg and radius of gyration 0.5 m comes to rest from a speed of 1800 revolutions per minute in 30 s. Assuming that the retardation is uniform, the value of the retarding torque, in N-m, is
(a) 10 π (b) 20 π
(c) 30 π (d) 40 π

32. If the radius of the earth suddenly contracts to $1/n$ of its present value without any change in its mass, the duration of one day will become approximately
(a) $24/n$ hours (b) $24/n^2$ hours
(c) $24n$ hours (d) $24n^2$ hours

33. The radius of a wheel is R and its radius of gyration about an axis passing through

its centre and perpendicular to its plane is k. If the wheel is rolling without slipping, the ratio of its rotational kinetic to its translational kinetic energy is

(*a*) $\frac{k^2}{R^2}$ (*b*) $\frac{R^2}{k^2}$

(*c*) $\frac{k^2}{R^2+k^2}$ (*d*) $\frac{R^2}{R^2+k^2}$

34. In Q. 33, the ratio of the rotational K.E. to the total K.E. is

(*a*) $\frac{k^2}{R^2+k^2}$ (*b*) $\frac{R^2}{R^2+k^2}$

(*c*) $\frac{1}{R^2+k^2}$ (*d*) none of these

35. In Q 33, the ratio of the translational K.E. to the total K.E. is

(*a*) $\frac{k^2}{R^2+k^2}$ (*b*) $\frac{R^2}{R^2+k^2}$

(*c*) $\frac{1}{R^2+k^2}$ (*d*) none of these

36. Two men A and B are carrying a uniform bar of length L on their shoulders. The bar is held horizontally such that A gets one-fourth load. If A is at one end of the bar, the distance of B from that end is

(*a*) $L/3$ (*b*) $L/2$

(*c*) $2L/3$ (*d*) $3L/4$

37. The moment of inertia of a thin square plate $ABCD$ of uniform thickness about an axis passing through the centre O and perpendicular to the plate is

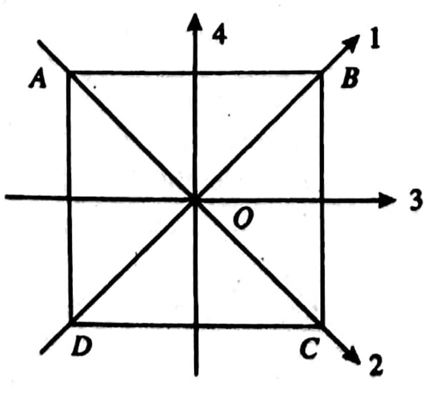


Fig. 9.17

(*a*) $I_1 + I_2$ (*b*) $I_3 + I_4$

(*c*) $I_1 + I_3$ (*d*) $I_1 + I_2 + I_3 + I_4$

where I_1, I_2, I_3 and I_4 are, respectively, the moments of inertia about axes 1, 2, 3 and 4 which are in the plane of the plate. **[IIT 92]**

38. A uniform bar of length $6a$ and mass $8m$ lies on a smooth horizontal table. Two point masses m and $2m$ moving in the same horizontal plane with speeds $2v$ and v, respectively, strike the bar as shown in the figure and stick to it after collision. Denoting angular velocity (about the centre of mass), total energy and centre of mass velocity by ω, E and V_c respectively, we have after collision **[IIT 91]**

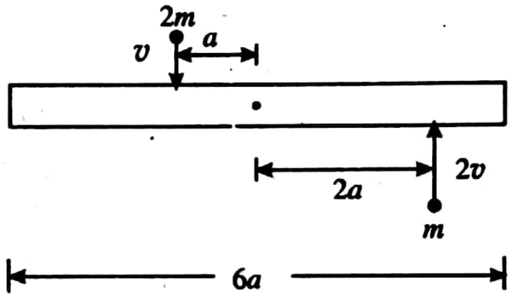


Fig. 9.18

(*a*) $V_c = 0$ (*b*) $\omega = \frac{3v}{5a}$

(*c*) $\omega = \frac{v}{5a}$ (*d*) $E = \frac{3mv^2}{5}$

39. The moment of inertia of a hoop of radius R and mass M about any tangential line is **[CPMT 92]**

(*a*) $\frac{3}{2}MR^2$ (*b*) $\frac{MR^2}{2}$

(*c*) $\frac{MR^2}{4}$ (*d*) MR^2

40. The moment of inertia of a ring about an axis passing through its centre and perpendicular to its plane is 200 g-cm^2. Its moment of inertia about a diameter is

(*a*) 100 g-cm^2 (*b*) 200 g-cm^2

(*c*) 300 g-cm^2 (*d*) 400 g-cm^2

41. A thin, uniform, circular disc is rolling down an inclined plane of inclination 30° without slipping. Its linear acceleration along the plane is **[CBSE PMT 92]**

