GGSRDN
Educational Services Private Limited
9th, 10th, NEET, JEE(Main/Advanced)
अभ्यास ही सबसे बड़ा गुरु है।

CLASS : XI (PHYSICS)

DPP

DAILY PRACTICE PROBLEM

DPP-51 TO 60

DPP 51 : **Circular Motion, Center of Mass**
DPP 52 : **Center of Mass, Work, Power and Energy**
DPP 53 : **Center of Mass, Work, Power and Energy, Circular Motion**
DPP 54 : **Center of Mass, Circular Motion**
DPP 55 : **Center of Mass**
DPP 56 : **Work, Power and Energy, Center of Mass, Circular Motion**
DPP 57 : **Rigid Body Dynamics, Newton's Law of Motion, Circular Motion, Center of Mass**
DPP 58 : **Friction, Center of Mass, Rigid Body Dynamics, Rotation**
DPP 59 : **Rigid Body Dynamics, Circular Motion**
DPP 60 : **Rigid Body Dynamics, Work ,Power and Energy, Center of Mass, Friction**

PHYSICS

DPP

DAILY PRACTICE PROBLEMS

DPP No. 51

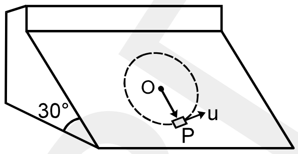
Total Marks : 30

Max. Time : 33 min.

Topics : Circular Motion, Center of Mass

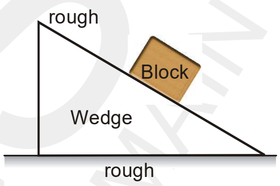
Type of Questions		M.M., Min.
Single choice Objective ('–1' negative marking) Q.1 to Q.6	(3 marks, 3 min.)	[18, 18]
Subjective Questions ('–1' negative marking) Q.7	(4 marks, 5 min.)	[4, 5]
Match the Following (no negative marking) (2 × 4)Q.8	(8 marks, 10 min.)	[8, 10]

1. A particle is attached with a string of length ℓ which is fixed at point O on an inclined plane what minimum velocity should be given to the particle along the incline so that it may complete a circle on inclined plane (plane is smooth and initially particle was resting on the inclined plane.)



(A) $\sqrt{5g\ell}$ (B) $\sqrt{\frac{5g\ell}{2}}$ (C) $\sqrt{\frac{5\sqrt{3}g\ell}{2}}$ (D) $\sqrt{4g\ell}$

2. When a block is placed on a wedge as shown in figure, the block starts sliding down and the wedge also start sliding on ground. All surfaces are rough. The centre of mass of (wedge + block) system will move

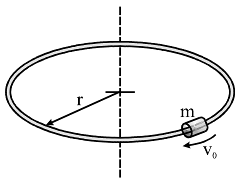


(A) leftward and downward. (B) right ward and downward.
(C) leftward and upwards. (D) only downward.

3. A shell of mass 4 kg moving with a velocity 10 m/s vertically upward explodes into three parts at a height 50 m from ground. After three seconds, one part of mass 2 kg reaches ground and another part of mass 1 kg is at height 40 m from ground. The height of the third part from the ground is: [g = 10 m/s^2]

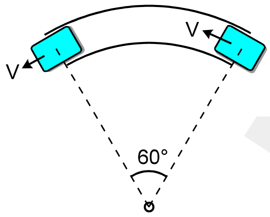
(A) 50 m (B) 80 m (C) 100 m (D) none of these

4 A small hoop of mass m is given an initial velocity of magnitude v_0 on the horizontal circular ring of radius 'r'. If the coefficient of kinetic friction is μ_k the tangential acceleration of the hoop immediately after its release is (assume the horizontal ring to be fixed and not in contact with any supporting surface)



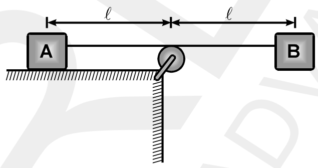
(A) $\mu_k g$ (B) $\mu_k \frac{v_0^2}{r}$ (C) $\mu_k \sqrt{g^2 + \frac{v_0^2}{r}}$ (D) $\mu_k \sqrt{g^2 + \frac{v_0^4}{r^2}}$

