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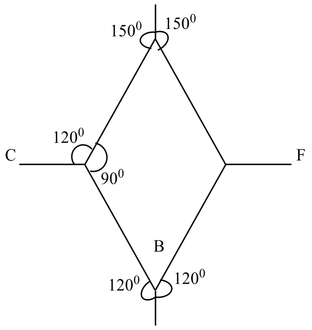
PHYSICS

LAWS OF MOTION

Single Correct Answer Type

1. The below figure is the part of a horizontally stretched note. Section AB is stretched with a force of 10 N. The tension in the section BC and BF are



a) 10 N, 11N
b) 10 N, 6 N
c) 10 N, 10 N
d) Cannot be calculated due to insufficient data

2. The kinetic energy acquired by a body of mass 'M' in travelling a certain distance 'd', starting from rest, under the action of constant force is
a) Directly proportional to $\sqrt{M}$
b) Inversely proportional to $\sqrt{M}$
c) Independent of M
d) Directly proportional to $\sqrt{M}$

3. 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

4. If the force acting on a inversely proportional to its speed. the kinetic energy of the body is
a) constant
b) directly proportional to time
c) inversely proportional to time
d) directly proportional to square of time

5. A block of mass 'm', kept on a horizontal surface, is moved through a distances by applying a horizontal force (F) to it. What is the work done by the normal reaction?
a) $\frac{F}{s}$
b) Zero
c) Fs
d) $\frac{s}{F}$

6. The kinetic energy of a light body and a heavy body is same. Which one of them has greater momentum?
a) A body having high velocity
b) Heavy body
c) Light body
d) A body having large displacement

7. Three bodies each of mass 1 kg are situated at the vertices of an equilateral triangle of side 1 m. The xy-coordinates of centre of mass of the system are
a) $\left(\frac{1}{2\sqrt{3}}, \frac{1}{2\sqrt{3}}\right)$
b) $\left(\frac{1}{2}, \frac{1}{2\sqrt{3}}\right)$
c) $\left(\frac{1}{2}, \frac{1}{3}\right)$
d) $\left(\frac{1}{2\sqrt{3}}, \frac{1}{2}\right)$

8. Three bodies P, Q and R have masses 'm' kg, '2m' kg and '3m' kg respectively. If all the bodies have equal kinetic energy, then greater momentum will be for body/bodies.
a) Q
b) R
c) P and Q
d) P

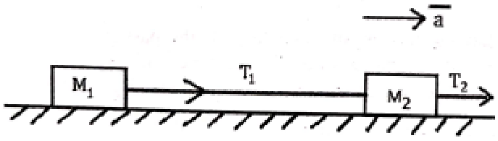
9. A particle at rest explodes into two particles of mass 'm_1' and 'm_2' which move in opposite direction with velocities 'V_1' and 'V_2' respectively. The ratio of kinetic energies 'E_1' to 'E_2' is
a) $1: m_2$
b) $m_2: m_1$
c) $m_1: m_2$
d) $1: 1$

10. A particle at rest explodes into two particles of masses m_1 and m_2 which move in opposite directions with velocities v_1 and v_2 respectively. The ratio of kinetic energies E_1 to E_2 respectively is
a) $m_2: m_1$
b) $m_1: m_2$
c) $1: m_2$
d) $1: 1$

11. A bullet of mass m moving with velocity 'v' is fired into a wooden block of mass 'M'. If the bullet remains embedded in the block, the final velocity of the system is

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

12. Two masses M_1 and M_2 are accelerated uniformly on frictionless surface as shown in figure. The ratio of the tensions T_1/T_2 is



a) $\frac{M_1}{M_1+M_2}$ b) $\frac{M_1}{M_2}$
c) $\frac{M_1+M_2}{M_2}$ d) $\frac{M_2}{M_1}$

13. A particle of mass m moving with a velocity $(3\hat{i}+2\hat{j})ms^{-1}$ collides with a stationary body of mass M and finally moves with a velocity $(-2\hat{i}+\hat{j})ms^{-1}$. If $\frac{m}{M}=\frac{1}{13}$, then
a) the impulse received by M is m $(5\hat{i}+\hat{j})$ b) the velocity of the M is $\frac{1}{13}(5\hat{i}+\hat{j})$
c) the coefficient of restitutions $\frac{11}{17}$ d) All of the above are correct

14. For a perfectly elastic collision, the coefficient of restitution is
a) 1 b) 0.75
c) Zero d) 0.5

15. A see-saw of length 6 m is pivoted at its centre. A child of mass 20 kg is sitting at one of its ends. Where should another child, of mass 30 kg, sit on the other end from the centre of see-saw, so that it is balanced?
a) 1 m b) 3 m
c) 2 m d) 4 m

16. A ball of mass 'm' falls from height 'h' on a floor for which the coefficient of restitution is 'e'. After two rebounds, the height attained by the ball is
a) eh b) $\sqrt{eh}$
c) e^4h d) e^2h

17. A car of mass 'm' moving with velocity 'u' on a straight road in a straight line, doubles its velocity in time t. The power delivered by the engine of a car for doubling the velocity is
a) $\frac{3mu^2}{2t}$ b) $\frac{mu^2}{2t}$
c) $\frac{2mu^2}{t}$ d) $\frac{3mu^2}{t}$

18. Two masses 'm_1' and 'm_2' moving with velocities 'v_1' and 'v_2' in opposite directions collide elastically and after collision masses 'm_1' and 'm_2' move with velocity 'v_2' and 'v_1' respectively. The ratio $\left(\frac{v_2}{v_1}\right)$ is
a) 1 b) 1.25
c) 0.75 d) 1.5

19. A shell of mass 'M' initially at rest suddenly explodes in three fragments. Two of these fragments are of mass 'M/4' each, which move with velocities $3ms^{-1}$ and $4\ ms^{-1}$ respectively in mutually perpendicular directions. The magnitude of velocity of the third fragment is
a) $2.5\ ms^{-1}$ b) $1.5\ ms^{-1}$
c) $3.0\ ms^{-1}$ d) $2.0\ ms^{-1}$

20. A black having mass m collides with an another stationary block having mass 2 m. The lighter block comes to rest after collision. If the velocity of first block is v, then the value of coefficient of restitution must be
a) 0.5 b) 0.4
c) 0.6 d) 0.8

21. If bullet of mass 'm_1' is fired from a gun of mass 'm_2' with a speed of 'V_1', then the recoil velocity of gun is
a) $-\frac{m_1V_1}{m_2}$ b) $-\frac{m_2}{m_1V_1}$
c) $-\frac{m_2}{m_1V_1}$ d) $\frac{m_1V_1}{m_2}$

22. A force F = Ay² +By + C acts on a body in the y -direction. The work done by force during a displacement from y = -a to y = a is
a) $\frac{2Aa^3}{3}$ b) $\frac{2Aa^3}{3}+2Ca$
c) $\frac{2Aa^3}{3}+\frac{Ba^2}{2}+Ca$ d) None of these

23. A body initially at rest is acted upon by a constant force (F) for time (t). The kinetic energy is time t is
a) $\frac{F^2t^2}{2m}$ b) $\frac{Ft}{2m}$
c) $\frac{F^2t^2}{m}$ d) $\left(\frac{Ft}{m}\right)^2$

24. A particle at rest explodes into two particles of masses 'm_1' and 'm_2' which move in opposite directions with velocities 'V_1' and 'V_2' respectively. The ratio of kinetic energies 'E_1' to 'E_2' respectively is
a) $m_2 : m_1$ b) 1: 1
c) $1 : m_2$ d) $m_1 : m_2$

25. Moment of a force of magnitude 20 N acting along positive x- direction at point (3, 0, 0) about the point (0, 2, 0) (in N-m) is

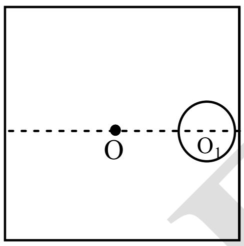
a) 20 b) 60
c) 40 d) 30

26. Out of the fundamental forces in nature, maximum and minimum range is respectively for
a) Electromagnetic force, gravitational force
b) Strong nuclear force, electromagnetic force
c) Gravitational force, weak nuclear force
d) Gravitational force, electromagnetic force

27. A wooden black of mass ‘m’ moves with velocity ‘V’ and collides with another block of mass ‘4m’, which is at rest. After collision the block of mass ‘m’ comes to rest. The coefficient of restitution will be
a) 0.7 b) 0.25
c) 0.4 d) 0.5

28. Force acting on a particle is (2i + 3j) N. Work done by this force is zero, when a particle is moved on the line $3y + kx = 5$. value of k is
a) 2 b) 4
c) 6 d) 8

29. A square plate of side 20 cm has uniform thickness and density. A circular part of diameter 8 cm is cut out symmetrically and show in figure. The position of centre of mass of the remaining portion is



a) at O_1 b) at O
c) 0.54 cm from O on the left hand side
d) None of the above

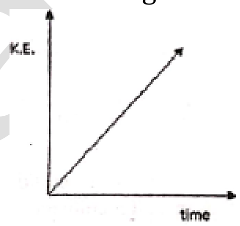
30. Five objects of different masses are simultaneously released vertically downwards from height ‘h’ (in air). Which physical quantity associated with the objects will change at the instant they strike the ground? (neglect the air resistance)
a) Time b) Momentum
c) Velocity d) Acceleration

31. A uniform rod of mass ‘M’ and length ‘L’ is suspended from the rigid support. A small bullet of mass ‘m’ hits the rod with velocity ‘v’ and gets embedded into the rod. The angular velocity of the system just after impact is
a) $\frac{3MV}{(M+m)L}$ b) $\frac{3MV}{(M+2m)L}$
c) $\frac{3mV}{(M+3m)L}$ d) $\frac{3mV}{(M+m)L}$

32. A metal ball of mass 2 kg moving with a speed of 10 ms^{-1} had a head-on collision with a stationary ball of mass 3 kg. If after collision, both the balls move together, then the loss in kinetic energy due to collision is
a) 100 J b) 60 J
c) 40 J d) 140 J

33. A particle of mass ‘m’ collides with another stationary particle of mass ‘M’. A particle of mass ‘m’ stops just after collision. The coefficient of restitution is
a) M/m b) m/M
c) $\frac{M-m}{M+m}$ d) $\frac{m+M}{m}$

34. A body moves along a straight line and the variation of its kinetic energy with time is linear as shown in the figure below. Then the force acting on the body is



a) Zero
b) Constant greater than zero
c) Inversely proportional to velocity
d) Directly proportional to velocity

35. A force $(\overline{F}) = -5\hat{i} - 7\hat{j} + 3\hat{k}$ acting on a particle causes a displacement $(\overline{g}) = 3\hat{i} - 2\hat{j} + a\hat{k}$ in its own direction. If the work done is 14 J, then the value of ‘a’ is
a) 0 b) 15
c) 5 d) 1

36. A wall is hit elastically and normally by ‘n’ balls per second. All the balls have the same mass ‘m’ and are moving with the same velocity ‘u’. The force exerted by the balls on the wall is
a) mnu b) $2mnu^2$
c) $\frac{1}{2}mnu^2$ d) 2mnu

37. The kinetic energy of a light body and a heavy body is same. Which one of the following statements is CORRECT?
a) Body having high velocity has greater
b) The heavy body has greater momentum

momentum

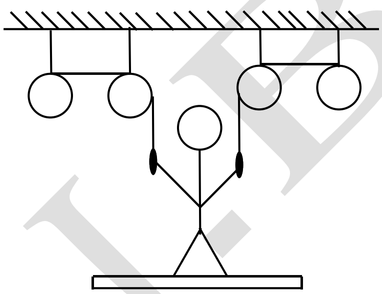
c) Both bodies have same momentum
d) The light body has greater momentum

38. A spring balance is attached to the ceiling of a lift. A man hangs his bag on the spring and the spring balance reads 49 N, when the lift is stationary. If the lift moves downward with an acceleration of 5 m/s^2, the reading of the spring balance will be
($g = 9.8\ m/s^2$)
a) 74 N
b) 15 N
c) 24 N
d) 49 N

39. A charge q_1 is moving along the circular path of radius 'R' with a charge q_2 at its centre. A charge q_1 makes two revolutions. The work done will be
a) Zero
b) $\frac{q_1 q_2}{4\pi\epsilon_0 R}$
c) $\frac{q_1}{4\pi\epsilon_0 R}$
d) $\frac{q_1 q_2}{4\pi\epsilon_0 R^2}$

40. A bullet of mass 20 g moving with a velocity of 200 m/s strikes a target and is brought to rest in $(1/50)^{th}$ of a second. The impulse and average force of impact are respectively
a) 2 Ns, 100 N
b) 4 Ns, 200 N
c) 2 Ns, 200 N
d) 4 Ns, 100 N

41. A man of mass m stands on a platform of equal mass m and pulls himself by two ropes passing over pulleys as shown in figure. If he pulls each rope with a force equal to half his weight, then his upward acceleration would be

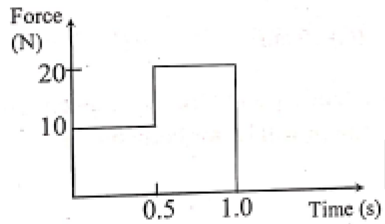


a) $\frac{g}{2}$
b) $\frac{g}{4}$
c) g
d) zero

42. A Diwali cracker releases 25 gram gas per second, with a speed of 400 ms^{-1} after explosion. The force exerted by gas on the cracker is
a) 16 newton
b) 100 dyne
c) 10,000 dyne
d) 10 newton

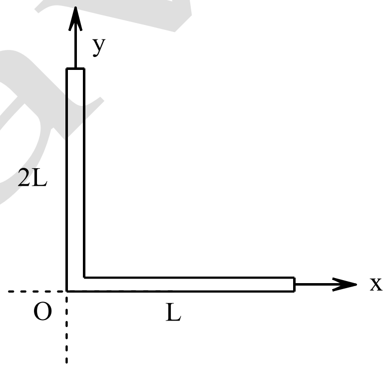
43. A vehicle without passengers is moving on a frictionless horizontal road with velocity 'u' can be stopped in a distance 'd'. Now, 40% of its weight is added. If the retardation remains same the stopping distance at velocity 'u' is
a) d
b) (1.2)d
c) (1.4)d
d) (1.6)d

44. Force is applied to a body of mass 2kg at rest on a frictionless horizontal surface as shown in the force against time (F – t) graph. The speed of the body after 1 second is



a) 7.5 m/s
b) 12.5 m/s
c) 10 m/s
d) 15 m/s

45. Figure shows a composite system of two uniform roads of lengths as indicated. Then, the coordinates of the centre of mass of the system of roads are



a) $\left(\frac{L}{2}, \frac{2L}{3}\right)$
b) $\left(\frac{L}{4}, \frac{2L}{3}\right)$
c) $\left(\frac{L}{6}, \frac{2L}{3}\right)$
d) $\left(\frac{L}{6}, \frac{L}{3}\right)$

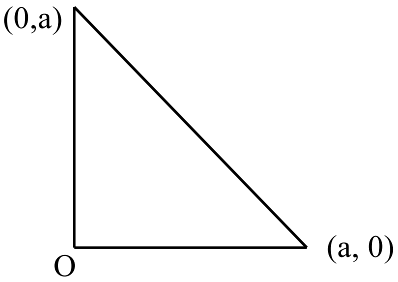
46. A body of mass m collides on, elastically with velocity u with another identical body at rest. After collision, velocity of the second body will be
a) zero
b) u
c) 2u
d) Data insufficient

47. A mass $2\sqrt{3}$ kg is acted upon by two forces which are inclined to each other at 60^0 and each of magnitude 1N. The acceleration of that mass in SI system is
$\sin 30^0 = \cos 60^0 = 0.5$
a) 0.9 m/s^2
b) 0.7 m/s^2
c) 0.5 m/s^2
d) 0.3 m/s^2

48. A ball released from a certain height strikes the ground after 2 second. After bouncing from the ground it rises to a highest point in 1 second. The coefficient of restitution is
a) 0.4
b) 0.3

c) 0.2 d) 0.5

49. Three rods of the same mass are placed as shown in figure. What will be the coordinates of centre of mass of the system?