(a) $g/4$ (b) $g/3$
(c) $g/2$ (d) $2g/3$

42. A particle is moved in a circle with a constant angular velocity. Its angular momentum is l. If the radius of the circle is halved keeping the angular velocity same, the angular momentum of the particle will become
(a) $l/4$ (b) $l/2$
(c) l (d) $2l$

43. A particle perform uniform circular motion with angular momentum l. If the frequency of the motion of the particle is doubled and its kinetic energy halved, the angular momentum becomes **[MNR 91]**
(a) $2l$ (b) $4l$
(c) $l/2$ (d) $l/4$

44. A solid sphere of mass 1 kg and radius 3 cm is rotating about an axis passing through its centre with an angular velocity of 50 rad/s. The kinetic energy of rotation is **[CPMT 89]**
(a) 9/20 J (b) 90 J
(c) 910 J (d) 4500 J

45. A mass slides down an inclined plane and reaches the bottom with a velocity v. If the same mass were in the form of a ring which rolls down this plane, its linear velocity at the bottom would be
(a) v (b) $v/\sqrt{2}$
(c) $\sqrt{2}v$ (d) $2v$

46. A ring and a disc, having the same mass, roll without slipping with the same linear velocity. If the kinetic energy of the ring in 8 J, that of the disc must be
(a) 2 J (b) 4 J
(c) 6 J (d) 16 J

47. The moment of inertia of a solid cylinder about its axis is I. It is allowed to roll on a surface without slipping. If its angular velocity is ω, then its kinetic energy is
(a) $\frac{1}{2}I\omega^2$ (b) $I\omega^2$
(c) $\frac{3}{2}I\omega^2$ (d) $2I\omega^2$

48. A torque of 100 N-m, acting on a wheel at rest, rotates it through 200 radians in 10 s. The angular acceleration of the wheel, in rad/s^2, is
(a) 2 (b) 4
(c) 6 (d) 8

49. In Q. 48, the moment of inertia of the wheel, in kg-m^2, is
(a) 25 (b) 30
(c) 50 (d) 75

50. A solid sphere of mass 2 kg rolls up a 30° incline with an initial speed of 10 m/s. The maximum height reached by the sphere is ($g = 10$ m/s^2)
(a) 3.5 m (b) 7.0 m
(c) 10.5 m (d) 14.0 m

51. A solid cylinder of mass 2 kg rolls down an inclined plane from a height of 4 m. Its rotational kinetic energy when it reaches the foot of the plane is ($g = 10$ m/s^2)
(a) 20 J (b) 40 J
(c) 80/3 J (d) 80 J

52. A flywheel is in the form of a uniform circular disc of radius 1 m and mass 2 kg. The work which must be done on it to increase its frequency of rotation from 5 to 10 rev/s is approximately
(a) 1.5×10^2 J (b) 3.0×10^2 J
(c) 1.5×10^3 J (d) 3.0×10^3 J

53. A solid cylinder of mass 50 kg and radius 0.5 m is free to rotate about its axis which is horizontal. A string is wound round the cylinder with one end attached to it and the other hanging freely. The tension in the string required to produce an angular acceleration of 2 rev/s^2 in the cylinder is
(a) 78.5 N (b) 157 N
(c) 314 N (d) 628 N

54. A balance is made of a rigid rod free to rotate about a point not at the centre of the rod. When an unknown mass m is placed in the left-hand pan, it is balanced by a mass m_1 placed in the right-hand pan, and similarly when the mass m is placed in the right-hand pan, it is balanced by a mass m_2 in the left-hand pan. Neglecting the masses of the pans, m is

(a) $\frac{m_1 + m_2}{2}$ (b) $\sqrt{m_1 m_2}$

(c) $\frac{\sqrt{m_1^2 + m_2^2}}{2}$ (d) $\sqrt{\frac{m_1^2 + m_2^2}{2}}$

55. Two uniform circular discs A and B of equal masses and thicknesses are made of materials of densities d_A and d_B respectively. If their moments of inertia about an axis passing through the centre and normal to the circular face are I_A and I_B respectively, then $I_A/I_B =$

(a) d_B / d_A (b) d_A / d_B

(c) d_B^2 / d_A^2 (d) d_A^2 / d_B^2

56. Two loops P and Q are made from a uniform wire. The radii of P and Q are r_1 and r_2 respectively, and their moments of inertia are I_1 and I_2 respectively. If $I_2/I_1 = 4$ then $\frac{r_2}{r_1}$ equals **[DPMT 92]**

