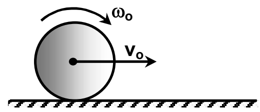
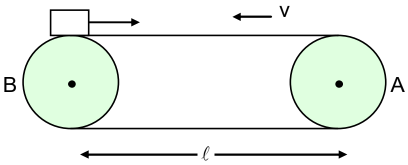
SINGLE CORRECT OPTION TYPE

1. A sphere of mass M and radius R is moving on a rough fixed surface, having co-efficient of friction μ as shown in figure. It will attain a minimum linear velocity after at time 't' is equal.



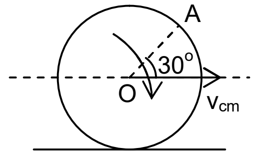
(A) $V_0 / \mu g$ (B) $\omega_0 R/\mu g$
(C) $(V_0 - \omega_0 R)/ \mu g$ (D) $2(V_0 - \omega_0 R)/7\mu g$

2. A conveyer belt of length ℓ is moving with velocity v. A block of mass m is pushed against the motion of conveyer belt with relative velocity v_0 from end B. Coefficient of friction between the block and belt is μ. The value of v_0 so that the amount of heat liberated as a result of retardation of block by conveyer belt is maximum, is



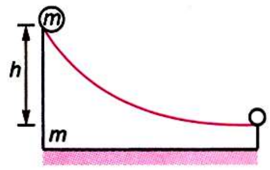
(A) $\sqrt{\mu g \ell}$ (B) $\sqrt{2\mu g \ell}$ (C) $2\sqrt{\mu g \ell}$ (D) dependent on v

3. A disc of mass m is rolling without slipping on a rough surface. The velocity of centre of mass of disc is 10 m/s. Find the velocity of point A which makes an angle 30^o from horizontal as shown in figure.



(A) $15\hat{i} - 5\sqrt{3}\hat{j}$ (B) $15\hat{i} + 5\sqrt{3}\hat{j}$ (C) $5\hat{i} - 5\sqrt{3}\hat{j}$ (D) $15\hat{i} - 15\sqrt{3}\hat{j}$

4. A hollow sphere is released from the top of a wedge as shown in the figure. There is no friction between the wedge and the ground. There is sufficient friction to provide pure rolling. The velocity of the sphere with respect to ground just before it leaves the wedge will be [Assume: Masses of the wedge and sphere are equal and h > > R the radius of sphere]

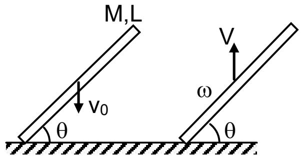


(A) $\sqrt{\frac{3gh}{7}}$ (B) $\sqrt{\frac{3}{7}gh}$ (C) $\sqrt{\frac{5}{7}gh}$ (D) $\sqrt{\frac{6}{5}gh}$

5. A thin circular ring of mass M and radius R rotates about an axis through its centre and perpendicular to its plane, with a constant angular velocity ω. Four small spheres each of mass m (negligible radius) are kept gently to the opposite ends of two mutually perpendicular diameters of the ring. The new angular velocity of the ring will be

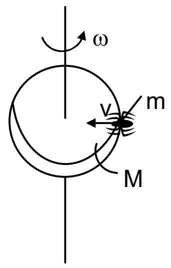
(A) $\left(\frac{M+4m}{M}\right)\omega$ (B) $\frac{M}{4m}\omega$ (C) $\left(\frac{M}{M-4m}\right)\omega$ (D) $\left(\frac{M}{M+4m}\right)\omega$

6. A uniform bar of mass M and length L collides with a horizontal surface. Before collision velocity of COM of bar was V_0 and angular velocity was zero. Just after collision velocity of centre of mass of bar becomes V in upward direction (as shown in the figure). Angular velocity of bar just after impact is



(A) $\frac{6(V_0+v)\cos\theta}{L}$ (B) $\frac{6(V_0-v)\cos\theta}{L}$ (C) $\frac{(V_0+v)\cos\theta}{6L}$ (D) $\frac{(V_0-v)\cos\theta}{6L}$

7. An insect of mass m is moving radially inwards at a constant low speed v with respect to the cylindrical round table of radius R and mass M. The system is freely rotating about an axis through the centre. The initial position of the insect is at the outer edge and angular speed of the table is ω_0. What is the angular speed of the table after a time t seconds. (0 < t < R/V)