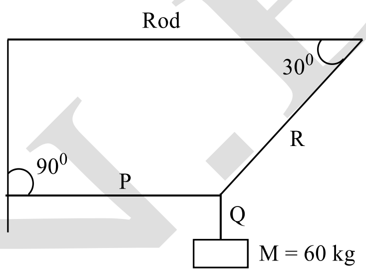


a) $\left[\frac{a}{2}, \frac{a}{2}\right]$ b) $\left[\frac{a}{\sqrt{2}}, \frac{a}{\sqrt{2}}\right]$
c) $[\sqrt{2}\,a, \sqrt{2}a]$ d) $\left[\frac{a}{3}, \frac{a}{3}\right]$

50. A 40 n block supported by two ropes. One rope is horizontal and the other makes an angle of 30^0 with the ceiling. The tension in the rope attached to the ceiling is approximately
a) 80 N b) 40 N
c) $40\sqrt{3}$ N d) $\frac{40}{\sqrt{3}}$ N

51. A lift is tied with thick iron rope having mass 'm'. The maximum acceleration of the lift is 'a' m/s^2 and maximum safe stress is 's' $\frac{N}{m^2}$. The minimum diameter of the rope is g = acceleration due to gravity
a) $\left[\frac{4m(g+a)}{\pi s}\right]^{1/2}$ b) $\left[\frac{4m(g+a)}{2\pi s}\right]^{1/2}$
c) $\left[\frac{m(g+a)}{\pi s}\right]^{1/2}$ d) $\left[\frac{4m(g-a)}{\pi s}\right]^{1/2}$

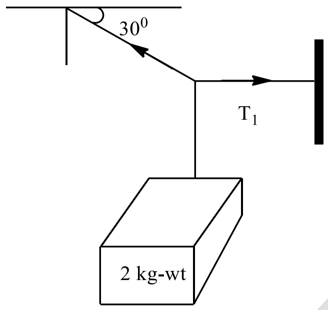
52. A body of mass 60 kg suspended by means of three strings P, Q and R as shown in the figure is in equilibrium. The tension in the string P is



a) 130.9 kgf b) 60 kgf
c) 50 kgf d) 103 kgf

53. The ratio of weights of a man inside a lift when it is stationary and when it is going down with a uniform acceleration 'a' is 3:2. The value of 'a' will be($a < g$, g = acceleration due to gravity)
a) $\frac{3}{2}g$ b) $\frac{g}{3}$
c) g d) $\frac{2}{3}g$

54. A body of weight 2 kg is suspended as shown in figure. The tension T_1 in the horizontal string (in kg-wt) is



a) $2/\sqrt{3}$ b) $\sqrt{3}/2$
c) $2\sqrt{3}$ d) 2

55. A bullet of mass 'm' hits a target of mass 'M' hung to a string and gets embedded in it. If the block with embedded bullet swings and rises to a height 'h' as a result of this inelastic collision, the velocity of the bullet before collision is
a) $\sqrt{(M+m)gh}$ b) $\left(\frac{M+m}{m}\right)\sqrt{2gh}$
c) $\left(\frac{M+m}{m}\right)2gh$ d) $(m+M)gh$

56. A lift of mass 'm' is ascending with an acceleration 'a' ($a < g$). The tension in the cable of the lift is (g = acceleration due to gravity)
a) $m(a-g)$ b) $m(g-a)$
c) $m(2g+a)$ d) $m(g+a)$

57. A force $F = -5\hat{i} - 7\hat{j} + 3\hat{k}$ acting on a particle causes a displacement $(s) = 3\hat{i} - 2\hat{j} + a\hat{k}$ in its own direction. If the work done is 14 J, then the value of a is
a) 0 b) 5
c) 15 d) 1

58. An aircraft is moving with uniform velocity 150 m/s in the space. If all the forces acting on it are balanced, then it will
a) Fall down on earth b) Keep moving with same velocity
c) Escape in space d) Remain floating at its place.

59. A block of mass 'm' collides with another stationary block of mass '2m'. The lighter block comes to rest after collision. If the velocity of first block is 'u', then the value of coefficient of restitution is
a) 0.6 b) 0.4
c) 0.5 d) 0.8

60. A block of mass 'm' moving on a frictionless surface at speed 'V' collides elastically with a block of same mass, initially at rest. Now the

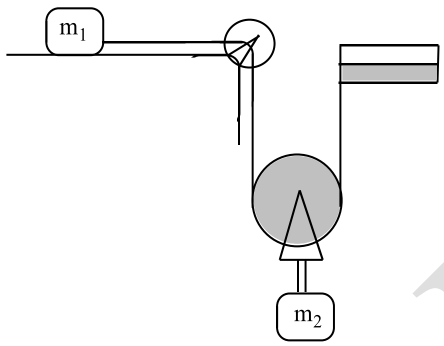
first block moves at an angle 'θ' with its initial direction and has speed 'V_1'. The speed of the second block after collision is

a) $\sqrt{V - V_1}$
b) $\sqrt{V^2 + V_1^2}$
c) $\sqrt{V^2 - V_1^2}$
d) $\sqrt{V_1^2 - V^2}$

61. A bomb at rest explodes in to three parts of same mass. The momentum of two parts is $(-)3P\hat{i}$ and $2P\hat{j}$ respectively. The magnitude of the momentum of third part is
a) $\sqrt{13}P$
b) $\sqrt{15}P$
c) $\sqrt{11}P$
d) $\sqrt{7}P$

62. Work done in sliding a 1 kg block up a rough inclined plane of height 5 m is 100 J. Work done against the friction is $(g = 10\ m/s^2)$
a) 75 J
b) 25 J
c) 50 J
d) 100 J

63. If the surface is smooth, the acceleration of the block m_2 will be



a) $\frac{m_2 g}{4m_1 + m_2}$
b) $\frac{2\,m_2 g}{4\,m_1 + m_2}$
c) $\frac{2\,m_2 g}{m_1 + 4m_2}$
d) $\frac{2\,m_1 g}{m_1 + m_2}$

64. A force $F = (10 + 0.5x)$ acts on a particle in the x-director. What would be the work done by this force during a displacement from $x = 0$ to $x = 2m$ (F is in newton and x in metre)?
a) 31.5 J
b) 63 J
c) 21 J
d) 42 J

65. If torque is zero, then
a) angular momentum is conserved
b) linear momentum is conserved
c) energy is conserved
d) angular momentum is not conserved

66. The motion of a rocket in upward direction with high speed is based on the principle of conservation of
a) Angular momentum
b) Kinetic energy
c) Linear momentum
d) Mass

67. A body of mass m moving with velocity v collides head on with another body of mass 2m which is initially at rest. The ratio of KE of colliding body before and after collision will be
a) 1:1
b) 2:1
c) 4:1
d) 9:1

68. A uniform metal rod of length 1 m is bent at 90^0, so as to form two arms of equal length. The centre of mass of this bent rod is
a) on the bisector of the angle, $\left(\frac{1}{\sqrt{2}}\right)$ m from vertex
b) on the bisector of the angle, $\left(\frac{1}{2\sqrt{2}}\right)$ m from vertex
c) on the bisector of the angle, $\left(\frac{1}{2}\right)$m from vertex
d) on the bisector of the angle, $\left(\frac{1}{4\sqrt{2}}\right)$ m from vertex

69. A sphere of mass 25 gram is placed on a vertical spring. It is compressed by 0.2 m using a force 5 N. When the spring is released, the sphere will reach a height of $(g = 10\ m/s^2)$
a) 6 cm
b) 8 cm
c) 10 cm
d) 2 m

70. An objective is displaced from point A (2m, 3m, 4m) to a point B (1m, 2m,3m) to a point B (1m,2m,3m) under a constant force $F = (22\hat{\imath} + 3\hat{\jmath} + 4\hat{k})N$, then the work done by this force in this process is
a) 9 J
b) -9 J
c) 18 J
d) -18 J

71. A force $\bar{F} = 3\hat{i} + 6\hat{j} + 2\hat{k}$ acting on a particle causes displacement $\bar{S} = -4\hat{i} + x\hat{j} + 3\hat{k}$ in the direction of $\bar{F}$. If the work done is 12 J, then value of 'x' is
a) Zero
b) 1
c) 3
d) 6

72. A wooden block of mass 'M' moves with velocity 'v' and collides with another block of mass '4M' which is at rest. After collision the block of mass 'M' comes to rest. The coefficient of restitution will be
a) 0.25
b) 0.15
c) 0.05
d) 0.30

73. Two masses of 1 gram and 4 gram are moving with equal kinetic energy. The ratio of the magnitudes of their momenta is
a) 1:16
b) 1:2
c) $\sqrt{2}:1$
d) 4:1

74. A force produces an acceleration of 6 ms^{-2} in a body of mass 'm_1' kg. The same force produces an acceleration of 4 ms^{-2} in the combination of mass $(m_1 + m_2)$kg. If the same force is applied to mass 'm_2' kg, then acceleration produced

will be

a) 6 ms^{-2} b) 9 ms^{-2}

c) 12 ms^{-2} d) 3 ms^{-2}

75. A particle of mass m moving in the x- direction with speed 2v is hit by another particle of mass 2m moving in the y-direction with speed v. If the collision is perfectly inelastic, the percentage loss in the energy during the collision is close to

a) 44% b) 50%

c) 56% d) 62%

76. A stationary body explodes into two parts of masses 'M_1' and 'M_2'. They move in opposite directions with velocities 'V_1' and 'V_2'. The ratio of their kinetic energies is

a) $M_2 : M_1$ b) $3M_2 : 4M_1$

c) $2M_2 : M_1$ d) $M_2 : 2M_1$

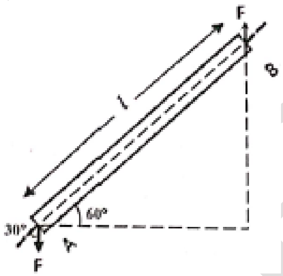
77. A bomb at rest explodes into 3 parts of same mass. The momentum of two parts is -3pî and 2pĵ, respectively. The magnitude of momentum of the third part is

a) p b) $\sqrt{5}\,p$

c) $\sqrt{11}\,p$ d) $\sqrt{13}\,p$

78. A rod 'l' m long is acted upon by a couple as shown in figure. The moment of couple is 'τ' Nm. If the force at each end of the rod, the magnitude of each force is

$(\sin 30^0 = \cos 60^0 = 0.5)$



a) $\frac{l}{2\tau}$ b) $\frac{\tau}{l}$

c) $\frac{2l}{\tau}$ d) $\frac{2\tau}{l}$

79. 'n' balls each of mass 'm' moving with the same velocity 'u' hit a wall elastically and normally in 2 second. The force exerted by the balls on the wall is

a) $\frac{mun^2}{2}$ b) 2mun

c) mun d) $\frac{mun}{2}$

80. A block of mass 'm' moving on a frictionless surface at speed 'V' collides elastically with a block of same mass, initially at rest. Now the first block moves at an angle 'θ' with its initial direction and has speed 'V_1'. The speed of the second block after collision is

a) $\sqrt{V^2 - V_1^2}$ b) $\sqrt{V_1^2 - V^2}$

c) $\sqrt{V^2 + V_1^2}$ d) $\sqrt{V - V_1}$

81. Two forces each of magnitude 'P' act at right angles. Their effect is neutralized by a third force acting along their bisector in opposite direction. The magnitude of the third force is $\left[\cos\frac{\pi}{2} = 0\right]$

a) P b) $P\sqrt{2}$

c) $\sqrt{2}P$ d) $\frac{P}{2}$

82. If a force of 250 N act on body, the momentum acquired is 125 kg-m/s. What is the period for which force act on the body?

a) 0.5 s b) 0.2 s

c) 0.4 s d) 0.25 s

83. A billet is fired from a gum. The fore on the bullet is given by $F = (600 \times 2 \times 10^5\, t)$, where F is in newton and t is second. The force on the bullet becomes zero as soon as it leaves the barrel. What is the average impulse imparted to the bullet?

a) 9 N-s b) Zero

c) 0.9 N-s d) 1.8 N-s

84. A body of mass 'm' moving with speed 3 m/s collides with a body of mass '2m' at rest. The coalesced mass will start to move with a speed of

a) 3 m/s b) 1 m/s

c) 6 m/s d) 9 m/s

85. The kinetic energy acquired by a body of mass 'M' in travelling a certain distance 'd', starting from rest, under the action of constant force is

a) Inversely proportional to $\sqrt{M}$ b) Directly proportional to M

c) Independent of M d) Directly proportional to $\sqrt{M}$

86. A mass of 1 kg is suspended by a string. It is first lifted up with an acceleration of 4.9 m/s^2 and then lowered down with same acceleration. The ratio of tensions in the string in the two cases, respectively is $g = 9.8\ m/s^2$

a) 1:3 b) 2:1

c) 3:1 d) 1:2

87. The torque of a force $F = -2\hat{i} + 2\hat{j} + 3\hat{k}$ acting on a point $r = \hat{i} + 2\hat{j} + \hat{k}$ about origin will be

a) $8\hat{i} + 5\hat{j} + 2\hat{k}$ b) $-8\hat{i} - 5\hat{j} - 2\hat{k}$

c) $8\hat{i} - 5\hat{j} + 2\hat{k}$ d) $-8\hat{i} + 5\hat{j} - 2\hat{k}$

88. A spring of spring constant ‘k’ is compressed through ‘x’ cm and is used to push a metal ball of mass ‘m’. The velocity with which the metal ball moves is

a) $x\left(\frac{m}{k}\right)^{1/2}$ b) $\frac{kx}{m}$

c) $x\left(\frac{k}{m}\right)^{1/2}$ d) $\frac{m}{kx}$

89. A lift is tied with thick iron ropes having mass ‘M’. The maximum acceleration of the lift is ‘a’ m/s^2 and maximum safe stress is ‘S’ N/m^2. The minimum diameter of the rope is
(g = acceleration due to gravity)

a) $\left[\frac{2M(g+a)}{\pi S}\right]^{1/2}$ b) $\left[\frac{2M(g-a)}{\pi S}\right]^{1/2}$

c) $\left[\frac{4M(g+a)}{\pi S}\right]^{1/2}$ d) $\left[\frac{4M(g-a)}{\pi S}\right]^{1/2}$

90. In a system of two particles of masses ‘m_1’ and ‘m_2’, the first particle is moved by a distance ‘d’ towards the centre of mass. To keep the centre of mass unchanged, the second particle will have to be moved by a distance

a) $\frac{m_1}{m_2}$d, away from the centre of mass b) $\frac{m_1}{m_2}$d, towards the centre of mass

c) $\frac{m_2}{m_1}$d, away from the centre of mass d) $\frac{m_2}{m_1}$d, towards the centre of mass

91. A block of mass ‘m’ collides with another stationary block of mass ‘2m’. The lighter block comes to rest after collision. If the velocity of first block is ‘u’, then the value of coefficient of restitution is

a) 0.8 b) 0.4

c) 0.5 d) 0.6

92. A child is sitting on a swing which performs S.H.M. It has minimum and maximum heights from ground 0.75 cm and 2 m respectively. Its maximum speed will be $\left[g = 10\frac{m}{s^2}\right]$

a) $\sqrt{1.25}$ m/s b) $\sqrt{12.5}$ m/s

c) 5 m/s d) 25 m/s

93. ‘N’ number of balls of mass ‘m’ kg moving along positive direction of x-axis, strike a wall per second and return elastically. The velocity of each ball is ‘u’ m/s. The force exerted on the wall by the balls in newton, is

a) 2mNu b) $\frac{mNu}{2}$

c) 0 d) mNu

94. A body of mass 5 kg is moving with velocity of $v = (2\hat{i} + 6\hat{j})$ m^{-1} at t = 0 s. After time t = 2 s, velocity of body is $(10\hat{i} + 6\hat{j})$, then change in momentum of body is

a) $40\hat{i}$ kg-ms^{-1} b) $20\hat{i}$ kg-ms^{-1}

c) $30\hat{i}$ kg-ms^{-1} d) $(50\hat{i} + 30\hat{j})$ kg-ms^{-1}

95. A sphere of mass ‘m’ moving with velocity ‘v’ collides head-on on another sphere of same mass which is at rest. The ratio of final velocity of second sphere to the initial velocity of the first sphere is (e is coefficient of restitution and collision is inelastic)

a) $\frac{e-1}{2}$ b) $\frac{e}{2}$

c) $\frac{e+1}{2}$ d) e

96. What is the amount of work done by a person when (i) he holds a mass of 2 kg for 5 second and (ii) he lifts the same mass through 1 meter to keep it on the top of a table? $g = 9.8\ m/s^2$

a) 4.9 J and zero b) Zero and 4.9 J

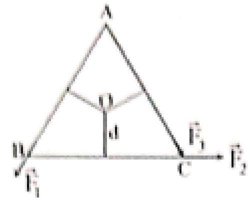
c) Zero and 19.6 J d) 19.6 J and zero

97. A stationary body explodes into two parts of masses ‘M_1’ and ‘M_2’. They move in opposite directions with velocities ‘v_1’ and ‘v_2’. The ratio of their kinetic energies is

a) $\left[\frac{M_2}{M_1}\right]$ b) $\left[\frac{M_2}{M_1}\right]^{1/2}$

c) $\left[\frac{M_2}{M_1}\right]^2$ d) $\left[\frac{M_1}{M_2}\right]^2$

98. Figure shows three forces $\overrightarrow{F_1}, \overrightarrow{F_2}$ and $\overrightarrow{F_3}$ acting along the sides of an equilateral triangle. If the total torque acting at point ‘O’ (centre of triangle) is zero, then the magnitude of ‘F_3’ is



a) $F_1 - F_2$ b) $F_1^2 - F_2^2$

c) $F_1^2 + F_2^2$ d) $F_1 + F_2$

99. A uniform metal disc of radius R is taken and out of it a disc of diameter R is cut- off from the end. The centre of mass of the remaining part will be

a) $\frac{R}{4}$ from the centre b) $\frac{R}{3}$ from the centre

c) $\frac{R}{5}$ from the centre d) $\frac{R}{6}$ from the centre

100. A light string passes over a smooth light pulley

and connects two masses m_1 and m_2 ($m_2 > m_1$) vertically at two ends. If the acceleration of the system is $\frac{1}{6}\,m/s^2$, the ratio of masses is ($g =$ acceleration due to gravity)

a) $7:9$ b) $5:7$
c) $2:3$ d) $3:4$

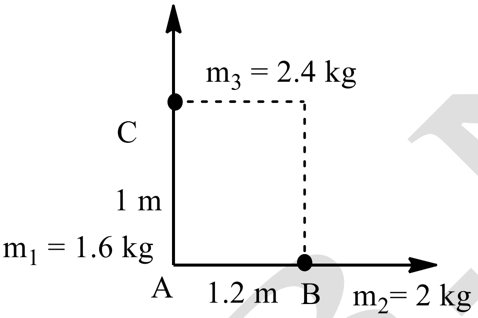
101. Two spheres of masses 2 kg and 4 kg are situated at the opposite ends of a wooden bar of length 9 m. Where will centre of mass of the system be?