(a) $4^{2/3}$ (b) $4^{1/3}$

(c) $4^{-2/3}$ (d) $4^{-1/3}$

57. Four spheres, each of mass M and diameter $2r$, are placed with their centres on the four corners of a square of side a (> $2r$). The moment of inertia of the system about one side of the square is **[DCE 92]**

(a) $\frac{2}{5}M(5r^2 + 4a^2)$

(b) $\frac{2}{5}M(5r^2 + 2a^2)$

(c) $\frac{2}{5}M(2r^2 + 5a^2)$

(d) $\frac{2}{5}M(4r^2 + 5a^2)$

58. The moment of inertia of a uniform circular disc about a diameter is I. Its moment of inertia about an axis perpendicular to its plane and passing through a point on its rim is **[CBSE 91]**

(a) $3\,I$ (b) $4\,I$

(c) $5\,I$ (d) $6\,I$

59. A circular loop of wire of mass m and radius r is making n revolutions per second about a point on its rim. Its rotational kinetic energy is

(a) $\pi^2 m r^2 n^2$ (b) $2\pi^2 m r^2 n^2$

(c) $4\pi^2 m r^2 n^2$ (d) $8\pi^2 m r^2 n^2$

60. A and B are two solid spheres of equal masses. A rolls down an inclined plane without slipping from a height of 3m. B falls vertically from the same height. Then on reaching the ground

(a) A can do more work than B

(b) B can do more work than A

(c) both can do equal work

(d) both will have different linear speeds.

61. A thin rod of mass m and length $2l$ is made to rotate about an axis passing through its centre and perpendicular to it. If its angular velocity changes from 0 to ω in time t, the torque acting on it is

(a) $\frac{ml^2\omega}{12t}$ (b) $\frac{ml^2\omega}{3t}$

(c) $\frac{ml^2\omega}{t}$ (d) $\frac{4ml^2\omega}{3t}$

62. A pan containing a layer of uniform thickness of ice is placed on a circular turntable with its centre coinciding with the centre of the turntable. The turntable is now rotated at a constant angular velocity about a vertical axis passing through its centre and the driving torque is withdrawn. There is no friction between the table and the pivot. The pan rotates with the table. As the ice melts

(a) the angular velocity of the system decreases

(b) the angular velocity of the system increases

(c) the angular velocity of the system remains unchanged

(d) the moment of inertia of the system increases.

63. A uniform horizontal circular platform of mass 200 kg is rotating at 10 rpm about a vertical axis passing through its centre. A boy of mass 50 kg is standing at its edge. If the boy moves to the centre of the platform, the frequency of rotation would become
(*a*) 7.5 rpm (*b*) 12.5 rpm
(*c*) 15 rpm (*d*) 20 rpm

64. A solid sphere and a spherical shell roll down an inclined plane from rest from the same height. The ratio of the times taken by them is
(*a*) $\sqrt{\frac{21}{25}}$ (*b*) $\frac{21}{25}$
(*c*) $\sqrt{\frac{25}{21}}$ (*d*) $\frac{25}{21}$

65. A circular plate of uniform thickness has a diameter of 56 cm. A circular portion of diameter 42 cm is removed from one edge of the plate. The distance of the centre of mass of the remaining portion from the centre of the plate is
(*a*) 5 cm (*b*) 7 cm
(*c*) 9 cm (*d*) 11 cm

66. The moment of inertia of a body about an axis is 1.2 kg-m^2. Initially the body is at rest. In order to produce a rotational kinetic energy of 1500 J, an angular acceleration of 25 rad/s^2 must be applied about the axis for a duration of **[CBSE 90]**
(*a*) 2 s (*b*) 4 s
(*c*) 8 s (*d*) 10 s

67. A particle of mass 5 grams is moving with a uniform speed of $3\sqrt{2}$ cm/s in the *xy* plane along the line $y = x + 4$. The magnitude of its angular momentum about the origin in g cm^2/s is
(*a*) zero (*b*) 30
(*c*) $30\sqrt{2}$ (*d*) 60

68. A solid sphere, a hollow sphere and a solid cylinder, all of the same radius, roll down an inclined plane from the same height, starting from rest. Which of them takes the least time in reaching the bottom of the plane? **[CBSE 93]**
(*a*) Solid sphere
(*b*) Hollow sphere
(*c*) Solid cylinder
(*d*) All will take the same time

69. The rotational kinetic energy of a body is E and its moment of inertia is I. The angular momentum of the body is **[MP PMT 93]**
(*a*) EI (*b*) $2\sqrt{EI}$
(*c*) $\sqrt{2EI}$ (*d*) E/I

70. Two circular rings have masses in the ratio 1 : 2 and diameters in the ratio 2 : 1. The ratio of their moments of inertia is **[MP PMT 93]**
(*a*) 1 : 4 (*b*) 2 : 1
(*c*) 4 : 1 (*d*) $\sqrt{2}$: 1