5. A car moves around a curve at a constant speed. When the car goes around the arc subtending 60° at the centre, then the ratio of magnitude of instantaneous acceleration to average acceleration over the 60° arc is :



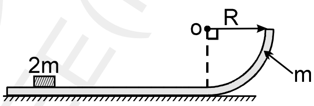
(A) $\frac{\pi}{3}$ (B) $\frac{\pi}{6}$ (C) $\frac{2\pi}{3}$ (D) $\frac{5\pi}{3}$

6. Two blocks A and B each of same mass are attached by a thin inextensible string through an ideal pulley. Initially block B is held in position as shown in figure. Now the block B is released. Bolck A will slide to right and hit the pulley in time t_A. Block B will swing and hit the surface in time t_B. Assume the surface as frictionless.



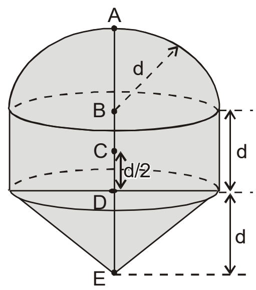
(A) $t_A = t_B$
(B) $t_A < t_B$
(C) $t_A > t_B$
(D) data are not sufficient to get relationship between t_A and t_B.

7. Mass 2m is kept on a smooth circular track of mass m which is kept on a smooth horizontal surface. The circular track is given a horizontal velocity $\sqrt{2gR}$ towards left. Find the maximum height reached by 2m.



8. **Match the following**

Following is a solid object formed by three parts which are a solid hemisphere, solid cyllinder and a solid cone. The material of the object is uniform and all the above parts are made up of the same material. The dimensions of the objects are indicated in the figure. The points A,B,C,D,E lie on the common axis of the system as shown in the figure. Point C is the centre of the cylinder.



Column I	Column II
(A) Centre of mass of the whole system lies on segment	(p) AB
(B) Centre of mass of the system of only hemisphere and cyllinder lies on segment	(q) BC
(C) Centre of mass of the system of only cone and cyllinder lies on segment	(r) CD
(D) Centre of mass of the system of only hemisphere and cone lies on segment	(s) DE

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PHYSICS

DPP

DAILY PRACTICE PROBLEMS

DPP No. 52

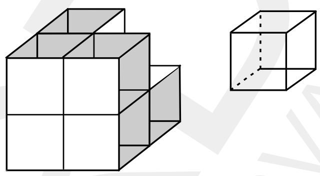
Total Marks : 24

Max. Time : 25 min.

Topics : Center of Mass, Work, Power and Energy

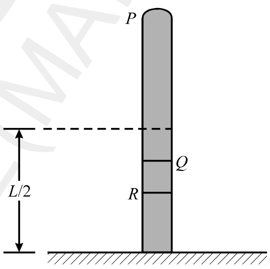
Type of Questions		**M.M., Min.**
Single choice Objective ('–1' negative marking) Q.1 to Q.4	**(3 marks, 3 min.)**	**[12, 12]**
Multiple choice objective ('–1' negative marking) Q.5 to Q.6	**(4 marks, 4 min.)**	**[8, 8]**
Subjective Questions ('–1' negative marking) Q.7	**(4 marks, 5 min.)**	**[4, 5]**

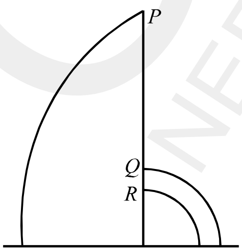
1. 8 small cubes of length ℓ are stacked together to form a single cube. One cube is removed from this system. The distance between the centre of mass of remaining 7 cubes and the original system is :