a) 3 m from 2kg sphere b) 6 m from 2kg sphere
c) 6 m from 4kg sphere d) 2 m from 4kg sphere

102. A particle of mass 'm' collides with another stationary particle of mass 'M'. The particle of mass 'm' stops just after collision. The coefficient of restitution is

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

103. Three point masses m_1, m_2 and M_3 are placed at the corners of a thin massless rectangular sheet (1.2 m × 1 m) as shown. Centre of mass will be located at the point?



a) (0.8, 0.6) m b) (0.6, 0.8) m
c) (0.4, 0.4) m d) (0.5, 0.6) m

104. A man of weight 'W' is standing in a lift which is moving upwards with acceleration 'a'. The apparent weight of the man is

a) W b) $W\left(1+\frac{a}{g}\right)$
c) $W\left(1-\frac{a}{g}\right)$ d) Zero

105. A ball at rest falls vertically on ground from a height of 5m. The coefficient of restitution is 0.4. The maximum height of the ball after the first rebound is $g = 10\ m/s^2$

a) 0.6 m b) 0.2 m
c) 0.8 m d) 0.4 m

106. Two bodies of masses 1 kg and 2 kg are lying in XY - plane at (-1, 2) and (2, 4) respectively. What are the coordinates of the centre of mass?

a) $\left(1,\frac{10}{3}\right)$ b) (1,0)
c) (0,1) d) None of these

107. A body of mass 'M' moving with velocity 'V' explodes into two equal parts. If one part comes to rest and the other part moves with velocity 'v_0'. What would be the value of 'v_0'?

a) V b) 2V
c) $\frac{V}{\sqrt{2}}$ d) 4V

108. N number of balls of mass m kg moving along positive direction of X- axis, strike a wall per second and return elastically. The velocity of each ball is u m/s. The force exerted on the wall by the balls (in newton) is

a) 0 b) 2mNu
c) $\frac{mNu}{2}$ d) mNu

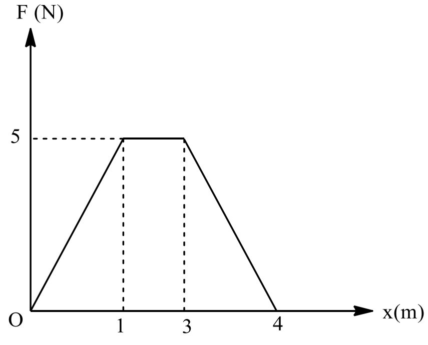
109. A smooth steel ball strikes a fixed smooth steel plate at an angle θ with the vertical. If the coefficient of restitution is e, the angle at which the rebounce will take place is

a) θ b) $\tan^{-1}\left(\frac{\tan\theta}{e}\right)$
c) e tan θ d) $\tan^{-1}\left(\frac{e}{\tan\theta}\right)$

110. A ball of mass 'm' moving with speed 'v' collides elastically with identical stationary ball which is initially at rest. After collision the first ball moves at an angle 'θ' to its initial direction and has speed '$\left(\frac{v}{3}\right)$'. The second ball moves in a straight line after collision. The speed of second ball after collision is

a) $\frac{2}{\sqrt{3}}v$ b) $\frac{4}{3}v$
c) $\frac{2\sqrt{2}}{3}v$ d) $\frac{3}{\sqrt{2}}v$

111. The force F acting on a particle is moving in a straight line as show in figure. What is the work done by the force on the 4 m of the trajectory



a) 5 J b) 10 J

c) 15 J d) 2.5 J

112. A body is suspended from a rigid support by an inextensible string of length 'L' on which another identical body of mass 'm' struck in-elastically moving with horizontal velocity $\sqrt{2gL}$. The increase in the tension in the string just after it is struck by the body is

a) 4mg b) 3mg
c) mg d) 2mg

113. A cricket ball of mass 150 g has an initial velocity
$u = (3\hat{i} + 4\hat{j})ms^{-1}$ and a final velocity
$v = (3\hat{i} + 4\hat{j})ms^{-1}$, after being hit.
The change in momentum (final momentum - initial momentum) is (in kg ms^{-1})

a) zero b) $-(0.45\hat{i} + 0.6\hat{j})$
c) $-(0.9\hat{i} + 1.2\hat{j})$ d) $-5(\hat{i} + \hat{j})\hat{i}$

114. A mass m moves with a velocity v and collides inelastically with another identical mass. After collision, the 1 st mass moves with velocity $\frac{v}{\sqrt{3}}$ *in a direction* perpendicular to the initial direction of motion . find the speed of the second mass after collision.

a) v b) $\sqrt{3}\,V$
c) $\frac{2}{\sqrt{3}}V$ d) $\frac{v}{\sqrt{3}}$

115. In system of two particles of masses m_1 and m_2, the first particle is moved by a distance d towards the centre of mass. To keep the centre of mass unchanged, the second particle will have to be moved by a distance

a) $\frac{m_2}{m_1}$d, towards the cer b) $\frac{m_1}{m_2}$d, away from the ce
c) $\frac{m_1}{m_2}$d, towards the cen d) $\frac{m_2}{m_1}$d, away from the ce

116. A gardener pushes a lawn roller through a distance 20 m. If he applied a force of 20 kg-wt in a direction inclined at 60^0 to the ground, the work done by him is

a) 1960 j b) 196 j
c) 1.96 j d) 196 kj

117. A body of mass 5kg is moving in a straight line. The relation between its displacement and time is $x = (t^3 - 2t - 10)$m. What is the force acting on it at the end of 5 second?

a) 120 N b) 80 N
c) 150 N d) 100 N

118. A wooden black of mass 'm' moves with velocity 'V' and collides with another block of mass '4m', which is at rest. After collision the block of mass 'm' comes to rest. The coefficient of restitution will be

a) 0.7 b) 0.25
c) 0.4 d) 0.5

119. Two masses 'm_a' and 'm_b' moving with velocities 'V_a' and 'V_b' opposite directions collide elastically. Alter the collision 'm_a' and 'm_b' move with velocities and 'V_b' and 'V_a' respectively, then the ratio $m_a : m_b$ is

a) $\frac{V_a + V_b}{V_a - V_b}$ b) $\frac{1}{2}$
c) 1 d) $\frac{V_a - V_b}{V_a + V_b}$

120. A ball at test falls vertically on the ground from a height of 5m. The coefficient of restitution is 0.4. The maximum height of the ball after the first rebound is [$g = 10\ ms^{-2}$]

a) 1 m b) 0.8 m
c) 4 m d) 2 m

121. A vehicle accelerates from speed 'V' to '2V'. Work done during this is

a) Less than the work done in accelerating it from rest to V
b) Four times as the work done in accelerating it from rest to V
c) Same as the work done in accelerating it from rest to V
d) Three times as work done in accelerating it from rest to V

122. A mass M moving with velocity 'v' along x axis collides and sticks to another mass 2M which is moving along Y-axis with velocity 3v. After collision, the velocity of the combination is

a) $\frac{v}{3}\hat{i} - 2v\hat{j}$ b) $v\hat{i} + \frac{v}{3}\hat{j}$
c) $\frac{2v}{3}\hat{i} + \hat{j}$ d) $\frac{v}{3}\hat{i} + 2v\hat{j}$

123. A block of mass 'M' is pulled along a smooth horizontal surface with a rope of mass 'm' by force 'F'. The acceleration of the block will be

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

124. A metal sphere is hanging from the ceiling of a vehicle. If the vehicle is moving along the horizontal road with uniform acceleration 'a' then the suspended thread of the sphere gets inclined to the vertical at an angle 'θ'. The value of acceleration 'a' is (g = acceleration due to gravity)

a) g		b) g cos θ
c) g sin θ		d) g tan θ

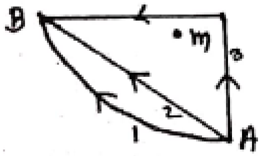
125. Consider a system of two particles having masses 'm_1' and 'm_2'. If the particle of mass m_1 is pushed towards the centre of mass of the particles through a distance 'd', by what distance particle of mass m_2 move so as to keep the centre of mass of particles at the original position?
a) $\frac{m_2}{m_1} \times d$		b) $\frac{m_1}{m_1 + m_2} \times d$
c) $\frac{m_1}{m_2} \times d$		d) d

126. A smooth sphere of mass 'M' moving with velocity 'u' directly collides elastically with another sphere of mass 'm' at rest. After collision, their final velocities are V' and V respectively. The value of V is given by
a) $\frac{2u}{1 + \frac{m}{M}}$		b) $\frac{2u}{1 + \frac{M}{m}}$
c) $\frac{2uM}{m}$		d) $\frac{2um}{M}$

127. A body of mass 2kg is acted upon by two each of magnitude 1N and inclined at 60^0 with each other. The acceleration of the body in$\frac{m}{s}$ is$\cos 60^0 = 0.5$
a) $\sqrt{0.75}$		b) $\sqrt{0.35}$
c) $\sqrt{0.65}$		d) $\sqrt{0.20}$

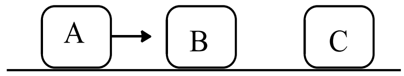
128. A ball falls in the downward direction from height 'h' with initial velocity V. It collides with ground, loses $\left(\frac{3}{4}\right)$ th of energy and comes back to the same height. The initial velocity 'V' is (g = acceleration due to gravity)
a) $\sqrt{gh}$		b) $\sqrt{2gh}$
c) $\sqrt{3gh}$		d) $\sqrt{6gh}$

129. If W_1, W_2 and W_3 represent the work done in moving a particle from A to B along three different paths 1, 2 and 3 (as shown in figure) in the gravitational field of the point mass 'm'. Find the correct relation between 'W_1', 'W_2' and 'W_3'.



a) $W_1 < W_3 < W_2$		b) $W_1 > W_3 > W_2$
c) $W_1 = W_2 = W_3$		d) $W_1 < W_2 < W_3$

130. Three identical blocks A, B and C are placed on horizontal frictionless surface. The blocks B and C are at rest. But A is approaching towards B with a speed $10ms^{-1}$. The coefficient of restitution for all collisions is 0.5. The speed of the block C just after collision is



a) 5.6 ms^{-1}		b) 6 ms^{-1}
c) 8 ms^{-1}		d) 10 ms^{-1}

131. Centre of mass is a point
a) Which is the geometric centre of a body		b) Which is the origin of reference frame
c) Where the whole mass of the body is supposed to be concentrated		d) From which distances of all particles are same

132. A batsman hits a ball of mass 0.2kg straight towards the bowler without changing its initial speed of 6 m/s. What is the impulse imparted to the ball?
a) 3.2 N-s		b) 1.6 N-s
c) 4 N-s		d) 2.4 N-s

133. A ball of mass 'm' falls height 'h' on a floor for which the coefficient of restitution is 'e'. After two rebounds, the height attained by the ball is
a) $\sqrt{eh}$		b) eh
c) e^2h		d) e^4h

134. In carbon monoxide molecules, the carbon and the oxygen atoms are separated by distance 1.2×10^{-10} m. The distance between the particles
a) 0.48×10^{-10} m		b) 0.51×10^{-10}m
c) 0.56×10^{-10} m		d) 0.69×10^{10}m

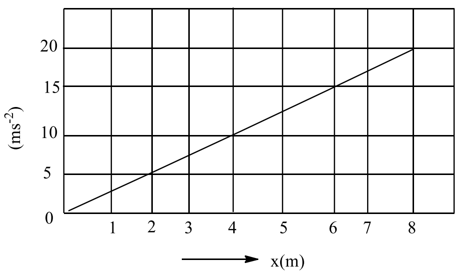
135. A force $F = (10 + 0.5x)$N acts on a particle in the x-direction. The work done by the force in displacing the particle from x = 0 to x = 2 metre is
a) 42 J		b) 63 J
c) 21 J		d) 31.5 J

136. A bullet of mass 20 gram is fired from a gun of mass 2.5 kg with a speed of 750 m/s. The magnitude of recoil velocity of the gun is
a) 6 m/s		b) 18 m/s
c) 12 m/s		d) 3 m/s

137. A door 1.2 m wide requires a force of 1 N to be applied perpendicular at the free end to open or close it. The perpendicular force required at a point 0.2 m distant from the hinges for opening or closing the door is
a) 6.0 N		b) 3.6 N

c) 1.2 N
d) 2.4 N

138. A 10 kg brick moves along X - axis. Its acceleration as a function of its position is shown in figure. What is the net work performed on the brick by the force causing the acceleration as the brick moves from x = 0 to x = 8.0 m ?



a) 4 J
b) 8 J
c) 2 J
d) 1 J

139. 'n' number of balls each having mass 'm' and velocity 'u' hit a wall elastically and normally in 2 seconds. The force exerted by them on the wall is

a) num
b) $\frac{1}{2}$num
c) −num
d) $-\frac{1}{2}$num

140. How much work must be done by a force on 50 kg body in order to accelerate it in the direction of force from rest to 20 ms^{-1} in 10 s ?

a) 10^{-3} J
b) 10^{4} J
c) 2×10^{3} J
d) 4×10^{4} J

141. The collision of two balls of equal mass takes place at the origin of coordinates. Before collision, the components of velocities are (v_x = - 50 cms^{-1} and v_y = 0) and (v_x = - 40 cms $^{-1}$ and = 30 cms^{-1}). The first ball comes to rest after collision.
The velocity (components v_x and $v_{y,}$ = respectively) of the second ball are

a) 10 cms^{-1} and 30 cms^{-1}
b) 30 cms^{-1} and 10 cms^{-1}
c) 5 cms^{-1} and 15 cms^{-1}
d) 15 cms^{-1} and 5 cms^{-1}

142. The torque of a force F = - 6î acting at a point r = -4j about origin will be

a) -24 $\hat{k}$
b) 24 $\hat{k}$
c) 24 $\hat{j}$
d) 24 $\hat{i}$

143. 10^4 small balls, each weighing 1 gram strike 1 cm^2 area per second with a velocity 100 m/s in perpendicular direction and rebound with the same velocity. The value of pressure on the surface will be

a) 2×10^7 N/m^2
b) 10^7 N/m^2
c) 2×10^3 N/m^2
d) 7×10^5 N/m^2

144. A bullet is fired from the gun. It hits the solid block resting on a frictionless surface, gets embedded into it and both move jointly. In this process,

a) Only kinetic energy is conserved
b) Both momentum and kinetic energy are not conserved
c) Both momentum and kinetic energy are conserved
d) Only momentum is conserved

145. A black of mass m moving on a frictionless surface at speed v collides elastically with a black of same mass, initially at rest. Now, the first block moves at an angle θ with its initial direction and has speed v_1. The speed of the second of the block after collision is

a) $\sqrt{v_1^2 - v^2}$
b) $\sqrt{v^2 - v_1^2}$
c) $\sqrt{v^2 + v_1^2}$
d) $\sqrt{v - v_1}$

146. A ball kept at 20 m height falls freely in downward direction vertically and hits the ground. The coefficient of restitution is 0.4. After the first rebound the upward velocity is g = 10 m/s^2

a) 4 m/s
b) 8 m/s
c) 16 m/s
d) 12 m/s

147. If there is a change of angular momentum from 1 J-s to 4J - s in 4 s, then the torque

a) $\frac{5}{4}$ J
b) $\frac{3}{4}$ J
c) 1 J
d) $\frac{4}{3}$ J

148. A force $(3\hat{i} + 4\hat{j})$ N acts on a body and displaces it by $(3\hat{i} + 4\hat{j})$ m. The work done by the force is

a) 10 j
b) 12 j
c) 16 j
d) 25 j

149. A body of mass 'm' begins to move under the action of time dependent force $\vec{F} = (t\hat{i} + 2t^2\hat{j})$N where î and ĵ are unit vectors along x and y axis respectively. The power developed by the force in watt at time 't' is

a) $\left(\frac{t^3}{3m} + \frac{3t^3}{2m}\right)$
b) $\left(\frac{t^2}{m} + \frac{4t^5}{3m}\right)$
c) $\left(\frac{t^3}{2m} + \frac{3t^4}{2m}\right)$
d) $\left(\frac{t^3}{2m} + \frac{4t^5}{3m}\right)$