71. You are given two circular discs having equal masses and equal thicknesses. Their densities, radii and moments of inertia about the central axis are d_1, R_1, I_1 and d_2, R_2, I_2 respectively. For I_1 to be greater than I_2, the condition(s) is (are) **[MP PET 93]**
(*a*) $d_1 > d_2$ (*b*) $R_1 > R_2$
(*c*) $d_1 > d_2$ and $R_1 > R_2$
(*d*) $d_1 < d_2$ and $R_1 < R_2$

72. A false balance has equal arms. An object weighs x when place in one pan and y when placed in the other pan. The true weight of the object is equal to **[AFMC 94]**
(*a*) $\sqrt{xy}$ (*b*) $\frac{x+y}{2}$
(*c*) $\frac{x^2+y^2}{2}$ (*d*) $\frac{\sqrt{x^2+y^2}}{2}$

73. Two rings of the same radius (r) and mass (m) are placed such that their centres are at a common point and their planes are perpendicular to each other. The moment of inertia of the system about an axis passing through the centre and perpendicular to the plane of one of the rings is **[PMT PMT 94]**

(a) $\frac{1}{2}mr^2$ (b) mr^2

(c) $\frac{3}{2}mr^2$ (d) $2.mr^2$

74. A cord of wound round the circumference of a wheel of radius r. The axis of the wheel is horizontal and its moment of inertia about this axis is I. A weight mg is attached to the end of the cord and is allowed to fall from rest. The angular velocity of the wheel, when the weight has fallen through a distance h, is **[MP PMT 94]**

(a) $\left[\frac{2gh}{I+mr}\right]^{1/2}$ (b) $\left[\frac{2mgh}{I+mr^2}\right]^{1/2}$

(c) $\left[\frac{2mgh}{1+2mr^2}\right]^{1/2}$ (d) $(2gh)^{1/2}$

75. The moment of inertia of a solid cylinder of mass m and radius R about a line parallel to the axis of the clyinder and lying on the surface of the cylinder is **[MP PET 94]**

(a) $\frac{2}{5}MR^2$ (b) $\frac{3}{5}MR^2$

(c) $\frac{3}{2}MR^2$ (d) $\frac{5}{2}MR^2$

76. A wheel rotates with a constant acceleration of 2.0 rad/s^2. If the wheel starts from rest, the number of revolutions it makes in the first ten seconds will be approximately **[MP PET 94]**

(a) 8 (b) 16

(c) 24 (d) 32

77. A body having moment of inertia about its axis of rotation equal to 2 kg m^2 is rotating with angular velocity equal to 3 rad/s. The kinetic energy of this body is the same as that of a body of mass 27 kg moving with a speed of **[SCRA 94]**

(a) 1.0 m/s (b) 0.5 m/s

(c) 1.5 m/s (d) 2.0 m/s

78. A disc is of mass M and radius r. The moment of inertia of this disc about an axis tangential to its edge and in the plane of the disc is **[MP PET 95]**

(a) $5Mr^2/4$ (b) $Mr^2/4$

(c) $3Mr^2/4$ (d) $Mr^2/2$

79. When the external torque on a system is zero, there will be conservation of its **[MP PET 95]**

(a) linear momentum

(b) angular momentum

(c) total energy

(d) none of the above

80. The moment of inertia of a thin uniform circular disc about one of its diameters is I. The moment of inertia about an axis perpendicular to the circular surface and passing through its centre is **[EAMCET 92]**

(a) $\sqrt{2}I$ (b) $2I$

(c) $I/2$ (d) $I/\sqrt{2}$

81. A disc of mass 2 kg and diameter 40 cm is free to rotate about an axis through its centre and perpendicular to its plane. If a force of 50 N is applied to the disc tangentially, its angular acceleration will be

(a) 100 rad/s^2 (b) 25 rad/s^2

(c) 250 rad/s^2 (d) 500 rad/s^2

82. A ring of mass m and radius r rotates about an axis passing through its centre and perpendicular to its plane with angular velocity ω. Its kinetic energy is **[CBSE 92]**

(a) $\frac{1}{2}mr^2\omega^2$ (b) $mr\omega^2$

(c) $mr^2\omega^2$ (d) $\frac{1}{2}mr\omega^2$

83. A man is standing on a table which is rotating with an angular velocity ω. He is holding two equal masses at arms length. If he drops the masses without moving his arms, his angular speed

(a) will be less than ω

(b) will be more than ω

(c) will remain equal to ω

(d) will be less than, equal to, or greater than ω depending on the quantity of masses

84. A uniform rod PQ of length L is hinged at one end P. The rod is kept in the horizontal position by a massless string tried to point Q as shown in the figure. If the string is cut, the initial angular acceleration of the rod will be **[AIPMT 06, 07]**