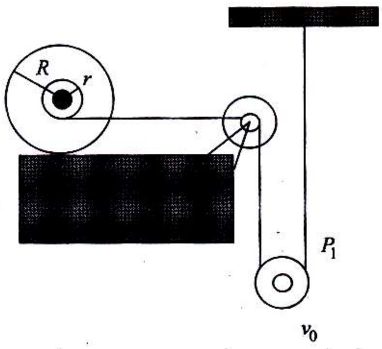
(A) $\frac{(m+M)R^2\omega_0}{MR^2+mV^2t^2}$ (B) $\frac{\left(m+\frac{M}{2}\right)R^2\omega_0}{\frac{MR^2}{2}+mV^2t^2}$

(C) $\frac{(m+M)R^2\omega_0}{\frac{MR^2}{2}+m(R-Vt)^2}$ (D) $\frac{\left(m+\frac{M}{2}\right)R^2\omega_0}{\frac{MR^2}{2}+m(R-Vt)^2}$

MULTI CORRECT OPTION TYPE

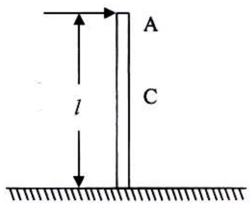
8. A rod of uniform cross section is thrown in gravitational field such that the velocity of centre of mass is $\sqrt{8}$ m/s and makes an angle of 60° with the horizontal. Its initial angular speed about an axis through centre of mass is 12 rad/s. The mass of the rod is 0.2 kg and its length is 1 m. Then which of the following is/are correct.
(A) its angular speed at the highest position is 12 rad/s
(B) its angular speed at the highest position is 6 rad/s
(C) ratio of total kinetic energy at the highest position to total initial kinetic energy is 7 : 10
(D) ratio of total kinetic energy at the highest position to total initial kinetic energy is 5 : 8

9. A bobbin with thread around it lies on a horizontal floor and can roll along it without slipping. Both pulleys P_1 and P_2 are light and frictionless. The pulley P_1 moves downwards with constant velocity v_0. The velocity of centre of mass of bobbin is
(A) in backward direction
(B) cannot be calculated
(C) remains stationary
(D) in forward direction



10. A solid sphere of mass 'm' is rolling down an inclined surface inclined at an angle θ to the horizontal without slipping. Then
(A) the frictional force acting on the sphere is f = μ mg cos θ ($\mu \rightarrow$ coefficient of static friction)
(B) 'f' is dissipative force
(C) Friction will increase the sphere's angular velocity and decrease its linear velocity
(D) If θ decreases, friction will decrease

11. A uniform slender rod of length ℓ = 1 m/s initially standing vertically on a smooth horizontal surface (as in the figure). It is struck by a sharp horizontal blow at the top end A, with the blow directed at right angles to the rod axis. As a result, the rod acquires an angular velocity of 3 rad/s. Then, immediately after the blow
(A) the translational velocity of the centre of mass C of the rod is zero
(B) the translational velocity of the centre of mass C of the rod is 0.5 m/s
(C) the point P of the rod which remains stationary is at AP = $\frac{\ell}{2}$
(D) the point P of the rod which remains stationary is at AP = $\frac{2\ell}{3}$.

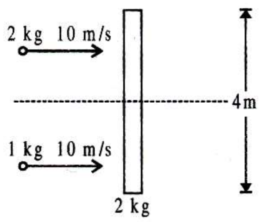


12. A table has a heavy circular top of radius r and mass M. It has four light legs fixed symmetrically on its circumference.
(A) the area of the circular table top, over which any weight may be placed without toppling it will be square shape
(B) the maximum area of the table top over which any weight may be placed without toppling it is $2r^2$.
(C) the maximum mass that may be placed anywhere on the table without toppling it is $\left(\frac{M}{\sqrt{2}-1}\right)$
(D) the maximum mass that may be placed anywhere on the table without toppling it is M

PARAGRAPH 1

A long rod of mass 2 kg and length 4 m is placed on a smooth horizontal table. Two particles of masses 2kg and 1kg strike the rod simultaneously and stick to the rod after collision as shown.

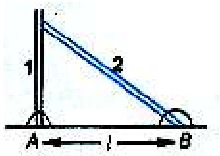
13. Velocity of C.O.M of the rod after the collision is
(A) 3 m/s
(B) 6 m/s
(C) 9 m/s
(D) 12 m/s



14. If two particles strike the rod in opposite direction, then after collision, as compared to the previous situation, so the rod will
(A) Rotate faster and translate slower. (B) Rotate slower and + translate faster
(C) Show no change in linear or angular velocity (D) Rotate faster, but translate at the same rate.