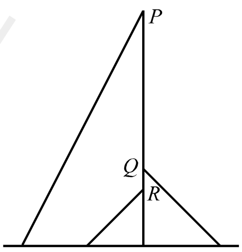


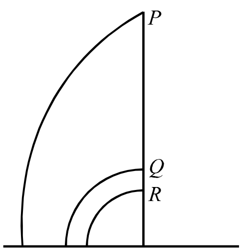
(A) $\frac{7\sqrt{3}\,\ell}{16}$ (B) $\frac{\sqrt{3}}{16}\ell$ (C) $\frac{\sqrt{3}}{14}\ell$ (D) zero

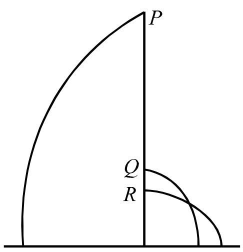
2. A uniform rod of mass M and length L falls when it is made to stand on a smooth horizontal floor. The trajectories of the points P, Q and R as shown in the figure given below is best represented by :



(A)


(B)


(C)


(D)


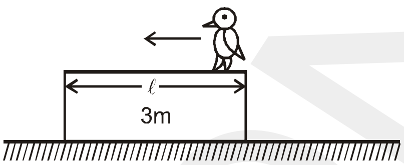
3. A man places a vertical uniform chain (of mass 'm' and length 'ℓ') on a table slowly. Initially the lower end of the chain just touches the table. The man drops the chain when half of the chain is in vertical position. Then work done by the man in this process is :

(A) $-\,mg\,\frac{\ell}{2}$ (B) $-\,\frac{mg\ell}{4}$ (C) $-\,\frac{3mg\ell}{8}$ (D) $-\,\frac{mg\ell}{8}$

4. The potential energy (in SI units) of a particle of mass 2 kg in a conservative field is U = 6x – 8y. If the initial velocity of the particle is $\vec{u} = -1.5\hat{i} + 2\hat{j}$ then the total distance travelled by the particle in first two seconds is

(A) 10 m (B) 12 m (C) 15 m (D) 18 m

5. A penguin of mass m stands at the right edge of a sled of mass 3m and legnth ℓ. The sled lies on frictionless ice. The penguin starts moving towards left, reaches the left end and jumps with a velocity u and at an angle θ relative to ground. (Neglect the height of the sled)



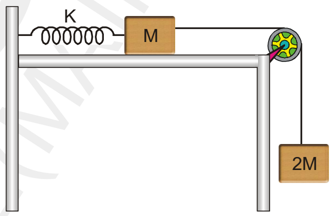
(A) Till the penguin reaches the left end, the sled is displaced by $\frac{\ell}{4}$

(B) Till the penguin reaches the left end, the sled is displaced by $\frac{\ell}{3}$

(C) After jumping, it will fall on the ground at a distance $\frac{4}{3}\frac{u^2\sin 2\theta}{g}$ from the left end of the sled.

(D) After jumping, it will fall on the ground at a distance $\frac{3}{4}\frac{u^2\sin 2\theta}{g}$ from the left end of the sled.

6. Two blocks, of masses M and 2M, are connected to a light spring of spring constant K that has one end fixed, as shown in figure. The horizontal surface and the pulley are frictionless. The blocks are released from rest when the spring is non deformed. The string is light.



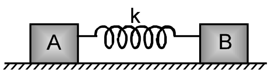
(A) Maximum extension in the spring is $\frac{4Mg}{K}$.

(B) Maximum kinetic energy of the system is $\frac{2M^2g^2}{K}$

(C) Maximum energy stored in the spring is four times that of maximum kinetic energy of the system.

(D) When kinetic energy of the system is maximum, energy stored in the spring is $\frac{4M^2g^2}{K}$

7. In the figure shown the spring is compressed by 'x_0' and released. Two blocks 'A' and 'B' of masses 'm' and '2m' respectively are attached at the ends of the spring. Blocks are kept on a smooth horizontal surface and released. Find the work done by the spring on 'A' by the time compression of the spring reduced to $\frac{x_0}{2}$.