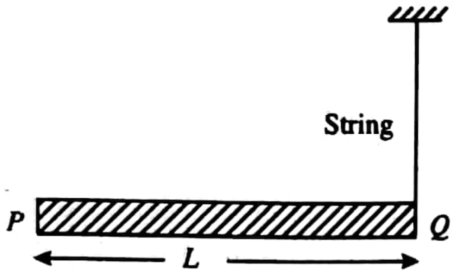
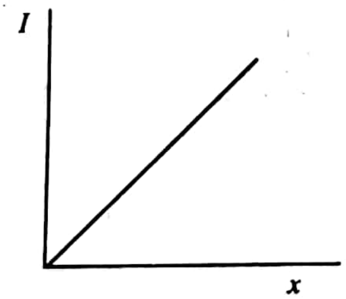
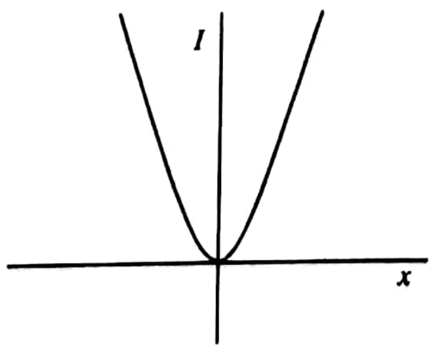


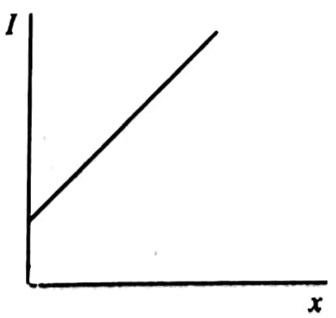
Fig. 9.19

(*a*) g/L (*b*) $2g/L$
(*c*) $2g/3L$ (*d*) $3g/2L$

85. If I is the moment of inertia of a solid sphere about an axis parallel to a diameter of the sphere and *t* a distance x from it, which of the following graphs represents the variation of I with x?

(*a*)


(*b*)


(*c*)


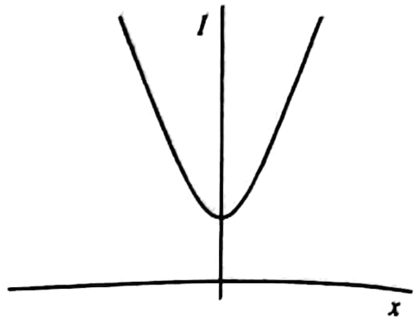
(*d*)


Fig. 9.20

86. A mass M is supported by a massless string wound round a uniform cylinder of mass M and radius R as shown in the figure. On releasing the mass M from rest, it will fall down with an acceleration

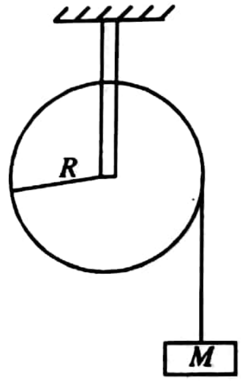


Fig. 9.21

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

(*c*) $\frac{2g}{3}$ (*d*) $\frac{3g}{4}$

87. In Q. 86, the tension in the string will be

(*a*) $\frac{Mg}{3}$ (*b*) $\frac{Mg}{2}$

(*c*) $\frac{2Mg}{3}$ (*d*) $\frac{3Mg}{4}$

88. The radius of gyration of a thin rod of mass 100 g and length 1 m about an axis passing through its centre of gravity and perpendicular to its length is

(*a*) $1/2\sqrt{3}$ m (*b*) $1/6\sqrt{2}$ m

(*c*) $1/3\sqrt{2}$ m (*d*) $1/4\sqrt{3}$ m

89. A couple produces **[CBSE 97]**

(*a*) purely linear motion
(*b*) purely rotational motion
(*c*) both linear and rotational motion
(*d*) no motion

90. A cylinder of 500 gm and radius 10 cm has moment of inertia (about its natural axis) **[AFMC 97]**
(*a*) 6×10^{-3} kg m^2
(*b*) 2.5×10^{-3} kg m^3
(*c*) 5×10^{-3} kg m^2
(*d*) none of these

91. If there is change of angular momentum from 1 Js to 4 Js in 4s, then the torque is **[AIIMS 97]**
(*a*) 1 J (*b*) 3/4 J
(*c*) 5/4 J (*d*) 4/3 J

92. A weightless ladder 20 ft long rests against a frictionless wall at an angle of 60° form the horizontal. A 150 pound man is 4 ft from the top of the ladder. A horizontal force is applied at the lower end to keep it from slipping. The magnitude of the force is **[CBSE PMT 98]**
(*a*) 10.0 lb (*b*) 12.0 lb
(*c*) 18.0 lb (*d*) 17.5 lb