PARAGRAPH 2

Two rods (1) and (2) are released from rest as shown in figure. Given $I_1 = 4I,\ m_1 = 2m,\ I_2 = 2I,\ m_2 = m$. There is no friction between the 2 rods. If α be the angular acceleration of rod 1 just after the rods are released, then answer the following questions



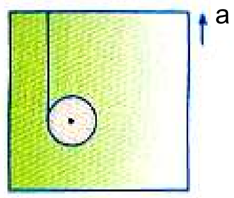
15. What is the normal reaction between the two rods at this instant?
(A) $16\sqrt{3}\ m\ell\alpha$ (B) $\frac{4}{\sqrt{3}} m\ell\alpha$ (C) $\frac{32}{\sqrt{3}} m\ell\alpha$ (D) $12\sqrt{3}\ m\ell\alpha$

16. What is the horizontal force on rod 1 by hinge A at this instant?
(A) $\left(\frac{32-12\sqrt{3}}{3\sqrt{3}}\right) m\ell\alpha$ (B) $\left(\frac{16-2\sqrt{3}}{\sqrt{3}}\right) m\ell\alpha$ (C) $(14+2\sqrt{3})\ m\ell\alpha$ (D) $12\sqrt{3}\ m\ell\alpha$

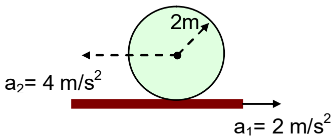
17. What is the angular acceleration of rod 2 in terms of the given parameters in the question?
(A) $\left(\frac{2\sqrt{3}}{2\ell} g + 2\sqrt{3}\alpha\right)$ (B) $\left(\frac{3}{8}\frac{g}{\ell} - 8\alpha\right)$ (C) $\left(\frac{6\sqrt{3}}{8\ell} g + 5\sqrt{3}\alpha\right)$ (D) $\left(\frac{3\sqrt{3}}{8\ell} g - \frac{8\alpha}{\sqrt{3}}\right)$

INTEGER

18. In the figure shown a thin light inextensible string is wrapped around a uniform disc. One end of the string is fixed to the ceiling of the lift and the other end is fixed to the circumference of the disc. Acceleration 'a' of the lift in such that the centre of disc doesn't move with respect to ground. Find the value of $\frac{a}{g}$. String doesn't slip on pulley.



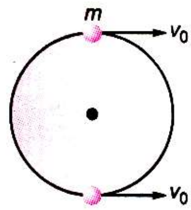
19. In the figure, a sphere of radius 2 m is rolling without slipping on a plank. The accelerations of the sphere and the plank are indicated. Find the value of α (in rad/s^2)



CONSERVATION OF LINEAR MOMENTUM

SINGLE CORRECT OPTION TYPE

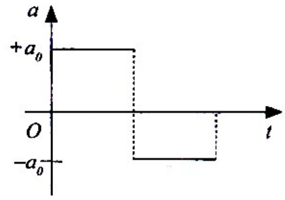
1. Two small beads each of mass m are attached to a smooth ring of mass m as shown in the figure. The beads can slide on the ring. The whole system is kept on a smooth horizontal table. Initially each bead has given velocity v_0 as shown. The velocity of the ring and the beads just before their impact is

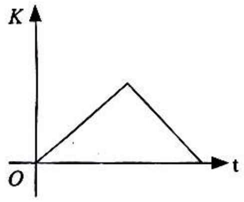


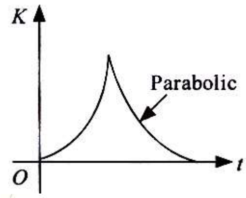
(A) $v_0, \frac{\sqrt{7}}{3} v_0$ (B) $\frac{2}{3} v_0, \frac{\sqrt{7}}{3} v_0$
(C) $\frac{2}{3} v_0, \frac{2}{7} v_0$ (D) $v_0, \frac{2}{7} v_0$

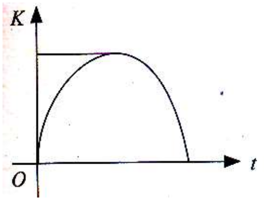
2. A particle of mass m moving with velocity v_0 collides head on inelastically (e = 0) with another particle of mass M. The fractional energy $\left(\frac{K_f}{K_i}\right)$ remaining with the system after collision is
(A) $\frac{m}{M}$ (B) $\frac{M}{(m+M)}$ (C) $\frac{m}{(m+M)}$ (D) $\frac{(M-m)}{(M+m)}$

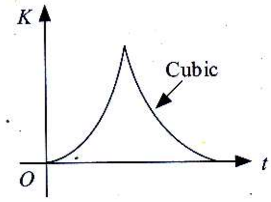
3. A particle starts moving along a straight line with constant acceleration as shown in the figure. Identify the graph showing the correct variation of kinetic energy (K) versus time (t).