PHYSICS
DPP
DAILY PRACTICE PROBLEMS

DPP No. 53

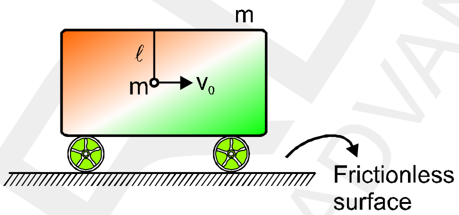
Total Marks : 27

Max. Time : 31 min.

Topics : Center of Mass, Work, Power and Energy, Circular Motion

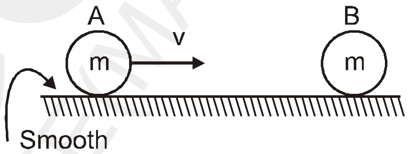
Type of Questions		M.M., Min.
Single choice Objective ('–1' negative marking) Q.1	(3 marks, 3 min.)	[3, 3]
Multiple choice objective ('–1' negative marking) Q.2 to Q.3	(4 marks, 4 min.)	[8, 8]
Subjective Questions ('–1' negative marking) Q.4 to Q.5	(4 marks, 5 min.)	[8, 10]
Match the Following (no negative marking) (2 × 4)Q.6	(8 marks, 10 min.)	[8, 10]

1. A small bob of mass 'm' is suspended by a massless string from a cart of the same mass 'm' as shown in the figure. The friction between the cart and horizontal ground is negligible. The bob is given a velocity V_0 in horizontal direction as shown. The maximum height attained by the bob is, (initially whole system (bob + string + cart) was at rest).



(A) $\frac{2V_0^2}{g}$ (B) $\frac{V_0^2}{g}$ (C) $\frac{V_0^2}{4g}$ (D) $\frac{V_0^2}{2g}$

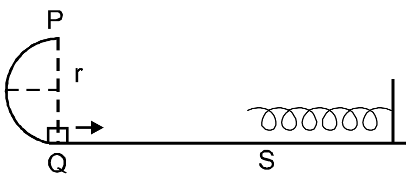
2. In the figure shown, coefficient of restitution between A and B is e = $\frac{1}{2}$, then :



(A) velocity of B after collision is $\frac{v}{2}$ (B) impulse on one of the balls during collision is $\frac{3}{4}$mv

(C) loss of kinetic energy in the collision is $\frac{3}{16}$mv^2 (D) loss of kinetic energy in the collision is $\frac{1}{4}$mv^2

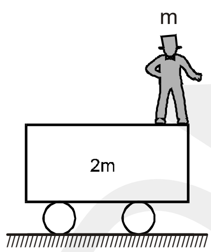
3. The circular vertical section of the fixed track shown is smooth with radius r = 0.9 cm and the horizontal straight section is rough with μ = 0.1. A block of mass 1 kg is placed at point 'Q' and given a horizontal velocity of $\sqrt{3}$ m/s towards the spring. Distance QS = 40 cm and maximum compression in the spring is 10 cm during the motion (g = 10 m/s^2) :



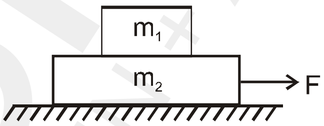
(A) The force constant of the spring is 200 N/m
(B) The velocity with which block returns to point 'Q' is 1 m/s
(C) At point P its velocity will be 0.8 m/s
(D) At point P, the normal reaction on the block is less than 55 N

4. The end 'A' of a uniform rod AB of length 'ℓ' touches a horizontal smooth fixed surface. Initially the rod makes an angle of 30° with the vertical. Find the magnitude of displacement of the end B just before it touches the ground after the rod is released.

5. A man is standing on a cart of mass double the mass of the man. Initially cart is at rest on the smooth ground. Now man jumps with relative velocity 'v' horizontally towards right with respect to cart. Find the work done by man during the process of jumping.



6. A small block of mass m_1 lies over a long plank of mass m_2. The plank in turn lies over a smooth horizontal surface. The coefficient of friction between m_1 and m_2 is μ. A horizontal force F is applied to the plank as shown in figure. Column-I gives four situation corresponding to the system given above. In each situation given in column-I, both bodies are initially at rest and subsequently the plank is pulled by the horizontal force F. Take length of plank to be large enough so that block does not fall from it. Match the statements in column-I with results in column-II.