150. In one dimensional collision between two identical particles A and B, where B is stationary and A has momentum p before impact. During impact B gives an impulse J to A. Then, coefficient of restitution between the two is

a) $\frac{2J}{p} - 1$ b) $\frac{2J}{p} + 1$

c) $\frac{J}{p} + 1$ d) $\frac{J}{p} - 1$

151. A metal wire has cross-sectional area 'A' and elastic limit 'E'. The maximum upward acceleration (a) is given to a mass 'm' of elevator supported by the cable of metal wire, so that stress does not exceed half the elastic limit. The mass of the elevator is (g = acceleration due to gravity)

a) $\frac{2(g+a)}{EA}$ b) $\frac{EA}{2(g+a)}$

c) $\frac{EA}{2(g-a)}$ d) $\frac{2(g-a)}{EA}$

152. A block of mass 'm' moving along a straight line with constant velocity $3\overline{v}$ collides with another block of same mass at rest. They stick together and move with common velocity. The common velocity is

a) $\frac{3\overline{v}}{2}$ b) $3\overline{v}$

c) $\overline{v}$ d) $2\overline{v}$

153. The torque of a force $F = -3\,\hat{i} + \hat{j} + 5\,\hat{k}$ acting on a point $r = 7\hat{i} + 3\hat{j} + \hat{k}$ about origin will be

a) $14\hat{i} - 38\hat{j} + 16\hat{k}$ b) $4\hat{i} + 4\hat{j} + 6\hat{k}$

c) $-14\hat{i} + 38\hat{j} - 16\hat{k}$ d) $-21\hat{i} + 3\hat{j} + 5\hat{k}$

154. A gardener pushes a lawn roller through a distance 20 m. If he applies a force of 30 kg-wt in a direction inclined at 60^0 to the ground, the work done by the gardener in pushing the roller is

$$\left[g = 9.8\frac{m}{s^2}, \sin 30^0 = \cos 60^0 = \frac{1}{4}, \cos 30^0 = \sin 60^0 = \frac{\sqrt{3}}{2}\right]$$

a) 3940 J b) 2460 J

c) 2940 J d) 3640 J

155. The centre of mass of a system of particles done not depend on

a) masses of the particles b) internal force on the particles

c) position of the particles d) relative distance between the particles

156. A body of mass 6 kg is acted upon by a force , so that its velocity changes from 3 ms^{-1}, then change in momentum is

a) 48 N-s b) 24 N-s

c) 30 N-s d) 12 N-s

157. A body of mass 'M' begins to move under the action of time dependent force $\vec{F} = (t\hat{i} + 2t^2\hat{j})N$ where $\hat{i}$ and $\hat{j}$ are unit vectors along X and Y axis respectively. The power developed by the force in watt at time t is

a) $\left(\frac{t^2}{3m} + \frac{3t^4}{4m}\right)$ b) $\left(\frac{t^3}{m} + \frac{4t^5}{2m}\right)$

c) $\left(\frac{t^2}{2m} + \frac{3t^4}{5m}\right)$ d) $\left(\frac{t^3}{2m} + \frac{4t^5}{3m}\right)$

158. A body of mass '4m' lying in x – y plane suddenly explodes into three parts. Two parts each of mass 'm' move with same speed 'v' as shown in figure. The total kinetic energy generated due to explosion is

$$\left(\sin 45^0 = \cos 45^0 = \frac{1}{\sqrt{2}}\right)$$

a) mv^2 b) $2mv^2$

c) $\frac{1}{2}mv^2$ d) $\frac{3}{2}mv^2$

159. A sphere of mass 'm' moving with velocity 'v' collides head-on with another sphere of same mass which is at rest. The ratio of final velocity of second sphere to the initial velocity of the first sphere is (e is coefficient of restitution and collision is inelastic)

a) $\frac{e+1}{2}$ b) e

c) $\frac{e-1}{2}$ d) $\frac{e}{2}$

160. Two perfectly elastic particles A and B of equal masses travelling along the line joining them, with velocities 15 ms^{-1} and 10 ms^{-1}. After collision, their velocities will be

a) 10 ms^{-1},10 ms^{-1} b) 15 ms^{-1},15 ms^{-1}

c) 10 ms^{-1}, 15 ms^{-1} d) 15 ms^{-1},10 ms^{-1}

161. A 4 kg mass and a 1 kg mass are moving with equal energies. The ratio of the magnitude of their momenta is

a) 4: 1 b) 1: 1

c) 1: 2 d) 2: 1

162. A cricket ball of mass 150 g moving with a velocity of 12 m/s is turned back with a velocity of 20 m/s on hitting the bat. The force of the blow lasts for 0.01 s. The force exerted on the ball by the bat is

a) 480 N b) 240 N

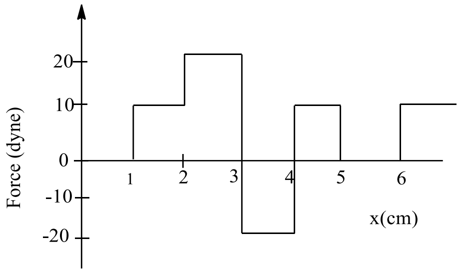
c) 120 N d) 360 N

163. A constant force acting on a body of mass 3.0 kg changes its speed from 2.0 m/s to 3.5 m/s in 25 s. The direction of motion of the body remains unchanged. What is the magnitude

and direction of the force?

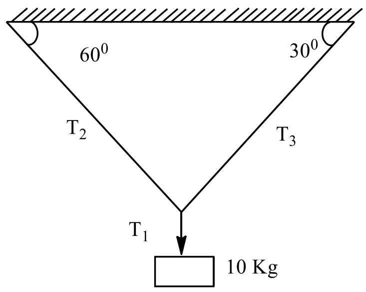
a) 0.018 N, along the direction of motion
b) 0.18 N, opposite to the direction of motion
c) 0.28 N, along the direction of motion
d) 0.28 N, opposite to the direction of motion

164. The relationship between force and position is shown in figure given (in the dimensional case). The work done by the force in displacing a body from $x = 1$ cm to $x = 5$ cm is



a) 20 erg
b) 60 erg
c) 70 erg
d) 700 erg

165. A block of mass 10 kg is suspended by three strings as shown in the figure. The tension T_2 is



a) 100 N
b) $\frac{100}{\sqrt{3}}$ N
c) $\sqrt{3} \times 100$ N
d) $50\sqrt{3}$ N

166. A block of mass 'm' moving on a frictionless horizontal surface collides with a spring of spring constant 'K' and compresses it through a distance 'x'. The maximum momentum of the block after collision is

a) $\sqrt{mK}\,x$
b) mx^2/K
c) Zero
d) $Kx^2/2m$

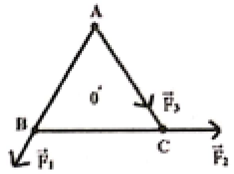
167. Two masses 'm_1' and 'm_2' moving with velocities 'v_1' and 'v_2' in opposite directions collide elastically and after collision 'm_1' and 'm_2' move with velocity 'v_2' and 'v_1' respectively, the ratio v_2/v_1 is

a) 0.5
b) 0.25
c) 1
d) 0.75

168. Let a force $\vec{F} = -F\hat{k}$ acts on the origin of Cartesian frame of reference. The moment of force about a point $(1, -1)$ will be

a) $F(\hat{i} - \hat{j})$
b) $F(\hat{i} + \hat{j})$
c) $-F(\hat{i} - \hat{j})$
d) $-F(\hat{i} + \hat{j})$

169. Figure shows three forces $\vec{F_1}, \vec{F_2}$ and $\vec{F_3}$ acting along the sides of an equilateral triangle. If the total torque acting at point 'O' (centre of the triangle) is zero then the magnitude of $\vec{F_3}$ is



a) $F_1 + F_2$
b) $F_1 - F_2$
c) $\frac{F_1 - F_2}{2}$
d) $\frac{F_1}{F_2}$

170. A metal ball released from height 'h' makes perfectly elastic collision with ground. The frequency of periodic vibratory motion is (g = acceleration due to gravity)

a) $\frac{1}{2}\sqrt{\frac{2h}{g}}$
b) $\frac{1}{2\pi}\sqrt{\frac{g}{h}}$
c) $\frac{1}{2\pi}\sqrt{\frac{2h}{g}}$
d) $\frac{1}{2}\sqrt{\frac{g}{2h}}$

171. The work done by a force on body of mass 5 kg to accelerate it in the direction of force from rest to 20 m/s^2 in 10 second is

a) 10^{-3} J
b) 4×10^{-3} J
c) 2×10^3 J
d) 10^{-3} J

172. A smooth sphere of mass M moving with velocity u directly collides elastically with another sphere of mass m at rest. After collision. their final velocities are v' and v, respectively. The value of v is

a) $\frac{2uM}{m}$
b) $\frac{2um}{M}$
c) $\frac{2u}{1+\frac{m}{M}}$
d) $\frac{2u}{1+\frac{M}{m}}$

173. A force of 26 N is acting on a body of mass 2 kg in the x-y plane. Force is directed at an angle $\cos^{-1}\left(\frac{12}{13}\right)$ with x-axis. The component of acceleration along y-axis is

a) 5 m/s^2
b) 8 m/s^2
c) 3 m/s^2
d) 12 m/s^2

174. A particle of mass 'm' collides with another stationary particle of mass 'M'. A particle of mass 'm' stops just after collision. The coefficient of restitution is

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

175. A force of $F = 2x^2 - x + 4$ acts on a body of mass 3 kg and displaces it from $x = 0$ to $x = 3$m. The work done by the force is

a) 30.5 J b) 35.5 J
c) 15.5 J d) 25.5 J

176. The weight of a man in a lift moving upwards with an acceleration 'a' is 620 N. When the lift moves downwards with the same acceleration, his weight is found to be 340 N. The real weight of the man is

a) 620 N b) 680 N
c) 380 N d) 480 N

177. The dimensions of torque are same as that of

a) Pressure b) Impulse
c) Moment of force d) Acceleration

178. In a system of two particles of masses 'm_1' and 'm_2', the second particle is moved by a distance 'd' towards the centre of mass. To keep the centre of mass unchanged, the first particle will have to be moved by a distance

a) $\frac{m_1}{m_2}d$, away from the centre of mass
b) $\frac{m_2}{m_1}d$, towards the centre of mass
c) $\frac{m_2}{m_1}d$, away from the centre of mass
d) $\frac{m_1}{m_2}d$, towards the centre of mass

179. A weight is suspended from the mid-point of a rope, whose ends are at the same level. In order to make the rope perfectly horizontal, the force applied to each of its ends must be

a) less than w b) equal to w
c) equal to 2w d) infinitely large

N.B.Navale

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PHYSICS

LAWS OF MOTION

: ANSWER KEY :

1)	c	2)	c	3)	d	4)	b	93)	a	94)	a	95)	c	96)	c
5)	b	6)	b	7)	b	8)	c	97)	a	98)	d	99)	d	100)	b
9)	b	10)	a	11)	a	12)	a	101)	b	102)	c	103)	c	104)	a
13)	d	14)	a	15)	c	16)	d	105)	c	106)	a	107)	b	108)	b
17)	a	18)	a	19)	a	20)	a	109)	b	110)	c	111)	c	112)	d
21)	a	22)	b	23)	a	24)	a	113)	c	114)	c	115)	c	116)	a
25)	c	26)	c	27)	b	28)	a	117)	c	118)	b	119)	c	120)	b
29)	d	30)	b	31)	c	32)	b	121)	d	122)	d	123)	c	124)	d
33)	b	34)	b	35)	c	36)	d	125)	c	126)	a	127)	a	128)	d
37)	b	38)	c	39)	a	40)	b	129)	c	130)	a	131)	c	132)	d
41)	d	42)	d	43)	c	44)	a	133)	d	134)	d	135)	c	136)	a
45)	c	46)	b	47)	c	48)	d	137)	a	138)	b	139)	a	140)	b
49)	d	50)	a	51)	a	52)	d	141)	a	142)	b	143)	a	144)	d
53)	b	54)	c	55)	b	56)	d	145)	b	146)	b	147)	b	148)	d
57)	b	58)	b	59)	c	60)	c	149)	d	150)	a	151)	b	152)	a
61)	a	62)	c	63)	a	64)	c	153)	a	154)	c	155)	b	156)	d
65)	a	66)	c	67)	d	68)	d	157)	d	158)	d	159)	a	160)	c
69)	d	70)	b	71)	c	72)	a	161)	d	162)	a	163)	a	164)	a
73)	b	74)	c	75)	c	76)	a	165)	d	166)	a	167)	c	168)	b
77)	d	78)	d	79)	c	80)	a	169)	a	170)	d	171)	d	172)	c
81)	c	82)	a	83)	c	84)	b	173)	a	174)	d	175)	d	176)	d
85)	c	86)	c	87)	b	88)	c	177)	c	178)	b	179)	d		
89)	c	90)	b	91)	c	92)	c								

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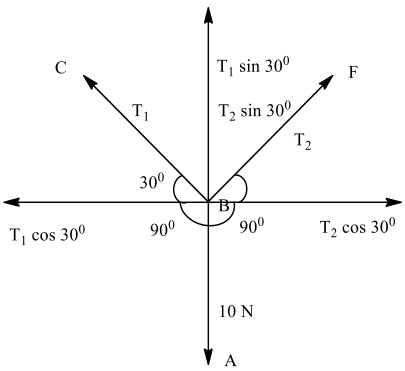
LAWS OF MOTION

: HINTS AND SOLUTIONS :

Single Correct Answer Type

1 **(c)**

As shown in figure



$T_1 \cos 30^0 = T_2 \cos 30^0$

$\therefore \quad T_1 = T_2 = T \quad$ (let)

Again, $T_1 \sin 30^0 + T_2 \sin 30^0 = 10$ and $2T \sin 30^0 = 10$

$\Rightarrow \quad 2T.\frac{1}{2} = 10$

$\Rightarrow \quad T = 10\text{ N}$

Thus, the tension in the sections BC and BF are 10 N and 10 N, respectively.

2 **(c)**

$v^2 = u^2 + 2ad$

$v^2 = 2 \times \frac{F}{m}.d$

$E = \frac{1}{2}mv^2 = \frac{1}{2}m \times 2\frac{F}{m}d = Fd$

3 **(d)**

τ required to open/close the door will remain constant.

$r_1 \times F_1 = r_2 \times F_2$

$1.6 \times 1 = 0.4 \times F_2 \Rightarrow F_2 = 4\text{ N}$

4 **(b)**

Given, $F \propto \frac{1}{v}$

$F = \frac{\lambda}{V}$, where $\lambda =$ constant,

$\because \quad ma = m\frac{dv}{dt} = \frac{\lambda}{v} \Rightarrow m\int_0^V V\,dv = \lambda \int_0^t dt$

$\Rightarrow \quad m\left|\frac{v^2}{2}\right|_0^V = \lambda\,|t|_0^t \Rightarrow \frac{1}{2}mv^2 = k = \lambda t$

$\because \quad K \propto t$

5 **(b)**

$W = NS\cos\theta$

Angle between the normal reaction N and the displacement S is 90^0. Hence the work done will be zero.

6 **(b)**

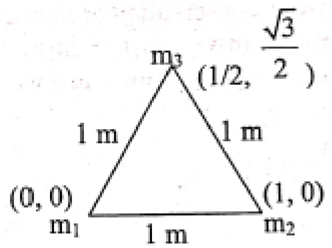
If k is the kinetic energy and p is the momentum then

$k = \frac{p^2}{2m}$

$\therefore p^2 = 2mk$

If k is constant, then $p^2 \propto m$

7 **(b)**



$x_{cm} = \frac{m_1x_1 + m_2x_2 + m_3x_3}{m_1 + m_2 + m_3}$

$m_1 = m_2 = m_3$

$$\therefore x_{cm} = \frac{1 \times 0 + 1 \times 1 + \frac{1}{2} \times 1}{1 + 1 + 1} = \frac{1.5}{3} = \frac{1}{2}$$

$$y_{cm} = \frac{m_1 y_1 + m_2 y_2 + m_3 y_3}{m_1 + m_2 + m_3}$$

$$= \frac{1 \times 0 + 1 \times 0 + 1 \times \sqrt{3}/2}{1 + 1 + 1}$$

$$= \frac{1}{2\sqrt{3}} = \left(\frac{1}{2}, \frac{1}{2\sqrt{3}}\right)$$

8 **(c)**

Kinetic energy $k = \frac{p^2}{2m}$

Where p is the momentum

$\therefore p^2 = 2mk$ or $p = \sqrt{2mk}$

$\therefore p \propto \sqrt{m}$

Hence bodies having greater mass will have greater momentum. Hence p and Q will have greater momentum compared to R.

9 **(b)**

Particle is initially at rest. Hence by law of conservation of momentum

$m_1 v_1 + m_2 v_2 = 0$

$\therefore m_1 v_1 = -m_2 v_2$

Their momenta are equal and opposite.

$\mathrm{K.E.}\,(K) = \frac{P^2}{2m}$

$\therefore K \propto \frac{1}{m}$; if P is constant

$\therefore \frac{E_1}{E_2} = \frac{m_2}{m_1}$

10 **(a)**

Since the particle was initially at rest its momentum was zero. Hence the net momentum of the two fragments should be zero. Hence the momentum of the two fragments must be equal to in magnitude but opposite in direction.