93. *O* is the centroid of an equilateral triangle *ABC*. F_1, F_2 and F_3 are three forces acting along the sides *AB*, *BC* and *AC* as shown in figure below. What should be the magnitude of F_3 so that the total torque about *O* is zero? **[CBSE PMT 98]**

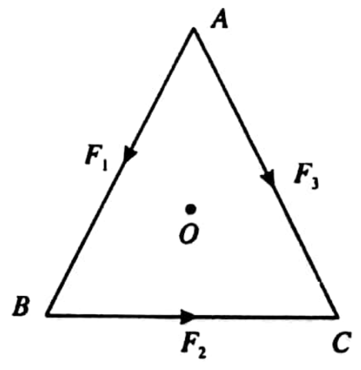


Fig. 9.22

(*a*) $(F_1 + F_2)/2$ (*b*) $(F_1 - F_2)$
(*c*) $2(F_1 + F_2)$ (*d*) $(F_1 + F_2)$

94. A solid cylinder rolls without slipping down a 30° incline. The acceleration of the sphere is **[DPMT 98]**
(*a*) $g/2$ (*b*) $g/3$
(*c*) $g/\sqrt{2}$ (*d*) $g/\sqrt{3}$

95. A uniform circular ring is rolling down an inclined plane of inclination 30° without slipping. Its linear acceleration is **[BHU PMT 98]**
(*a*) g/2 (*b*) g/3
(*c*) g/4 (*d*) 2g/3

96. Two rings have their moments of inertia in the ratio 2 : 1 and diameters in the ratio 2 : 1. The ratio of their masses is **[MP CET 98]**
(*a*) 2 : 1 (*b*) 1 : 2
(*c*) 1 : 4 (*d*) 1 : 1

97. Let *I* be the moment of inertia of a uniform square plate about an axis *AB* that passes through its centre and is parallel to two of its sides. *CD* is a line in the plane of the plate that passes through the centre of the plate and makes an angle θ with *AB*. The moment of inertia of the plate about the axis *CD* is then equal to **[IIT 98]**
(*a*) I (*b*) $I\sin^2\theta$
(*c*) $I\cos^2\theta$ (*d*) $I\cos^2(\theta/2)$

98. The torque $\vec{\tau}$ on a body about a given point is found to be equal to $\vec{A} \times \vec{L}$, where $\vec{A}$ is a constant vector and $\vec{L}$ is the angular momentum of the body about the point. From this it follows that **[IIT 98]**
(*a*) $\frac{d\vec{L}}{dt}$ is perpendicular to $\vec{L}$ at all instants of time
(*b*) the component of $\vec{L}$ in the direction of $\vec{A}$ does not change with time
(*c*) the magnitude of $\vec{L}$ does not change with time
(*d*) $\vec{L}$ does not change with time

99. A wheel is rotating at 900 r.p.m. about its axis. When the power is cut off it comes to rest in 1 minute. The angular retardation in radian/s^2 is **[MP CET 98]**
(*a*) $\pi/2$ (*b*) $\pi/4$
(*c*) $\pi/6$ (*d*) $\pi/8$

100. A disc of mass M and radius R is rolling with angular speed ω on a horizontal plane as shown. The magnitude of angular momentum of the disc about the origin O is

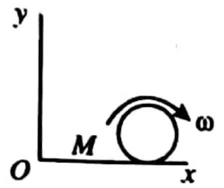


Fig. 9.23

(*a*) $(1/2)\,MR^2\omega$ (*b*) $MR^2\omega$

(*c*) $(3/2)\,MR^2\omega$ (*d*) $2MR^2\omega$

101. A cubical block of side a is moving with velocity v on a horizontal smooth plane as shown. It hits a ridge at point O. The angular speed of the block after it hits O is [MP CET 99]

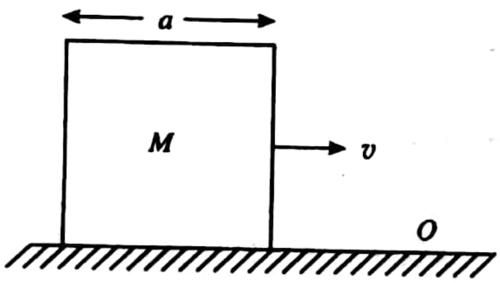


Fig. 9.24

(*a*) $3v/(4a)$ (*b*) $3v/(2a)$

(*c*) $\sqrt{3}v/(\sqrt{2}a)$ (*d*) zero

102. A long horizontal rod has a bead which can slide along its length, and initially placed at a distance L from one end A of the rod. The rod is set in angular motion about A with constant angular acceleration α. If the coefficient of friction between the rod and the bead is μ, and gravity is neglected, then the time after which the bead starts slipping is [IIT 2000]