Column-I	Column-II
(A) If there is no relative motion between the block and plank, the work done by force of friction acting on block in some time interval is	(p) positive
(B) If there is no relative motion between the block and plank, the work done by force of friction acting on plank is some time interval	(r) zero
(C) If there is relative motion between the block and plank, then work done by friction force acting on block plus work done by friction acting on plank is	(q) negative
(D) If there is no relative motion between the block and plank, then work done by friction force acting on block plus work done by friction acting on plank is	(s) is equal to non mechanical energy produced

PHYSICS

DPP
DAILY PRACTICE PROBLEMS

DPP No. 54

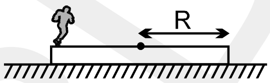
Total Marks : 27

Max. Time : 29 min.

Topics : Center of Mass, Circular Motion

Type of Questions		M.M., Min.
Single choice Objective ('–1' negative marking) Q.1 to Q.2	(3 marks, 3 min.)	[6, 6]
Multiple choice objective ('–1' negative marking) Q.3	(4 marks, 4 min.)	[4, 4]
Subjective Questions ('–1' negative marking) Q.4 to Q.5	(4 marks, 5 min.)	[8, 10]
Comprehension ('–1' negative marking) Q.6 to Q.8	(3 marks, 3 min.)	[9, 9]

1. A uniform disc of mass 'm' and radius R is placed on a smooth horizontal floor such that the plane surface of the disc is in contact with the floor. A man of mass m/2 stands on the disc at its periphery. The man starts walking along the periphery of the disc. The size of the man is negligible as compared to the size of the disc. Then the centre of disc.



(A) moves along a circle of radius $\frac{R}{3}$ (B) moves along a circle of radius $\frac{2R}{3}$

(C) moves along a circle of radius $\frac{R}{2}$ (D) does not move along a circle

2. For a two-body system in absence of external forces, the kinetic energy as measured from ground frame is K_o and from center of mass frame is K_{cm}. Pick up the wrong statement

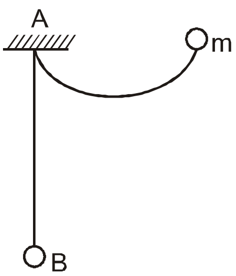
(A) The kinetic energy as measured from center of mass frame is least

(B) Only the portion of energy K_{cm} can be transformed from one form to another due to internal changes in the system.

(C) The system always retains at least $K_o - K_{cm}$ amount of kinetic energy as measured from ground frame irrespective of any kind of internal changes in the system.

(D) The system always retains at least K_{cm} amount of kinetic energy as measured from ground frame irrespective of any kind of internal changes in the system

3. A ball of mass m = 200 gm is suspended from a point A by an inextensible string of length L. Ball is drawn to a side and held at same level as A but at a distance $\frac{\sqrt{3}}{2}L$ from A as shown. Now the ball is released. Then : (assume string applies only that much jerk which is required so that velocity along string becomes zero).



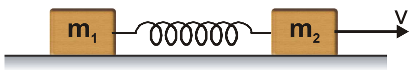
(A) speed of ball just before experiencing jerk is $\sqrt{gL}$

(B) speed of ball just after experiencing jerk is $\frac{\sqrt{3gL}}{2}$

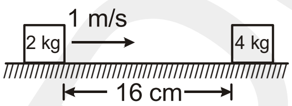
(C) Impulse applied by string $\frac{\sqrt{gL}}{10}$

(D) ball will experience jerk after reaching to point B.

4. Two blocks of mass m_1 and m_2 are connected with an ideal spring on a smooth horizontal surface as shown in figure. At t = 0 m_1 is at rest and m_2 is moving with a velocity v towards right. At this time spring is in its natural length. Prove that if $m_1 < m_2$ block of mass m_2 will never come to rest.