Kinetic energy $E = \frac{1}{2}mv^2 = \frac{p^2}{2m}$ where p is the momentum

or $p^2 = 2mE$

If p is constant then $m_1 E_1 = m_2 E_2$ or $\frac{E_1}{E_2} = \frac{m_2}{m_1}$

11 **(a)**

According to law of conservation of momentum

$mv = (m + M)v'$

$\therefore v' = \frac{m}{m + M} v$

12 **(a)**

$T_2 = (M_1 + M_2)a$

$T_1 = M_1 a$

$\therefore \frac{T_1}{T_2} = \frac{M_1}{M_1 + M_2}$

13 **(d)**

impulse received by m

$$J = m(v_f - v_i)$$

$$= m\,(-2\,\hat{i} + \hat{j} - 3\,\hat{i} - 2\,\hat{j})$$

$$= m(-5\,\hat{i} - J)$$

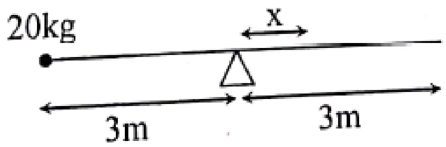
a. Impulse received by M = -J = m $(5\,\hat{i} + \hat{j})$

b. Mv = m $(5\,\hat{i} + \hat{j})$

or $v = \frac{m}{M}(5\,\hat{i} + \hat{j}) = \frac{1}{13}(5\,\hat{i} + \hat{J})$

c. e= (relative velocity of separation / relative velocity of approach) in the direction of $-\hat{J}$ = 11/17

15 **(c)**



$\therefore 20 \times 3 = x \times 30$

$\therefore x = \frac{60}{30} = 2$ m

16 **(d)**

$e = \sqrt{\frac{h_1}{h}}$

$\therefore e^2 = \frac{h_1}{h}$ or $h_1 = e^2 h$

similarly, $h_2 = e^2 h_1 = e^4 h$

17 **(a)**

Initial kinetic energy $k_1 = \frac{1}{2}mu_1^2$

Final kinetic energy $k_2 = \frac{1}{2}mu_2^2 = \frac{1}{2}m(2u_1^2)$

$$= \frac{1}{2}(4mu^2)$$

$\therefore k_2 - k_1 = \frac{3}{2}mu^2$

Change in K. E. is work done

power $p\frac{\text{Work done}}{t} = 3mu^2/2t$

18 **(a)**
By law of conservation of momentum

$m_1v_1 + m_2v_2 = m_1v_2 + m_2v_1$

$\therefore (m_1 - m_2)v_1 = (m_1 - m_2)v_2$

$\therefore v_1 = v_2$

$\therefore \frac{v_2}{v_1} = 1$

19 **(a)**
The mass M is initially at rest, hence its initial momentum is zero. By law or conservation of momentum, the net momentum of the three pieces should be zero.

$p_1 = \frac{3M}{4}$ and $p_2 = \frac{5M}{4}$

Three are at right angles to each other.

Their resultant will be $p = \sqrt{p_1^2 + p_2^2}$

$= \sqrt{\left(\frac{3M}{4}\right)^2 + \left(\frac{4M}{4}\right)^2} = \frac{M}{4}\sqrt{3^2 + 4^2} = \frac{M}{4\sqrt{25}} = \frac{5M}{4}$

The momentum of the third piece will be equal and opposite to this.

The mass of the third piece will be $\frac{M}{2}$

If its velocity is V, then

$\frac{M}{2}.V = \frac{5M}{4}$

$\therefore V = 2.5\ ms^{-1}$

20 **(a)**
Let the velocity of block of mass 2 m after the collision be v', then from conservation of momentum,

$$mv = 2mv' \Rightarrow v' = \frac{v}{2}$$

Now, the coefficient of restitution,

$$e = \frac{\text{velocity ofseparation}}{\text{velocityof approach}}$$

$$= \frac{V'}{V} = \frac{\frac{V}{2}}{V} = \frac{1}{2} = 0.5$$

21 **(a)**
$m_1V_1 - m_2V_2 = 0$

$\therefore V_2 = -\frac{m_1V_1}{m_2}$

22 **(b)**
Work done,

$W = \int_{-a}^{+a} Fdy = \left[\frac{Ay^3}{3} + \frac{By^2}{2} + Cy\right]_{-a}^{+a} = \frac{2Aa^3}{3} + \ 2Ca$

23 **(a)**
acceleration $a = \frac{F}{m}$

At time t, velocity $v = at = \frac{Ft}{m}$

Kinetic energy $= \frac{1}{2}mv^2$

$= \frac{1}{2}m\frac{F^2t^2}{m^2} = \frac{1}{2}\frac{F^2t^2}{m}$

24 **(a)**
Since the particle is initially at rest, its initial momentum is zero. Since no external force is acting on it, its momentum should remain constant.

$\therefore m_1v_1 + m_2v_2 = 0$

$\therefore m_1v_1 = -m_2v_2$

Their momenta will be same in magnitude (but opposite in direction)

Kinetic energy (k) is given by

$k = \frac{p^2}{2m}$

$\therefore p = \sqrt{2mk} =$

$\therefore \sqrt{2m_1k_1} = \sqrt{2m_2k_2}$

25 **(c)**
Torque, $\tau = r \times F = [(0-3)\,\hat{i} + (2-0)\,\hat{j} + (0-0)\hat{k}] \times [20\,\hat{i}]$

$= [-3\,\hat{i} + 2\,\hat{j}] \times [20\,\hat{i}]$

$= -40\hat{k}$

$|\tau| = 40\ \text{N} - \text{m}$

26 **(c)**
Theoretical equation

27 **(b)**
$m_1 = m, u_1 = v, \vartheta_1 = 0$

$m_2 = 4m, u_2 = 0, \vartheta_2 = ?$

By law of conservation of momentum we have

$m_1u_1 + m_2u_2 = m_1\vartheta_1 + m_2\vartheta_2$

$\therefore mv + 0 = 0 + 4m_2\vartheta_2$

$\therefore v = 4\vartheta_2 \text{ or } \vartheta_2 = \frac{v}{4}$

Coefficien of restitution $e = \frac{\vartheta_2 - \vartheta_1}{u_1 - u_2} = \frac{\frac{v}{4} - 0}{v - 0} = \frac{1}{4}$

$= 0.25$

28 **(a)**
Given, force, $F = (2\hat{i} + 3\hat{j})$ N

Displacement , $ds = (dx\,\hat{i} + dy\hat{j})\ dz\,\hat{k}$

Work done, $W = \int F \,.\, ds = \int (2dx + 3dy)$

Also, $3y + kx = 5 \Rightarrow \frac{3dy}{dx} + k = 0$

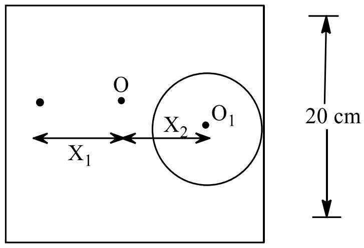
$\Rightarrow \quad 3dy = -\,kdx \Rightarrow W = \int (2dx - kdx) = 0$

$\Rightarrow \quad 2x = kx \Rightarrow k = 2$

29 **(d)**
As, here, $A_1x_1 = A_2x_2$

or $\quad x_1 = \frac{A_2}{A_1} . x_2$

$= \frac{\left(\frac{\pi}{4}\right)(8)^2}{(20)^2} \times 6$



$= 0.7539$ cm from O

30 **(b)**
$h = \frac{1}{2}gt^2$

$\therefore t = \sqrt{\frac{2h}{g}}$

$\therefore$ Time is same for all

Acceleration is equal to g for all

p = mV, Since m is different, momentum p will be different for all.

31 **(c)**
Angular momentum of the bullet about the pivoted end of the rod is $L = mVL$

The angular momentum of the system just after the collision is

$$L' = \frac{ML^2}{3}\omega + mL^2\omega = \left(\frac{M}{3} + m\right)L^2\omega$$
$$= \left(\frac{M + 3m}{3}\right)L^2\omega$$

$\therefore$ By law of conservation of angular momentum

$L' = L$

$\therefore \left(\frac{M + 3m}{3}\right)L^2\omega = mVL$

$\therefore \omega = \frac{3mV}{(M + 3m)L}$

32 **(b)**
Initial kinetic energy
$k_1 = \frac{1}{2}m_1u_1^2 = \frac{1}{2} \times 2 \times (10)^2 = 100$ J
By law of conservation of momentum
$m_1u_1 + m_2u_2 = (m_1 + m_2)v$

$\therefore v = \dfrac{m_1u_1 + m_2u_2}{m_1 + m_2}$

$= \dfrac{2 \times 10 + 0}{2 + 3} = \dfrac{20}{5} = 4\dfrac{m}{s}$

$\therefore$ Final kinetic energy $k_2 = \dfrac{1}{2}(m_1 + m_2)v^2$

$= \dfrac{1}{2} \times 5 \times (4)^2 = \dfrac{5 \times 16}{2} = 40\ J$

$\therefore$ Loss of kinetic energy $= k_1 - k_2 = 100 - 40$

$= 60\ J$

33 **(b)**

According to conservation of linear momentum

$Mu + 0 = Mv + 0$

u and v are respective initial and final velocities of m and M

$\therefore e = \dfrac{v}{u} = \dfrac{m}{M}$

34 **(b)**

KE is constantly increasing

$\therefore \frac{1}{2}mv^2 =$ constantly increasing

$v^2 =$ constantly increasing

$\therefore$ acceleration = constant and positive

$\therefore$ force is constant and greater than zero.

35 **(c)**

$F = -5i - 7j + 3k$

$S = 3i - 2j + ak$

$14 = -15 + 14 + 3a$

$a = \dfrac{15}{3} = 5$

36 **(d)**

Since the balls hit elastically, they will rebound with the same velocity. Hence the change in momentum for each collision is$-(-mv) = 2mv$

Since n balls hit per second, the change in momentum per second is 2nmv. This is equal to force.

37 **(b)**

$E = \dfrac{1}{2}mv^2 = \dfrac{p^2}{2m}$

$\therefore p^2 \propto m$

$p \propto \sqrt{m}$

$\therefore$ heavy body has greater momentum.

38 **(c)**

$W = 49\ N$

$\therefore m = \dfrac{W}{g} = \dfrac{49}{9.8} = 5\ kg$

$W' = W - ma = 49 - 5 \times 5 = 49 - 25 = 24\ N$

40 **(b)**

Initial momentum $P_1 = mV$

$= 20 \times 10^{-3}\ kg \times 200\ m/s$

Final momentum $= 0$

Change in momentum $= 4\ kg\ m/s$

Impulse = change in momentum $= 4\ kg\ m/s$

Force $= \dfrac{\text{Impulse}}{\text{time}} = \dfrac{4Ns}{\left(\frac{1}{50}\right)s} = 200\ N$

41 **(d)**

Total upward force $=2\left(\frac{mg}{2}\right) = mg$.

(weight of man is balance by total tension acting upwards)

Total downward force is also mg.

$\therefore \qquad F_{net} = 0 = a_{net}$

42 **(d)**

F = rate of change of momentum

$= 25 \times 10^{-3}\ kg/s \times 400$

$= 10\ N$

43 **(c)**

If u is the initial velocity and d is the distance

then $u^2 = 2ad$ ... (i)

Where a is the retardation

If m is increase to 1.4 m, and the retarding force remains same, then the retardation becomes $\frac{a}{1.4}$

$\therefore u^2 = \dfrac{2ad'}{1.4}$ ... (ii)

By (i)and (ii)

$$2ad = \frac{2ad'}{1.4}$$

$$\therefore d' = 1.4d$$

44 **(a)**

Area under the F-t graph gives change in momentum. Since the body is initially at rest, it gives the momentum of the body after 1 second.

$$\text{Area} = 10 \times 0.5 + 20 \times 0.5$$

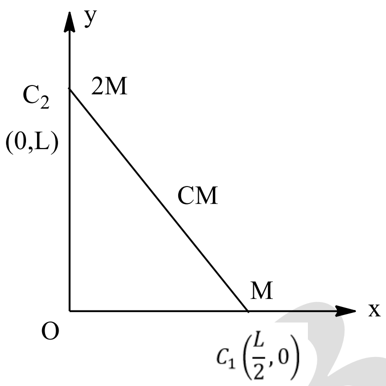
$$= 5 + 10 = 15\ \text{N} - \text{s}$$

$$\therefore mV = 15\ \text{N} - \text{s}$$

$$V = \frac{15}{m} = \frac{15}{3} = 7.5\ \text{m/s}$$

45 **(c)**

As rods are uniform, therefore centre of mass of both rods will be at their geometrical centres. The coordinates of CM of first rod C_1 are $\left(\frac{L}{2}, o\right)$ and second rods C_2 are $(0, L)$

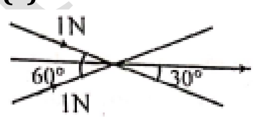


$$\therefore \quad x_{CM} = \frac{M\left(\frac{L}{2}\right) + 2M(0)}{M + 2M} = \frac{L}{6}$$

$$\text{and } y_{CM} = \frac{M(0) + 2M(L)}{M + 2M} = \frac{2L}{3}$$

Hence, coordinates of CM are $\left(\frac{L}{6}, \frac{2L}{3}\right)$.

47 **(c)**



$$m = 2\sqrt{3}\ \text{kg},$$

$$F_1 = 1\cos 30^0 = \frac{\sqrt{3}}{2}\text{N}$$

$$F_2 = \frac{\sqrt{3}}{2}\text{N}$$

$$\therefore F_1 + F_2 = \sqrt{3}\ \text{N}$$

$$\therefore a = \frac{F}{m} = \frac{\sqrt{3}}{2\sqrt{3}} = \frac{1}{2} = 0.5\ \text{m/s}^2$$

48 **(d)**

When the ball is released $u = 0$

$$v = gt_1 = 2g$$

After bouncing let u' be the initial velocity.

Final velocity is zero, $t_2 = 1s$

$$0 = u' - gt_2$$

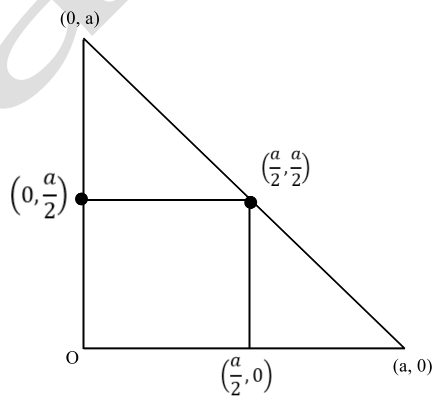
$$\therefore u' = gt_2 = g$$

$$\text{Coefficient of restitution } v = \frac{u'}{V} = \frac{g}{2g} = 0.5$$

49 **(d)**

As shown in figure, centre of mass of respective rods are at their respective mid-points.

Hence, centre of mass of the system has coordinates (x_{CM}, Y_{CM}), then

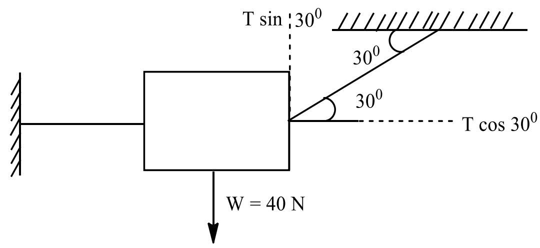


$$X_{CM} = \frac{m \times \frac{a}{2} + m \times \frac{a}{2} + m \times 0}{3\ m} = \frac{a}{3}$$

$$Y_{CM} = \frac{m \times 0 + m \times \frac{a}{2} + m \times \frac{a}{2}}{3\ m} = \frac{a}{3}$$

50 **(a)**

$$T \sin 30^0 = w = 40N$$



$$\therefore \qquad \frac{T}{2} = 40 \text{ or } T = 80\ \text{N}$$

51 **(a)**

$F = m(a+g)$

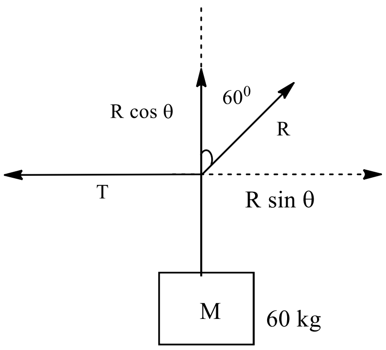
$$s \times \frac{\pi d^2}{4} = m(a+g)$$

$$d^2 = \frac{4m(a+g)}{s\pi}$$

$$d = \left(\frac{4m(a+g)}{\pi s}\right)^{1/2}$$

52 **(d)**

The given figure can be drawn as



Taking component of forces, $R\cos\theta = Mg$

$\Rightarrow \quad R\cos 60^0 = Mg \quad$ ...(i)

and $\quad R\sin 60^0 = T \quad$ ...(ii)

From Eqs. (i) and (ii), we get

$\Rightarrow \tan 60^0 = \frac{T}{Mg} \Rightarrow T = Mg\tan 60^0$

or $\quad T = 60 \times g \times \sqrt{3} = 103.9$ kgf

53 **(b)**

$$\frac{W_1}{W_2} = \frac{mg}{m(g-a)} = \frac{3}{2}$$

$$\therefore \frac{g}{g-a} = \frac{3}{2}$$

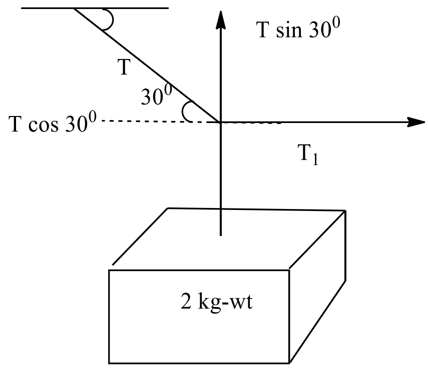
$\therefore 2g = 3g - 3a$

$g = 3a$

$$\therefore a = \frac{g}{3}$$

54 **(c)**

$T\sin 30^0 = 2$ kg - wt



$T = 4$ kg-wt

$\Rightarrow \quad T_1 = T\cos 30^0 = 4\cos 30^0 = 2\sqrt{3}\ \text{kg} - \text{wt}$

55 **(b)**

$mv = (M+m)V$

$$v = \frac{M+m}{m}V$$

But $(M+m)gh = \frac{1}{2}(M+m)V^2$

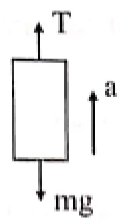
$\therefore V = \sqrt{2gh}$

$$\therefore v = \left(\frac{M+m}{m}\right)\sqrt{2gh}$$

56 **(d)**

$T - mg = ma$

$\therefore T = m(g+a)$



57 **(b)**

Given, $F = -5\hat{i} - 7\hat{j} + 3\hat{k}, s = 3\hat{i} - 2\hat{j} + a\hat{k}$ and
$W = 14$ J