(*a*) $\sqrt{\dfrac{\mu}{\alpha}}$ (*b*) $\dfrac{\mu}{\sqrt{\alpha}}$

(*c*) $\dfrac{1}{\sqrt{\mu\alpha}}$ (*d*) infinitesimal

103. A thin wire of length L and uniform linear mass density ρ is bent into a circular loop with centre at O as shown. The moment of inertia of the loop about the axis XX' is [IIT 2000]

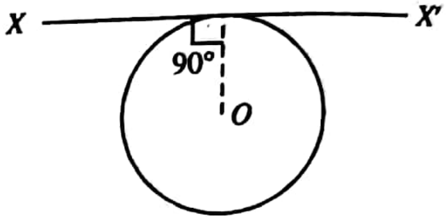


Fig. 9.25

(*a*) $\dfrac{\rho L^3}{8\pi^2}$ (*b*) $\dfrac{\rho L^3}{16\pi^2}$

(*c*) $\dfrac{5\rho L^3}{16\pi^2}$ (*d*) $\dfrac{3\rho L^3}{8\pi^2}$

104. There is a flat uniform triangular plate ABC such that $AB = 4$ cm, $BC = 3$ cm and $ABC = 90°$. The moments of inertia of the plate about AB, BC and CA as axes are respectively I_1, I_2 and I_3. Which one of the following is true? [CBSE PMT 2000]

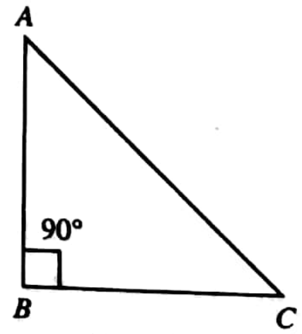


Fig. 9.26

(*a*) $I_3 > I_2$ (*b*) $I_2 > I_1$

(*c*) $I_3 > I_1$ (*d*) $I_1 > I_2$

105. A solid cylinder and a hollow cylinder, both of the same mass and same external diameter, are released from the same height at the same time on an inclined plane. Both roll down without slipping. Which one will reach the bottom first? [CBSE PMT 2000]

(*a*) Both together

(*b*) Solid cylinder

(*c*) One with higher density
(*d*) Hollow cylinder

106. The moment of inertia of a sphere of mass M and radius R about an axis passing through its centre is $\frac{2}{5}MR^2$. The radius of gyration of the sphere about a parallel axis to the above and tangent to the sphere is **[EAMCET Engg 2000]**

(*a*) $\frac{7}{5}R$ (*b*) $\frac{3}{5}R$
(*c*) $\left(\sqrt{\frac{7}{5}}\right)R$ (*d*) $\left(\sqrt{\frac{3}{5}}\right)R$

107. A wheel has a speed of 1200 revolutions per minute and is made to slow down at a rate 4 radians/s^2. The number of revolutions it makes before coming to rest is **[EAMCET ENGG. 2000]**

(*a*) 143 (*b*) 272
(*c*) 314 (*d*) 722

108. Four particles each of mass m are placed at the corners of a square of side length l. The radius of gyration of the system about an axis perpendicular to the square and passing through its centre is **[EAMCET MED 2000]**

(*a*) $\frac{l}{\sqrt{2}}$ (*b*) $\frac{l}{2}$
(*c*) l (*d*) $(\sqrt{2})\,l$

109. A metre scale is standing vertically on the earth's surface on one of its ends. It now falls on earth without slipping. Find the velocity with which the free end of the scale strikes the earth. [g = 10 m/s^2] **[MP PET 2000]**

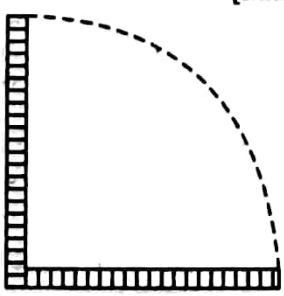


Fig. 9.27

(*a*) 9.8 m/sec (*b*) 5.4 m/sec
(*c*) 4.5 m/sec (*d*) 1 m/sec

110. Three rings, each of mass M and radius R, are arranged as shown in the figure. The moment of inertia of the system about YY' will be: **[MP PET 2000]**

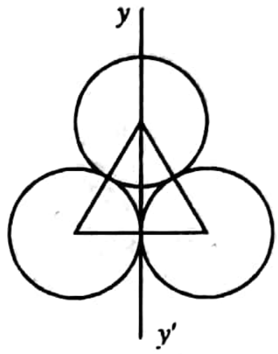


Fig. 9.28

(*a*) $3MR^2$ (*b*) $(3/2)\,MR^2$
(*c*) $5\,MR^2$ (*d*) $(7/2)\,MR^2$

111. A thin hollow cylinder open at both ends (*i*) slips without rolling (*ii*) rolls without slipping with the same velocity. The ratio of the kinetic energies in the two cases is: **[CPMT 2000]**