(A) 

(B) 

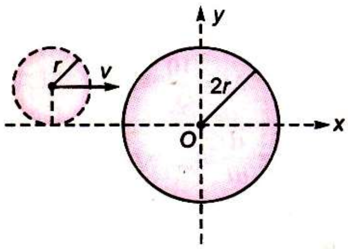
(C) 

(D) 

4. A man standing on a trolley pushes another identical trolley (both the trolleys are initially at rest on a rough surface), so that they are set in motion and stop after some time. If the ratio of mass of 1st trolley with man to mass of 2nd trolley is 3, then the ratio of the stopping distances of the trolleys would be

(A) $\frac{1}{3}$ (B) 3 (C) $\frac{1}{9}$ (D) 3

5. A small smooth disc of mass m and radius r moving with an initial velocity v along the positive x-axis collides with a big disc of mass 2 m and radius 2 r which was initially at rest with its centre at origin as shown in figure if the coefficient of restitution is zero, then velocity of larger disc after collision is



(A) $\frac{8v}{27}\hat{i}-\frac{2\sqrt{2}}{27}v\,\hat{j}$ (B) $\frac{8v}{27}\hat{i}+\frac{2\sqrt{2}}{27}v\,\hat{j}$ (C) $\frac{v}{3}\hat{i}$ (D) $\frac{2\sqrt{2}}{27}v\,\hat{i}-\frac{8v}{27}\hat{j}$

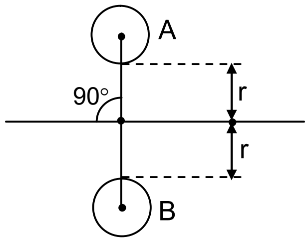
6. The centre of mass of a system of three particles of masses 1 g, 2 g and 3 g is taken as the origin of a coordinate system. The position vector of a fourth particle of mass 4 g such that the centre of mass of the four particle system lies at the point (1, 2, 3) is $\alpha(\hat{i}+2\hat{j}+3\hat{k})$, where α is a constant. The value of α is

(A) $\frac{10}{3}$ (B) $\frac{5}{2}$ (C) $\frac{1}{2}$ (D) $\frac{2}{5}$

7. A train is running at a speed of 108 km/h. An inspection cart is also moving with a speed 10 m/s in the same direction as the train. The train hits the cart $\left(e=\frac{1}{2}\right)$. The velocity of the cart after the collision is

(A) 20 m/s (B) 30 m/s (C) 40 m/s (D) 50 m/s

8. Two identical caroms coins A and B are initially at rest and the distance between their centres is 4r. The mass and radius of A and B are m and r respectively. A striker C of mass $\frac{3m}{2}$ and radius 3r moves along the perpendicular bisector of line segment connecting the centres of coins with an initial speed u_c and it collides elastically with the coins. Then which of the following is/are correct.

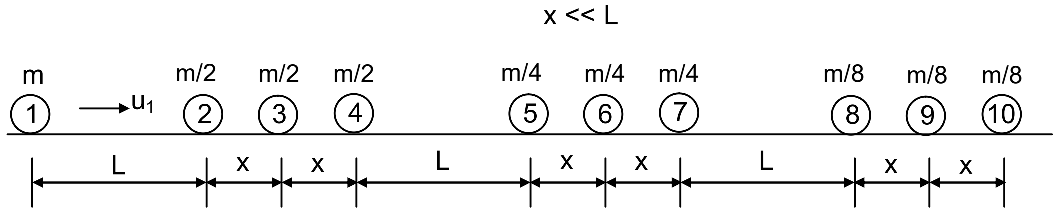


(A) the speed of striker C after collision is zero.

(B) the speed of striker C after collision is $\frac{2u_c}{3}$

(C) the speeds of coin A and coin B are $\frac{u_c}{2}$ with an included angle of 90°

9. There are ten balls placed on a smooth horizontal surface along a straight line so that head on collision can occur between them. The masses and spacing between them are shown in the diagram where x is very small when compared with L. The coefficient of restitution for all the collisions is 1. Initial speed of ball(1) is u_1 and those of remaining 9 balls are zero. Then which of the following is correct?