The work done by a force in displacing a particle through a distance is given by
$W = F.s \qquad$ ...(i)

Substituting above values in Eq. (i), we get

$14 = (-5\hat{i} - 7\hat{j} + 3\hat{k}) \cdot (3\hat{i} - 2\hat{j} + a\,\hat{k})$

$\Rightarrow 14 = -15 + 14 + 3a$

$\Rightarrow a = \dfrac{15}{3} = 5$

59 **(c)**
If V is the velocity of heavier block after collision, then by law of conservation of momentum

$mu = 2mV$

$\therefore e = \dfrac{V}{u} = \dfrac{1}{2} = 0.5$

60 **(c)**
$\dfrac{1}{2}mV^2 + 0 = \dfrac{1}{2}mV_1^2 + \dfrac{1}{2}mV_2^2$
$V_2 = \sqrt{V^2 - V_1^2}$

61 **(a)**
Before explosion momentum = 0

After explosion total momentum will be zero

$\therefore -3P\hat{i} + 2P\hat{j} + A = 0$

$A = 3P\hat{i} - 2P\hat{j}$

$|A| = \sqrt{9 + 4P} = \sqrt{13}P$

62 **(c)**
Total work done $W = W_1 + W_2$

where W_1 = work done against gravity

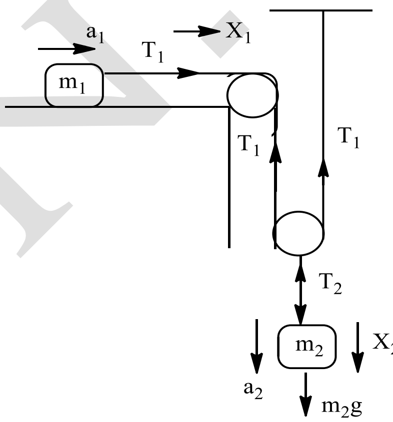
and W_2 = work done against friction

$W = 100$ J,

$W_1 = mgh = 1 \times 10 \times 5 = 50$ J

$W_2 = W - W_1 = 100 - 50 = 50$ J

63 **(a)**



From force diagram, $T_1 = m_1a_1$

..............................(i)

$T_2 = 2T_1$
..............................(ii)

$m_2g - T_2 = m_2a_2$

$m_2g - 2T_1 = m_2a_2$
..............................(iii)

Total work done by tension should be zero.

$\therefore \quad T_1x_1 - T_2x_2 = 0$

or $\quad T_1x_1 = T_2x_2$

or $\quad T_1x_1 = 2T_2x_2$

or $\quad x_1 = 2x_2$

or $\quad \frac{d^2x_1}{dt_2} = \frac{2d^2x_2}{dt^2}$

$\therefore \quad a_1 = 2a_2$
.................................(iv)

After solving Eqs. (i). (iii) and (iv), we get

$a_2 = \frac{m_2g}{4m_1+m_2}$

64 **(c)**
Given, force , $F = 10 + 0.5x = 10 + \frac{1}{2}x$

Let during small displacement, the work done by the force is $dW = Fdx$.

So, work done during displacement from from $x = 0$ to $x = 2$ m is

$W = \int_0^W dW = \int_0^2 Fdx = \int_0^2 \left(10 + \frac{1}{2}x\right) dx$

$= \left[10x + \frac{x^2}{4}\right]_0^2 = 20 + \frac{2^2}{4} - 0 - 0 = 21$ J

65 **(a)**
Torque, $\tau = \frac{dL}{dt}$

where, L = angular momentum.

If $\quad \tau = 0$, then

en $\frac{dL}{dt} = 0$

i.e L = constant

66 **(c)**
Theory question

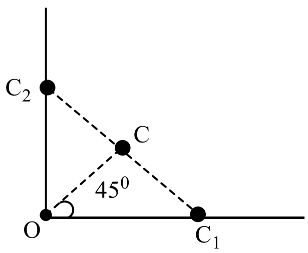
67 **(d)**
$v_2 = \left(\frac{m_2 - m_1}{m_2 + m_1}\right) v_2 + \left(\frac{2m_1}{m_1 + m_2}\right) v_1$

As, $v_1 = 0$

$\therefore \quad \frac{V_2}{V_2'} = \left(\frac{m_2 + m_1}{m_2 - m_1}\right) = \left(\frac{m + 2m}{m - 2m}\right) = -3$

$\therefore \quad \frac{K_2}{K_2'} = \left(\frac{v_2}{v_2'}\right)^2 = 9$ or $9 : 1$

68 **(d)**
As, here in figure below, $OC_1 = \frac{1}{4}$ m



$\therefore \quad OC = OC_1 \cos 45^0 = \frac{1}{4\sqrt{2}}$ m

69 **(d)**
Gravitational potential energy gained by the ball = Elastic potential energy in the spring

$mgh = \frac{1}{2} Fx$

$\therefore h = \frac{Fx}{2mg} = \frac{5 \times 0.2}{2 \times 25 \times 10^{-3} \times 10} = 2m$

70 **(b)**
Given, $F = (2\hat{i} + 3\hat{j} + 4\hat{k})N$

We know that $W = F \cdot s$

Here , $s = r_f - r_i = (\hat{i} + 2\hat{j} + 3\hat{k}) - (2\hat{i} + 3\hat{j} + 4\hat{k})$

$= (-\hat{i} - \hat{j} - \hat{k})$

$\therefore \quad W = (2\hat{i} + 3\hat{j} + 4\hat{k}) \cdot (-\hat{i} - \hat{j} - \hat{k})$

$= -2 - 3 - 4 = -9$ J

71 **(c)**
$F = 3i + 6j + 2k$

$s = -4i + xj + 3k$

$12 = -12 + 6x + 6$

$\therefore x = 3$

72 **(a)**
$Mv + 0 = 0 + 4MV$

$\therefore V = \frac{Mv}{4M} = \frac{v}{4}$

$e = \frac{v/4}{v} = \frac{1}{4} = 0.25$

73 **(b)**
$m_1 = 1gm$

$m_2 = 4gm$

$\therefore \frac{1}{2}\frac{p_1^2}{m_1} = \frac{1}{2}\frac{p_2^2}{m_2}$

$\frac{p_1^2}{1} = \frac{p_2^2}{4}$

$\therefore \frac{p_1}{p_2} = \frac{1}{2}$

74 **(c)**
Acceleration $a_1 = 6\ ms^{-2} = \frac{F}{m_1}$

$\therefore F = 6m_1 \quad \dots (i)$

Acceleration $a = 4\ ms^{-2} = \frac{F}{m_1 + m_2}$

$\therefore F = 4m_1 + 4m_2 \quad \dots (ii)$

By (i) and (ii),

$6m_1 = 4m_1 + 4m_2$

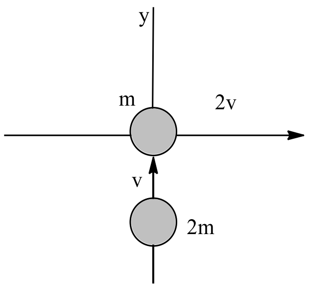
$\therefore 2m_1 = 4m_2$

$\therefore m_2 = \frac{m_1}{2}$

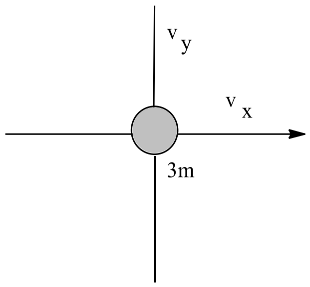
$a_2 = \frac{F}{m_2} = \frac{2F}{m_1} = 2a_1 = 2 \times 6 = 12\ ms^{-2}$

75 **(c)**
Conservation of linear momentum can be applied but energy is not conserved. Consider the

movement of two particles as shown below.



(Just before collision)



(Just after collision)

According to conservation of linear momentum in x - direction, we have

$(p_1)_x = (P_2)_x$ or $2mv = (2m + m)v_x$

or $\quad v_x = \frac{2}{3}v$

As, conserving linear momentum in y-direction , we get $(p_1)_x = (p_2)_y$

or $2mv = (2m + m)v_y$ or $v_y = \frac{2}{3}v$

Initial kinetic energy of the two particles system is

$$E_1 = \frac{1}{2}m(2v)^2 + \frac{1}{2}(2m)(v)^2$$

$$= \frac{1}{2} \times 4\ mv^2 + \frac{1}{2} \times 2mv^2$$

$$= 2\ mv^2 + mv^2 = 3\ mv^2$$

Final energy of the combined two particles system is

$$E_2 = \frac{1}{2}(3m)\left(v_x^2 + v_y^2\right)$$

$$= \frac{1}{2}(3m)\left[\frac{4v^2}{9} + \frac{4v^2}{9}\right]$$

$$= \frac{3m}{2}\left[\frac{8v^2}{9}\right] = \frac{4mv^2}{3}$$

Loss in the energy.

$$\Delta E = E_1 - E_2 = mv^2\left[3 - \frac{4}{3}\right] = \frac{5}{3}\ mv^2$$

Percentage loss in the energy during the collision,

$$\frac{\Delta E}{E_1} \times 100 = \frac{\frac{5}{3}mv^2}{3\ mv^2} \times 100 = \frac{5}{3} \times 100 = 56\%$$

76 **(a)**

Initially the body is at rest and its momentum is zero.

∴ by law of conservation of linear momentum we have

$M_1V_1 + M_2V_2 = 0$

$\therefore M_1V_1 = -M_2V_2$

The magnitude of their momenta in same.

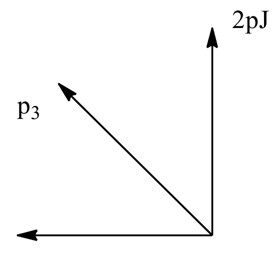
Kinetic energy is given by $K = \frac{p^2}{2m}$

Where p = momentum

$\therefore \frac{K_1}{K_2} = \frac{M_2}{M_1}$

77 **(d)**

According to the question, we can draw the following diagram



Now, the magnitude of momentum of the third part is given by

$$p_3 = \sqrt{(p_1^2) + (p_2)^2}$$

$$= \sqrt{(-3p)^2 + (2p)^2}$$

$$= \sqrt{9p^2 + 4p^2} = \sqrt{13p^2}$$

$$p_3 = \sqrt{13}p$$

78 **(d)**

$$\tau = F \times l\cos 60^0 = \frac{Fl}{2}$$

$$\therefore F = \frac{2\tau}{l}$$

79 **(c)**
Since the collision is elastic, the ball rebound with the same velocity.

$\therefore$ Change in momentum= 2mun, time 2s

Force = Rate of change of momentum

$$= \frac{2mun}{2} = mun$$

80 **(a)**
$mV + 0 = mV_1 + mV_2$

$V = V_1 + V_2 \quad \dots(1)$

$V^2 = V_1^2 + V_2^2 \quad \dots(2)$

$V_2^2 = V^2 - V_1^2$

$$V_2 = \sqrt{V^2 - V_1^2}$$

81 **(c)**
The third force will have magnitude equal to their resultant. The resultant is given by

$$R = \sqrt{P^2 + P^2 + 2P^2\cos 90}$$

$$= \sqrt{2P^2} = \sqrt{2}P$$

82 **(a)**
Change in momentum = Impulse $\Longrightarrow \Delta p = F \times \Delta t$

$\Rightarrow \quad \Delta t = \frac{\Delta p}{F} = \frac{125}{250} = 0.5$ s

83 **(c)**
Given, $F = 600 - 2 \times 10^5 t$

At $t = 0$, $F = 600$ N

According to equation ,

$F = 0$, on leaving the barrel

$\Rightarrow \quad 0 = 600 - 2 \times 10^5 t$

$\therefore \quad t = \frac{600}{2 \times 10^5} = 3 \times 10^{-3}$ s

This is the time spent by the bullet in the barrel.

Average force, $F = \frac{600 + 0}{2} = 300$ N

Average impulse imparted = $F \times t$

$= 300 \times 3 \times 10^{-3} = 0.9$ N -s

84 **(b)**
$v(m_1 + m_2) = m \times 3 + 0$

$$\therefore v = \frac{3m}{m + 2m} = 1 \text{ m/s}$$

85 **(c)**
Acceleration $a = \frac{F}{M}$

$V^2 = 2as$

$$K.E. = \frac{1}{2}MV^2 = \frac{1}{2}M \times 2as = Mas$$

$$= M \times \frac{F}{M} \times s = FS$$

Kinetic energy is independent of M

86 **(c)**
$$\frac{a_1}{a_2} = \frac{a + g}{g - a} = \frac{g + g/2}{g - g/2} = \frac{3/2}{1/2} = \frac{3}{1}$$

87 **(b)**
Torque, $\tau = r \times F$

$$= \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 1 & -2 & 1 \\ -2 & 2 & 3 \end{vmatrix}$$

$= \hat{i}(-6 - 2) + \hat{j}(-2 - 3) + \hat{k}(2 - 4)$

Torque of force, $\tau = -8\hat{i} - 5\hat{j} - 2\hat{k}$

88 **(c)**
Potential energy of the spring = kinetic energy of the ball

$$\therefore \frac{1}{2}kx^2 = \frac{1}{2}mv^2$$

$$\therefore v^2 = \frac{k}{m}x^2$$

$$\therefore v = x\sqrt{\frac{k}{m}}$$

89 **(c)**

Stress × area= M(g + a)

$$S \times \pi\frac{d^2}{4} = M(g + a)$$

$$d^2 = \frac{4M(g + a)}{S\pi}$$

$$d = \left[\frac{4M(g + a)}{\pi S}\right]^{1/2}$$

90 **(b)**

For centre of mass we have $m_1x_1 = m_2x_2$

If x_1 decreases x_2 should also decrease.

$$\therefore m_1(x_1 - d) = m_2(x_2 - d')$$

$$\therefore m_1x_1 - m_1d = m_2x_2 - m_2d'$$

$$\therefore m_1d = m_2d' \text{ or } d' = \frac{m_1}{m_2}d$$

91 **(c)**

$$e = \frac{v_2 - v_1}{u_1 - u_2}$$

$$mu = 2m \times v$$

$$\therefore v = \frac{u}{2}$$

$$= \frac{\frac{u}{2} - 0}{u - 0} = \frac{1}{2} = 0.5$$

92 **(c)**

Maximum potential energy is attained at the highest point which gets converted into kinetic energy at the lowest point.

$$h = 2 - 0.75 = 1.25 \text{ m}$$

$$\frac{1}{2}mv^2 = mgh$$

$$\therefore v^2 = 2gh = 2 \times 10 \times 1.25 = 25$$

$$\therefore v = 5 \text{ m/s}$$

93 **(a)**

Force = rate of change of momentum= Nmu— Nmu = 2Nmu

94 **(a)**

Here, mass, m = 5 kg

Change in velocity, $\Delta v = v_f - v_i = [(10 - 2)\hat{i} + (6 - 6)\hat{j}]$

$\therefore$ Change in momentum = $m\Delta v = 5[8\hat{i}] = 40\hat{i}$ kg-ms^{-1}

95 **(c)**

$$e = \frac{u_2 - u_1}{u_1 - u_2}$$

$$\frac{u_2}{v} = ?$$

$$u_1 = v, u_2 = 0$$

$$e = \frac{u_2 - u_1}{v} = \frac{u_2}{v} - \frac{u_1}{v} \quad \dots(1)$$

By law of conservation of momentum:

$$mv = mu_1 + mu_2$$

$$1 = \frac{u_1}{v} + \frac{u_2}{v}$$

$$\therefore \frac{u_1}{v} = 1 - \frac{u_2}{v} \quad \dots(2)$$

Putting in equation (1)

$$e = \frac{u_2}{v} - \left(1 - \frac{u_2}{v}\right)$$

$$\therefore e = \frac{u_2}{v} - 1 + \frac{u_2}{v}$$

$$e = \frac{2u_2}{v} - 1$$

$$\therefore \frac{2u_2}{v} = e + 1$$

$$\therefore \frac{u_2}{v} = \frac{e + 1}{2}$$

96 **(c)**

In the first case, there is no displacement. Hence work done is zero.

In the second case, work done

$$W = mgh = 2 \times 9.8 \times 1 = 19.6 \text{ J}$$

97 **(a)**

Law of conservation of momentum:

$$M_1V_1 + M_2V_2 = 0$$

$$\therefore M_1V_1 = -M_2V_2$$

$$(KE)_1 = \frac{(M_1V_1)^2}{2M_1};$$

$$(KE)_2 = \frac{(M_2V_2)^2}{2M_2} = \frac{(M_1V_1)^2}{2M_2}$$

$$\therefore \frac{(KE)_1}{(KE)_2} = \frac{M_2}{M_1}$$

98 **(d)**

Torques due to $\overrightarrow{F_1}$ and $\overrightarrow{F_2}$ are in anticlockwise direction and that due to $\overrightarrow{F_3}$ is in clockwise direction. The perpendicular distance from the centre 'd' is same for all the forces. Since, the net torque about the centre is zero, the clockwise torque must be equal to the anticlockwise torque.