(*a*) 1 : 2 (*b*) 2 : 1
(*c*) 1 : 1 (*d*) 3 : 2

112. One quarter sector is cut from a uniform circular disc of radius R. This sector has mass M. It is made to rotate about a line perpendicular to its plane and passing through the centre of the original disc. Its moment of inertia about the axis of rotation is **[IIT 2001]**

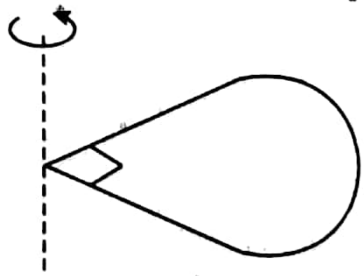


Fig. 9.29

(*a*) $\frac{1}{2}MR^2$ (*b*) $\frac{1}{4}MR^2$
(*c*) $\frac{1}{8}MR^2$ (*d*) $\sqrt{2}MR^2$

113. When a ceiling fan is switched off, its angular velocity reduces by 50% while it makes 36 rotations. How many more rotations will it make before coming to rest? (Assume uniform angular retardation) **[Karnataka CET 2001]**

(*a*) 48 (*b*) 36
(*c*) 12 (*d*) 18

114. From a uniform wire, two circular loops are made (*i*) *P* of radius *r* and (*ii*) *Q* of radius *nr*. If the moment of inertia of *Q* about an axis passing through its centre and perpendicular to its plane is 8 times that of *P* about a similar axis, the value of *n* is (diameter of the wire is very much smaller than *r* or *nr*) **[EAMCET ENGG. 2001]**

(*a*) 8 (*b*) 6
(*c*) 4 (*d*) 2

115. The mass of a circular disc is 0.5 kg and its radius is 10 cm. The moment of inertia of the disc about an axis parallel to its own axis and tangential to it is **[MP PMT 2001]**

(*a*) 7.5×10^{-3} kg × m^2

(*b*) 5.0×10^{-3} kg × m^2

(*c*) 1.5×10^{-3} kg × m^2

(*d*) 1.5×10^{-3} kg × m^2

ANSWERS

1. *b*	**2.** *a*	**3.** *b*	**4.** *b*	**5.** *b*	**6.** *b*	**7.** *b*	**8.** *c*
9. *b*	**10.** *b*	**11.** *d*	**12.** *c*	**13.** *b*	**14.** *c*	**15.** *b, c*	**16.** *d*
17. *d*	**18.** *a*	**19.** *d*	**20.** *a*	**21.** *b*	**22.** *c*	**23.** *c*	**24.** *b*
25. *c*	**26.** *c*	**27.** *d*	**28.** *c*	**29.** *c*	**30.** *b, d*	**31.** *b*	**32.** *b*
33. *a*	**34.** *a*	**35.** *b*	**36.** *c*	**37.** *a, b*	**38.** *a,c,d*	**39.** *a*	**40.** *a*
41. *b*	**42.** *a*	**43.** *d*	**44.** *a*	**45.** *b*	**46.** *c*	**47.** *c*	**48.** *b*
49. *a*	**50.** *b*	**51.** *c*	**52.** *c*	**53.** *b*	**54.** *b*	**55.** *a*	**56.** *b*
57. *d*	**58.** *d*	**59.** *c*	**60.** *c, d*	**61.** *b*	**62.** *a, d*	**63.** *c*	**64** *a*
65. *c*	**66.** *a*	**67.** *d*	**68.** *a*	**69.** *c*	**70.** *b*	**71.** *b*	**72.** *b*
73. *c*	**74.** *b*	**75.** *c*	**76.** *b*	**77.** *a*	**78.** *a*	**79.** *b*	**80.** *b*
81. *c*	**82.** *a*	**83.** *b*	**84.** *d*	**85.** *d*	**86.** *c*	**87.** *a*	**88.** *a*
89. *b*	**90.** *b*	**91.** *b*	**92.** *d*	**93.** *d*	**94.** *b*	**95.** *c*	**96.** *b*
97. *a*	**98.** *a,b,c*	**99.** *a*	**100.** *c*	**101.** *a*	**102.** *d*	**103.** *d*	**104.** *b*
105. *b*	**106.** *c*	**107.** *c*	**108.** *d*	**109.** *b*	**110.** *d*	**111.** *a*	**112.** *a*
113. *c*	**114.** *d*	**115.** *a*					