(A) time between the starting of ball (1) and ball (10) approximately is

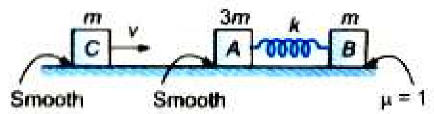
$$\frac{L}{u_1}\left[1+\left(\frac{3}{4}\right)^3+\left(\frac{3}{4}\right)^6\right]$$

(B) time between the starting of ball (1) and ball (10) approximately is $\frac{L}{u_1}\left[1+\left(\frac{3}{4}\right)+\left(\frac{3}{4}\right)^2\right]$

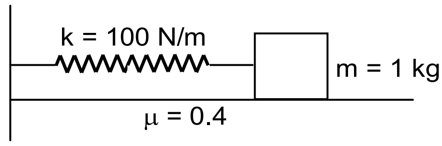
(C) the final speed of 10^{th} ball is $\left(\frac{4}{3}\right)^9 u_1$

(D) the final speed of 10^{th} ball is $\left(\frac{4}{3}\right)^5 u_1$

10. A block of mass m collides with another block of mass 3 m completely inelastically as shown in figure. What is the maximum value of ν for which the block B doesn't move. Assume that initially spring is in natural length and blocks A and B are at rest. (k/m = 100 SI unit)

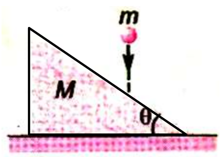


11. A spring mass system is kept on a horizontal rough surface having coefficient of friction μ = 0.4. The spring is connected to the vertical wall. The spring is extended by 27 cm to the right and then it is released. The total distance travelled by the block before it comes to permanent rest is n x 10 in cm find n.



Paragraph 1

A ball of mass m = 1kg is colliding with a wedge of mass M = 0.9 kg with a velocity of 15 m/s as shown in the figure. After striking the wedge, the ball rebounds in some arbitrary direction and, due to the impulse the wedge recoils in backward direction with a speed of 10 m/s. Assume all the surfaces to be smooth: Take θ = 37° and g = 10 m/s^2. Duration of collision is 10 sec.

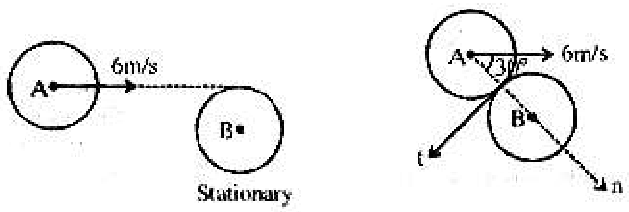


12. The velocity of the ball after collision would be
(A) $\sqrt{90}$ m/s (B) 10 m/s (C) 5 m/s (D) 14.3 m/s

13. The coefficient of restitution between ball and wedge is
(A) 0.5 (B) 0.75 (C) 0.68 (D) 0.4

Paragraph 2

Two identical smooth spheres undergo a collision for which coefficient of restitution is 0.6. The initial velocities are indicated in figure.

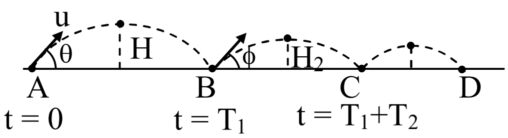


14. The speed of sphere B after collision is
(A) 3.17 m/s (B) 4.16 m/s (C) 1.039 m/s (D) 3 m/s

15. The speed of the ball A after collision
(A) 3.17 m/s (B) 1.039 m/s (C) 4.16 m/s (D) 3 m/s

MATRIX MATCH TYPE

16. A particle of mass m is projected with an initial velocity u at an angle θ with the horizontal. It collides the horizontal smooth surface inelasticlly at B,C,D etc. The coefficient of restitution is e. Match the following



	Column – I		Column – II
(A)	$\frac{H_1}{H_2}$ (ratio of successive maximum heights)	(p)	e^{-1}
(B)	$\frac{AB}{BC}$	(q)	e^{-2}
(C)	$\frac{T_1}{T_2}$ (ratio of successive time of flights)	(r)	e
(D)	$\frac{\tan\phi}{\tan\theta}$	(s)	e^2

ROTATION

1.	**D**	**2.**	**B**	**3.**	**A**	**4.**	**A**
5.	**D**	**6.**	**A**	**7.**	**D**	**8.**	**A, C**
9.	**D**	**10.**	**C,D**	**11.**	**B,D**	**12.**	**A,B,C**
13.	**A**	**14.**	**A**	**15.**	**C**	**16.**	**A**
17.	**B**	**18.**	**2**	**19.**	**3**		

CONSERVATION OF LINEAR MOMENTUM

1.	**B**	**2.**	**C**	**3.**	**B**	**4.**	**C**
5.	**A**	**6.**	**B**	**7.**	**C**	**8.**	
9.	**B**	**10.**	**2**	**11.**	**9**	**12.**	**A**
13.	**B**	**14 .**	**B**	**15.**	**A**		

16. **A – q; B – p ; C – p; D – r**