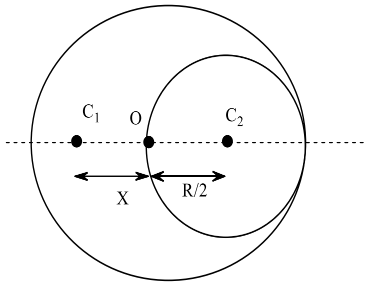
$\therefore F_1 d + F_2 d = F_3 d$

or $F_1 + F_2 = F_3$

99 **(d)**

Centre of mass of complete disc should lie at point O. C_1 is the position of centre of mass of remaining portion and C_2 the position of mass of the removed disc.

$\therefore$ x (Area of remaining portion) = $\frac{R}{2}$ (Area of removed disc)



$\therefore \quad x\left[\pi R^2 - \frac{\pi R^2}{4}\right] = \frac{R}{2}\left[\frac{\pi R^2}{4}\right]$

$\therefore \quad x = \frac{R}{6}$

101 **(b)**

$m_1 = 2$ kg, $m_2 = 4$ kg

Taking m_1 as origin, the centre of mass is given by

$$x_{cm} = \frac{2 \times 0 + 9 \times 4}{2 + 4} = \frac{36}{6} = 6 \text{ m}$$

102 **(c)**

Let u_1 be the initial velocity of 'm' and its velocity after collision $v_1 = 0$. For mass 'm' initial velocity $u_2 = 0$. By law of conservation of momentum

$$\therefore \frac{m}{M} = \frac{v_2}{u_1}$$

coefficient of restitution $= \frac{v_2 - v_1}{u_1 - u_2} = \frac{v_2}{u_1}$

103 **(c)**

$m_1 = 1.6$ kg; $(x_1\ y_1) = (0,0)$

$m_2 = 2\ kg$; $(x_2, y_2) = (1.2, 0)$

$m_3 = 2.4$ kg; $(x_3, y_3) = (0,1)$

$\therefore$ Coordinates of centre of mass will be

$$x_{CM} = \frac{m_1x_1 + m_2x_2 + m_3x_3}{m_1 + m_2 + m_3} = \frac{(1.6)(0) + (2)(1.2) + (2.4)(0)}{1.6 + 2 + 2.4}$$

$x_{CM} = 0.4$ m

and $y_{CM} = \frac{m_1y_1 + m_2y_2 + m_3y_3}{m_1 + m_2 + m_3} = \frac{(1.6)(0) + (2)(0) + (2.4)(1)}{1.6 + 2 + 2.4}$

$y_{CM} = 0.4$ m

$\therefore$ Coordinates of centre of mass = (0.4, 0.4) m.

104 **(a)**

Apparent weight $W' = m(g + a)$

$$= mg\left(1 + \frac{a}{g}\right) = w\left(1 + \frac{a}{g}\right)$$

105 **(c)**

The coefficient of restitution $e = \sqrt{\frac{h_2}{h_1}}$

$\therefore \frac{h_2}{h_1} = e^2$

or $h_2 = e^2 h_1 = (0.4)^2 \times 5 = 0.16 \times 5 = 0.8$ m

106 **(a)**

Let the coordination of the centre of mass be (x,y).

$$x = \frac{m_1x_1 + m_2x_2}{m_1 + m_2} = \frac{1 \times (-1) + 2 \times 2}{3} = \frac{-1 + 4}{3} = 1$$

$$Y = \frac{m_1y_1 + m_2y_2}{m_1 + m_2} = \frac{1 \times 2 + 2 \times 4}{3} \quad \frac{2 + 8}{3} = \frac{10}{3}$$

Therefore, the coordinates of centre of mass be $\left(1, \frac{10}{3}\right)$.

107 **(b)**

By law of conservation of momentum

$$MV = \frac{M}{2} v_0$$

$\therefore v_0 = 2V$

108 **(b)**

The change in momentum of one ball,

$$\Delta p = mu - (-mu) = 2mu$$

The force exerted on the wall by N balls,

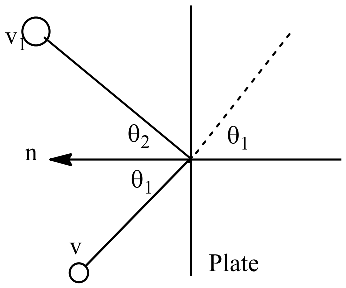
$$F = \frac{\text{Change in momentum for N balls}}{\text{Total time (t)}}$$

$$= \frac{2mNu}{1} \quad (\because t = 1\ s)$$

$= 2\ n\ Nu$

109 **(b)**

Since, no force is present along the surface, so momentum conservation principle for ball is applicable along the surface of plate.



$$mv \sin\theta_1 = mv_1 \sin\theta_2$$

or $\quad v \sin\theta_1 = v_1 \sin\theta_2$

$\because \quad e = \frac{v_1 \cos\theta_2}{v \cos\theta_1} = \frac{v_1 \cos\theta_2}{v \cos\theta} \quad [\because\ \theta_1 = \theta]$

$\Rightarrow \quad v_1 \cos\theta_2 = ev \cos\theta$

$\therefore \quad \frac{v_1 \sin\theta_2}{v_1 \cos\theta_2} = \frac{v \sin\theta}{ev \cos\theta} = \frac{\tan\theta}{e}$

$\Rightarrow \quad \tan\theta_2 = \frac{\tan\theta}{e}$

$\Rightarrow \quad \theta_2 = \tan^{-1}\left(\tan\frac{\theta}{e}\right)$

110 **(c)**

Let V' be the speed of the second ball after collision. Since the collision is elastic, the kinetic energy is conserved.

$$\therefore \frac{1}{2}mv^2 = \frac{1}{2}m\left(\frac{v}{3}\right)^2 + \frac{1}{2}mv'^2$$

$$\therefore v^2 = \left(\frac{v}{3}\right)^2 + v'^2$$

$$v'^2 = v^2 - \frac{v^2}{9} = \frac{8v^2}{9}$$

$$\therefore v' = \frac{2\sqrt{2}v}{3}$$

111 **(c)**

Work done, W Area under the F - x graph

$= \text{Area of trapezium} = \frac{1}{2} \times (4 + 2) \times 5 = 15\ J$

112 **(d)**

Let velocity after the collision be V $mv = 2mV$

$$V = \frac{V}{2} = \sqrt{\frac{2gL}{2}}$$

Initially the tension is $T_1 = mg$ after collision

$$T_2 - 2mg = 2m\frac{V^2}{L} = 2m\frac{2gL}{4L} = mg$$

$\Rightarrow T_2 = 3mg$

Thus, $T_2 - T_1 = 2mg$

113 **(c)**

Given, $u = (3\hat{i} + 4\hat{j})ms^{-1}$ and $v = -(3\hat{i} + 4\hat{j})ms^{-1}$

Mass of the ball $= 150\ g = 0.15kg$

Δp = Change in momentum

= Final momentum - Initial momentum

= mv-mu

$= m\ (v\text{-}u) = (0.15)[-(3\hat{i} + 4\hat{j}) - (3\hat{i} + 4\hat{j})]$

$= (0.15)[-6\hat{i} - 8\hat{j})] = -[0.15 \times 6\hat{i} + 0.15 \times 8\hat{j})]$

$= -(0.9\,\hat{i} + 1.2\hat{j})$

Hence, $\Delta p = -(0.9\hat{i} + 1.2\hat{j})$

114 **(c)**

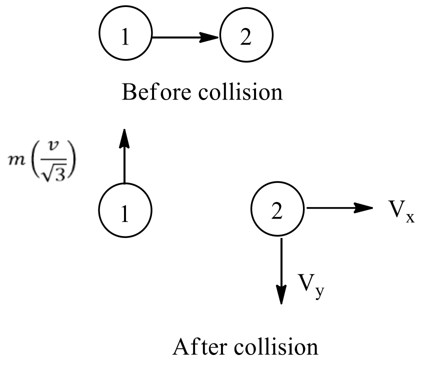
in x- direction,

Apply conservation of momentum, we get

$$mu_1 + 0 = mv_x$$

$\Rightarrow \quad mv = mv_x$

$\Rightarrow \quad v_x = v$



In y-direction, apply conservation of momentum, we get

$$0+0=m\left(\frac{v}{\sqrt{3)}}\right)-mv_y \Rightarrow v_y=\frac{v}{\sqrt{3}}$$

Velocity of second mass after collision ,

$$v'=\sqrt{\left(\frac{v}{\sqrt{3}}\right)^2+v^2}=\sqrt{\frac{4}{3}v^2}$$

or $\quad v'=\frac{2}{\sqrt{3}}v$

115 **(c)**

Let x_1 and x_2 be the position of masses m_1 and m_2, respectively.

The position of centre of mass, $x_{CM}=\frac{x_1m_1+x_2m_2}{m_1+m_2}$

If Δx_1 and Δx_2 be the changes in positions, then change in the position of centre of mass,

$$\Delta x_{CM}=\frac{\Delta x_1m_1+\Delta x_2m_2}{m_1+m_2}$$

Given, the centre of mass remains unchanged, i.e. $\Delta x_{CM}=0$ and $\Delta x_1=d$

$$\Rightarrow 0=\frac{dm_1+m_2\Delta x_2}{m_1+m_2}$$

Or $\Delta x_2=-\frac{m_1}{m_2}d$

Here, negative sign shows that the second particle should be moved towards the centre of mass.

116 **(a)**

Given, F = 20 kg-wt = 20 × 9.8 N and s = 20 m , θ = 60^0

$\therefore \quad$ Work done $=F\,s\cos\theta$

$=20\times 9.8\times 20\times\cos 60^0=$ 1960 j

117 **(c)**

$x=t^3-2t-10$

$$\frac{dx}{dt}=3t^2-2$$

$$\frac{d^2x}{dt^2}=6t$$

$$\therefore \frac{d^2x}{dt^2}\Big|_5=30$$

$m=5$ kg

$\therefore F=5\times 30=150$ N

118 **(b)**

$m_1=m, u_1=v, \vartheta_1=0$

$m_2=4m, u_2=0, \vartheta_2=?$

By law of conservation of momentum we have

$$m_1u_1+m_2u_2=m_1\vartheta_1+m_2\vartheta_2$$

$$\therefore mv+0=0+4m_2\vartheta_2$$

$$\therefore v=4\vartheta_2 \text{ or } \vartheta_2=\frac{v}{4}$$

Coefficien of restitution $e=\frac{\vartheta_2-\vartheta_1}{u_1-u_2}=\frac{\frac{v}{4}-0}{v-0}=\frac{1}{4}$

$=0.25$

119 **(c)**

When two bodies of equal masses collide elastically, they exchange their velocities. Since the two masses are exchanging their velocities, their masses must be equal.

Hence, $\frac{m_a}{m_b}=1$

120 **(b)**

$h_1=2m, e=0.4$

$$e=\sqrt{\frac{h_2}{h_1}}$$

$$\therefore e^2=\frac{h_2}{h_1}$$

$$\therefore h_2=e^2h_1$$

$= (0.4)^2 \times 2 = 0.16 \times 2 = 0.8$ m

121 **(d)**

Work done = Change in KE

$$= \frac{1}{2}m(4V^2 - V^2) = \frac{3V^2m}{2} = 3\left(\frac{1}{2}mv^2\right)$$

122 **(d)**

$$M \times v\hat{i} + 2M \times 3v\hat{j} = 3M\bar{v}$$

$$v\hat{i} + 6v\hat{j} = 3\bar{v}$$

$$\frac{v}{3}\hat{i} + 2v\hat{j} = \bar{v}$$

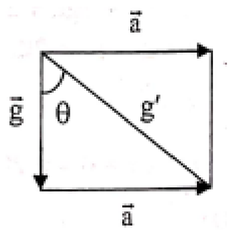
123 **(c)**

Total mass $(m + M)$

$$\therefore \text{acceleration} = \frac{F}{M + m}$$

124 **(d)**

The effective acceleration due to gravity due to gravity is the resultant of $\vec{a}$ and $\vec{g}$.



$$\tan\theta = \frac{a}{g}$$

$$\therefore a = g\tan\theta$$

125 **(c)**

If x_1 and x_2 are distances from centre of mass, then we have

$$m_1x_1 = m_2x_2$$

$$\therefore m_1(x - d) = m_2(x_2 - d')$$

$$\therefore m_1x_1 - m_1d = m_2x - m_2d'$$

$$\therefore m_1d = m_2d'$$

$$\therefore d' = \frac{m_1}{m_2}d$$

126 **(a)**

Velocity of the second sphere is given by

$$v_2 = \frac{2m_1u_1}{m_1 + m_2} + \frac{m_2 - m_1}{m_1 + m_2}.u_2$$

Here, $m_1 = M, m_2 = m, u_1 = u, u_2 = 0$

$$\therefore v = \frac{2Mu}{M + m} = \frac{2u}{1 + m/M}$$

127 **(a)**

$M = 2$ kg

$F_1 = F_2 = 1$ N

$\theta = 60^0$

Total effective force $= 2 \times F\cos 30^0 = 2 \times 1 \times \frac{\sqrt{3}}{2}$

$= \sqrt{3}$

$$\therefore \text{acceleration} = \frac{\sqrt{3}}{2} = \sqrt{3/4} = \sqrt{0.75}$$

128 **(d)**

$$\text{TE(at h)} = \frac{1}{2}mV^2 + mgh$$

Energy of the ball after collision

$$\frac{1}{4}\left(\frac{1}{2}mV^2 + mgh\right)$$

As the ball rebounds to the same height

$$\therefore mgh = \frac{1}{2}\left(\frac{1}{2}mV^2 + mgh\right) = \frac{1}{8}mV^2 + \frac{1}{4}mgh$$

$$\frac{3}{4}mgh = \frac{1}{8}mV^2$$

$$V^2 = 6gh$$

$$v = \sqrt{6gh}$$

129 **(c)**

Since gravitational field is conservative type, so $W_1 = W_2 = W_3$

130 **(a)**

For collision between blocks A and B,

$$e = \frac{v_B - v_A}{u_A - u_B} = \frac{v_B - v_A}{10 - 0} = \frac{v_B - v_A}{10}$$

$\therefore \quad v_B - v_A = 10\,e = 10 \times 0.5 = 5 \quad$ ...(i)

From principle of momentum conservation,

$$m_Au_A + m_Bu_B = m_Av_A + m_Bv_B$$

or $\quad m \times 10 + 0 = mv_A + mv_B$

$\therefore \quad v_A + v_B = 10 \quad$ ...(ii)

On adding Eqs. (i) and (ii), we get

$v_B = 7.5\ ms^{-1} \quad$ ...(iii)

Similarly, for collision between B and C,

$v_C - v_B = 7.5\ e = 7.5 \times 0.5 = 3.75$

$v_C - v_B = 3.75 \quad$ ...(iv)

and $\quad v_C + v_B = 7.5 \quad$ ...(v)

On adding Eqs. (iv) and (v), we get

$2V_C = 11.25$

$V_C = \frac{11.25}{2} = 5.6\ ms^{-1}$

132 **(d)**
The impulse is equals to change in linear momentum. Change in momentum $= m(v - u) = 0.2(-6 - 6) = -2.4\ N - s$ The negative sign shows the direction of impulse is from batsman to bowler.

133 **(d)**
Coefficient of restitution is given by

$$e = \sqrt{\frac{h_2}{h_1}}$$

$\therefore h_2 = e^2 h_1$

$h_3 = e^2 h_2 = e^4 h_1 = e^4 h$

134 **(d)**
Distance distributes in inverse ratio of masses.

Hence, $r_c = d\left(\frac{m_o}{m_o + m_c}\right) = 1.2 \times 10^{10}\left(\frac{16}{16+12}\right)$

$= 0.69 \times 10^{-10} m$

135 **(c)**

$$W = \int_0^2 F\,dx = \int_0^2 (10 + 0.5x)\,dx$$

$$= [10x + 0.5\,x^2/2]_0^2 = 21\ J$$

136 **(a)**
$mv = Mv$

$$v = \frac{mv}{M} = \frac{20 \times 10^{-3} \times 750}{2.5} = 6\ m/s$$

137 **(a)**
$F_1 = 1\ N, r_1 = 1.2\ m, F_2 = 0.2\ m$

Torque should be same in the two cases.

$\therefore \tau = F_1 r_1 = F_2 r_2$

$\therefore F_2 = F_1 \frac{r_1}{r_2} = \frac{1 \times 1.2}{0.2} = 6\ N$

138 **(b)**
According to the graph, the acceleration a varies linearly with the coordinate x. We may write a= αx, where α is the slope of the graph.

$\alpha = \frac{20}{8} = 2.5\ s^{-2}$

The force on the brick is in the positive x - direction and according to Newton's second law, its magnitude is given by

$F = \frac{a}{m} = \frac{\alpha}{m} x$

If x_f is the final coordinate, the work done by the force is

$W = \int_0^{x_f} F\,dx = \frac{\alpha}{m}\int_0^{x_f} x\,dx$

$= \frac{\alpha}{2m} x_f^2 = \frac{2.5}{2 \times 10} \times (8)^2 = 8\ J$

139 **(a)**
Change in momentum $= nmu - (-mu) = 2nmu$

Rate of change of momentum $= \frac{2nmu}{2} = num$

140 **(b)**
From first equation of motion,

$v = u + at \Rightarrow 20 = 0 + a \times 10$

$\Rightarrow \quad 20 = a \times 10 \Rightarrow a = 2\ m/s^2$

Now, distance, $s = ut + \frac{1}{2} at^2$

$\Rightarrow \quad s = 0 + \frac{1}{2} \times 2 \times 10 \times 10$

or $\quad s = 100\ m$

$\therefore$ Work done, $W = F.\,s = mass \quad (\because F = ma)$

$= 50 \times 2 \times 100 = 10^4$ J

141 **(a)**

In x - direction, $m \times 50 - m \times 40 = m \times 0 + mv_x$

$\Rightarrow \quad v_x = 10$ cms^{-1}

In y- direction, $m\times 0 = m \times 30 = m \times 0 + mv_y$

$\Rightarrow \quad v_y = 30$ cms^{-1}

142 **(b)**

Torque, τ r× F

$\Rightarrow \tau = 4\hat{j} \times (-6\hat{i}) = -(-24\hat{k}) = 24\hat{k}$

143 **(a)**

$N = 10^4, m = 1\text{ g} = 10^{-3}\text{ kg}, A = 1\text{ cm}^2$

$= 10^{-4}\text{ m}^2, v = 100\dfrac{\text{m}}{\text{s}}$

Change in momentum in each collision=
$m[v—v) = 2\text{ mv}$

$\therefore$ change in momentum per second $= 10^4 \times 2mv$
$= 10^4 \times 2 \times 10^{-3} \times 100$

$= 2000$ N

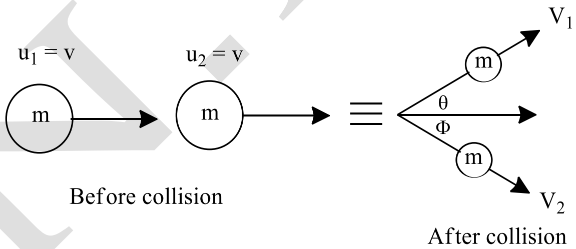
Pressure $= \dfrac{F}{A} = \dfrac{2000}{10^{-4}} = 2 \times 10^7\text{ N/m}^2$

144 **(d)**

It is a perfectly inelastic collision and hence there is a loss of kinetic energy, but momentum is conserved.

145 **(b)**

The situation can be shown as below.



Applying law of conservation of kinetic energy,

KE (before collision) = KE (after collision)

$$\frac{1}{2}mv^2 + \frac{1}{2}m(0)^2 = \frac{1}{2}mv_1^2 + \frac{1}{2}mv_2^2$$

$\Rightarrow v^2 = v_1^2 + v_2^2$

$\Rightarrow v_2 = \sqrt{v^2 - v_1^2}$

Thus, the velocity of second block after collision is $\sqrt{v^2 - v_1^2}$

146 **(b)**

$h = 20\text{ m}, e = 0.4\text{ m}$

$\therefore v^2 = 0 + 2gh = 2 \times 10 \times 20$

$\therefore v = 2 \times 10 = 20$

$e = \dfrac{u}{v}$

$\therefore u = ev = 0.4 \times 20 = 8\text{ m/s}$

147 **(b)**

In rotational motion, the relation between torque τ and angular momentum L is $\tau = \frac{dL}{dt}$

Here, $dL = (4 - 1) = 3\text{ J} - \text{s}$

and $dt = 4$ s

$\therefore \tau = \dfrac{3\text{ J} - \text{s}}{4\text{ s}} = \dfrac{3}{4}$ J

148 **(d)**

Given, force, $F = (3\hat{i} + 4\hat{j})$ N

Displacement, $s = (3\hat{i} + 4\hat{j})$ m

$\therefore$ Work done, W = F. s

$= (3\hat{i} + 4\hat{j}).(3\hat{i} + 4\hat{j}) = 9 +$
16

$\Rightarrow$ W = 25 J

149 **(d)**

$F = t\hat{i} + 2t^2\hat{j}$

$ma = t\hat{i} + 2t^2\hat{j}$

$m\dfrac{dv}{dt} = t\hat{i} + 2t^2\hat{j}$

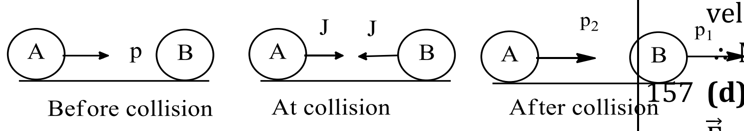
$mv = \dfrac{t^2}{2}\hat{i} + \dfrac{2t^3}{3}\hat{j}$

$v = \dfrac{t^2}{2m}\hat{i} + \dfrac{2t^3}{3m}\hat{j}$

$$\therefore P = F.v = \frac{t^3}{2m} + \frac{4t^5}{3m}$$

150 **(a)**

Let p_1 and p_2 be the momenta of A and B after collision.



Then, impulse = change in linear momentum of two particles

For B, $J = p_1$ ....(i)

For A, $J = p - p_2$ ....(ii)

or $p_2 = p - J$ ....(iii)

Coefficient of restitution, $e = \frac{p_1 - p_2}{p} = \frac{p_1 - p_2 + J}{p}$

$$= \frac{J - p + J}{p} = \frac{2J}{p} - 1$$

151 **(b)**

$$\text{Stress} = \frac{F}{A} = \frac{E}{2}$$

$$\therefore F = \frac{EA}{2}$$

For upward motion

$$m(a+g) = F = \frac{EA}{2}$$

$$\therefore m = \frac{EA}{2(a+g)}$$

152 **(a)**

$$(m+m)v_2 = m \times 3v$$

$$v_2 = \frac{3}{2}\bar{v}$$

153 **(a)**

Torque of the force, $\tau = r \times F$

$$\tau = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 7 & 3 & 1 \\ -3 & 1 & 5 \end{vmatrix} = (14\hat{i} - 38\hat{j} + 16\hat{k})$$

154 **(c)**

Force = 30 kg wt = $30 \times 9.8 = 294$ N

Displacement S = 20 m

$$W = FS\cos 60^0 = 294 \times 20 \times \frac{1}{2} = 2940 \text{ J}$$

156 **(d)**

Given, mass, m = 6 kg

velocity, $v = v_2 - v_1 = 5 - 3 = 2 \text{ ms}^{-1}$

$\therefore$ Momentum, $p = mv = 6 \times 2 = 12$ N-s

157 **(d)**

$$\vec{F} = (t\hat{i} + 2t^2\hat{j})N$$

$$\therefore \text{acceleration } \vec{a} = \frac{\vec{F}}{m} = \frac{1}{m}(t\hat{i} + 2t^2\hat{j})\frac{m}{s^2}$$

$$\vec{a} = \frac{d\vec{v}}{dt}$$

$$\therefore d\vec{v} = \vec{a} = dt$$

$$\therefore \vec{v} = \int \vec{a}.dt = \int \frac{1}{m}(t\hat{i} + 2t^2\hat{j})\,dt$$

$$= \frac{1}{m}\left(\frac{t^2}{2}\hat{i} + \frac{2t^3}{3}\hat{j}\right)$$

$$p = \vec{F} - \vec{v} = (t\hat{i} + 2t^2\hat{j}).\frac{1}{m}\left(\frac{t^2}{2}\hat{i} + \frac{2t^3}{3}\hat{j}\right)$$

$$= \frac{1}{m}\left(\frac{t^3}{2} + \frac{4}{3}t^5\right)$$

158 **(d)**

The body is initially at rest and hence its momentum is zero. By law of conservation of momentum its total momentum after explosion should also be zero.

The two fragments of mass m are at right angles to each other. Each has momentum p = mv. The resultant momentum of these will be

$$P' = mv\cos 45^0 + mv\cos 45^0$$

$$= 2mv\cos 45^0 = 2mv\frac{1}{\sqrt{2}} = \sqrt{2}\,mv$$

(The sine components are equal and opposite and get cancelled)

The momentum of the third fragment will be equal and opposite to P′

$$\therefore 2mV_0 = \sqrt{2}mV$$

$$\therefore V_0 = \frac{V}{\sqrt{2}}$$

The total kinetic energy

$$= \frac{1}{2}mv^2 + \frac{1}{2}mv^2 + \frac{1}{2} \times 2m \times \left(\frac{V}{\sqrt{2}}\right)^2$$

$$= mv^2 + \frac{1}{2}mv^2 = \frac{3}{2}mv^2$$

159 **(a)**

Let initial velocity of first sphere be $u_1 = v, u_2 = 0$

Let v_1 and v_2 be their final velocities.

By law of conservation of momentum: $mu_1 = mv_1 + mv_2$

$\therefore u_1 = v_1 + v_2$

$\therefore v_1 = u_1 - v_2$

Coefficient of restitution: $e = \frac{v_2 - v_1}{u_1 - 0} = \frac{v_2 - v_1}{u_1}$

$$= \frac{v_2}{u_1} - \frac{v_1}{u_1}$$

$\therefore \frac{v_2}{u_1} = e + \frac{v_1}{u_1} = e + \left(\frac{u_1 - v_2}{u_1}\right) = e + 1 - \frac{v_2}{u_1}$

$\therefore 2\frac{v_2}{u_1} = e + 1$

$\therefore \frac{v_2}{u_1} = \frac{e+1}{2}$

160 **(c)**

In perfectly elastic collision between two bodies of equal masses, velocities are exchanged. So, after collision, particle A will move with 10 ms^{-1} and particle B with 15 ms^{-1}.

161 **(d)**

Kinetic energy $= \frac{p_1^2}{2m_1} = \frac{p_2^2}{2m_2}$

$\therefore \frac{p_1^2}{p_2^2} = \frac{m_1}{m_2}$

$\therefore \frac{P_1}{P_2} = \sqrt{\frac{m_1}{m_2}} = \sqrt{4/1} = 2$

162 **(a)**

Force $= \frac{\text{change in momentum}}{\text{time}} = mv - mu$

Taking initial direction as negative

$u = -12\frac{m}{s}, v = 20\frac{m}{s}$

$\therefore F = \frac{0.150[20 - (-12)]}{0.01} = \frac{0.150[20 + 12]}{0.01}$

$= 480$ N

163 **(a)**

Mass of the body, m = 3.0 kg

Initial speed, u =2.0 m/s

Final speed, v = 3.5 m/s

Time, t = 25s

Force, F =?

Using the first equation of motion of motion, v = u + at

$\Rightarrow \quad 3.5 = 2.0 + a \times 25$

$\Rightarrow \quad a = \frac{3.5 - 2.0}{25}$

Acceleration, $a = \frac{1.5}{25}$ m/s^2

$\therefore$ Force acting on the body,

$$F = ma = 3.0 \times \frac{1.5}{25} = 0.18 \text{ N}$$

As, direction of motion of the body remains unchanged, therefore the direction of force acting on the body is along the direction of motion.

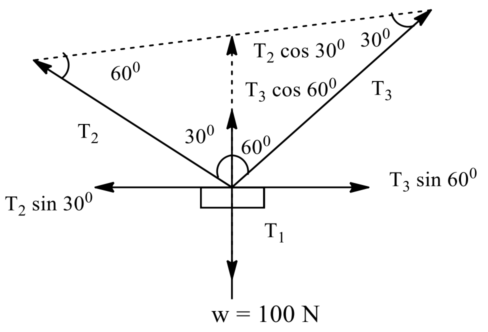
164 **(a)**

Work done = Area between the graph and position axis

W = $10 \times 1 + 20 \times 1 - 20 \times 1 + 10 \times 1 = 20$ erg

165 **(d)**

$\because \quad T_3 \sin 60^0 = T_2 \sin 30^0 \Rightarrow T_3 = \frac{T_2}{\sqrt{3}}$



Now, $T_2 \cos 30^0 + T_3 \cos 60^0 = T_1 = 100$

or $\frac{\sqrt{3}T_2}{2} + \frac{T_2}{\sqrt{3}} \times \frac{1}{2} = 100$ or $\frac{8T_2}{4\sqrt{3}} = 100$

$T_2 = 50\sqrt{3}$ N

166 **(a)**

Initial kinetic energy$= \frac{1}{2}mv^2 = \frac{1}{2}\frac{m^2v^2}{m} = \frac{p^2}{2m}$

The potential energy of the spring$= \frac{1}{2}kx^2$

$\therefore \frac{p^2}{2m} = \frac{1}{2}kx^2$

$\therefore p = \sqrt{mk}x$

167 **(c)**

Initial velocity of m_1 is v_1 and of m_2 is v_2. The final velocity of m_1 is v_2

Hence, we have the relation:

$$v_2 = \left(\frac{m_1 - m_2}{m_1 + m_2}\right)v_1 + \frac{2m_2v_2}{m_1 + m_2}$$

$$\therefore v_2 - \frac{2m_2v_2}{m_1 + m_2} = \left(\frac{m_1 - m_2}{m_1 + m_2}\right)v_1$$

$$\therefore \left(\frac{m_1 - m_2}{m_1 + m_2}\right)v_2 = \left(\frac{m_1 - m_2}{m_1 + m_2}\right)v_1$$

$\therefore v_2 = v_1$

or $\frac{v_2}{v_1} = 1$

168 **(b)**

$F = -F\hat{k}$

$P(1, -1)$

$\vec{r} = \hat{\imath} - \hat{\jmath}$

$$\vec{\tau} = \vec{r} \times \vec{F} = \begin{vmatrix} \hat{\imath} & \hat{\jmath} & \hat{k} \\ 1 & -1 & 0 \\ 0 & 0 & -F \end{vmatrix}$$

$= F\hat{\imath} - \hat{\jmath}(-F) = F(\hat{\imath} + \hat{\jmath})$

169 **(a)**

Force $\overline{F_1}$ and $\overline{F_2}$ produce anticlockwise torques while force $\overline{F_3}$ produce clockwise torque. The torques in the two directions balance each other. The perpendicular distance of the forces from the centre is the same.

$\therefore F_1r + F_2r = R_3r$ or $F_1 + F_2 = F_3$

170 **(d)**

$h = \frac{1}{2}gt^2$

$\therefore t = \sqrt{\frac{2h}{g}}$

$t_{total} = 2t = 2\sqrt{\frac{2h}{g}}$

$\therefore f = \frac{1}{t_{total}} = \frac{1}{2}\sqrt{\frac{g}{2h}}$

171 **(d)**

Work done by the force is equal to gain in kinetic energy.

$K.E. = \frac{1}{2}mv^2 = \frac{1}{2} \times 5 \times (20)^2 = 1000$ J

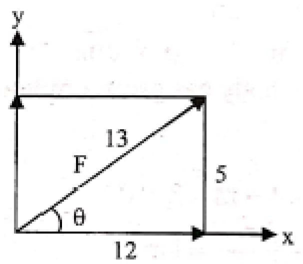
172 **(c)**

$v_2 = \left(\frac{m_2 - m_1}{m_1 + m_2}\right)u_2 + \frac{2m_1u_1}{m_1 + m_2}$

$\because \quad v = \frac{2Mu}{M + m} \qquad (\because u_2 = 0)$

$\Rightarrow \quad v = \frac{2u}{1 + \frac{m}{M}}$

173 **(a)**



$\cos\theta = \frac{12}{13}$

$\sin\theta = \frac{5}{13}$

Y − component of the force $F_y = F\sin\theta$

$= 26 \times \frac{5}{13} = 10\ N$

$\therefore$ Acceleration along y − axis $a_y = \frac{F_y}{m} = \frac{10}{2} 5\ m/s^2$

174 **(d)**

Let v be the velocity of mass m and v′ be the velocity of mass M after collision.

By law of conservation of momentum

$mv = Mv'$

$\therefore \frac{v'}{v} = \frac{m}{M}$

Coefficient of restitution

$$= \frac{\text{Relative velocity after collision}}{\text{Relative velocity before collision}} = \frac{v'}{v}$$

175 **(d)**

$$W = \int_0^3 F\,dx = \int_0^3 (2x^2 - x + 4)dx$$

$$= \left[2.\frac{x^3}{3} - \frac{x^2}{2} + 4x\right]_0^3 = 2.\frac{27}{3} - \frac{9}{2} + 12$$
$$= 18 - 4.5 + 12 = 25.5\ J$$

176 **(d)**

$W_1 = 620\ N, W_2 = 340\ N$

$W_1 = m(g + a)$ ... (i)

$W_2 = m(g - a)$ ... (ii)

$\therefore \frac{W_1}{W_2} = \frac{620}{340} = \frac{g + a}{g - a}$

$\therefore \frac{31}{17} = \frac{g + a}{g - a}$

Solving: $a = \frac{7}{24} g$

Putting this value in Eq. (i) and solving we get $mg = 480\ N$

177 **(c)**

Torque = force × distance

Moment of force = force × distance

178 **(b)**

For centre of mass we have $m_1 x_1 = m_2 x_2$

If x_1 decreases x_2 should also decrease.

$\therefore m_1(x_1 - d') = m_2(x_2 - d)$

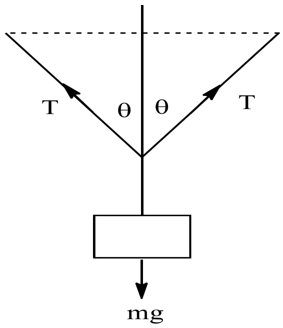
$\therefore m_1 x_1 - m_1 d' = m_2 x_2 - m_2 d$

$\therefore m_1 d' = m_2 d$ or $d' = \frac{m_2}{m_1} d$

179 **(d)**

For equilibrium of body, $mg = 2T\cos\theta$

$$\Rightarrow \quad T = \frac{mg}{2\cos\theta}$$



For the string to be horizontal, $\theta = 90^0$

$\therefore \quad T = \frac{mg}{2\cos 90°} \Rightarrow T = \infty$