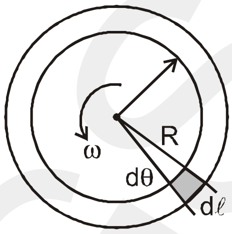


5. The friction coefficient between the horizontal surface and each of the blocks shown in figure is 0.20. The collision between the blocks is perfectly elastic. Find the separation between the two blocks (in cm) when they come to rest. Take g = 10 m/s².



COMPREHENSION

A ring of radius R is made of a thin wire of material of density ρ having cross section area a. The ring rotates with angular velocity ω about an axis passing through its centre and perpendicular to the plane. If we consider a small element of the ring, it rotates in a circle. The required centripetal force is provided by the component of tensions on the element towards the centre. A small element of length $d\ell$ of angular width dθ is shown in the figure.



6. The centripetal force acting on the element is

(A) $(a.\rho\, d\ell\, \omega^2 R)$ (B) $R^2 d\theta.\omega^2$ (C) $\frac{1}{2} a\rho\, d\ell\, \omega^2 R$ (D) zero

7. If T is the tension in the ring, then

(A) $T = \frac{a\rho R^2\omega^2}{2}$ (B) $T = a\,\rho\, R^2\omega^2$ (C) $a^2\,\rho\,\omega^2$ (D) $T = 2\,a\,\rho\,R^2\omega^2$

8. If for a given mass of the ring and angular velocity, the radius R of the ring is increased to 2R, the new tension will be

(A) T/2 (B) T (C) 2T (D) 4T

PHYSICS

DPP

DAILY PRACTICE PRACTICE PROBLEMS

DPP No. 55

Total Marks : 24

Max. Time : 24 min.

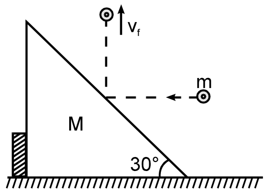
Topic : Center of Mass

Type of Questions		**M.M., Min.**
Single choice Objective ('–1' negative marking) Q.1 to Q.3	**(3 marks, 3 min.)**	**[9, 9]**
Comprehension ('–1' negative marking) Q.4 to Q.8	**(3 marks, 3 min.)**	**[15, 15]**

1. A glass ball collides with a smooth horizontal surface in xz plane with a velocity $\vec{v} = a\hat{i} - b\hat{j}$. If the coefficient of restitution of collision is e, then the velocity of the ball just after the impact will be :

(A) $a\hat{i} + b\hat{j}$ (B) $a\hat{i} + eb\hat{j}$ (C) $a\hat{i} - b\hat{j}$ (D) $a\hat{i} - eb\hat{j}$

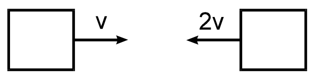
2. As shown in the figure a body of mass m moving horizontally with speed $\sqrt{3}$ m/s hits a fixed smooth wedge and goes up with a velocity v_f in the vertical direction. If $\angle$ of wedge is 30°, the velocity v_f will be:



(A) $\sqrt{3}$ m/s (B) 3 m/s

(C) $\frac{1}{\sqrt{3}}$ m/s (D) this is not possible

3. A plank of mass m moving with a velocity 'v' along a frictionless horizontal track and a body of mass m/2 moving with 2v collides with plank elastically. Final speed of the plank is :



(A) $\frac{5v}{3}$ (B) $\frac{3v}{3}$ (C) $\frac{2v}{3}$ (D) none of these

COMPREHENSION

Two friends A and B (each weighing 40 kg) are sitting on a frictionless platform some distance d apart. A rolls a ball of mass 4 kg on the platform towards B which B catches. Then B rolls the ball towards A and A catches it. The ball keeps on moving back and forth between A and B. The ball has a fixed speed of 5 m/s on the platform.

4. Find the speed of A after he rolls the ball for the first time

(A) 0.5 m/s (B) 5m/s (C) 1 m/s (D) None of these

5. Find the speed of A after he catches the ball for the first time.

(A) $\frac{10}{21}$ m/s (B) $\frac{50}{11}$ m/s (C) $\frac{10}{11}$ m/s (D) None of these

6. Find the speeds of A and B after the ball has made 5 round trips and is held by A :

(A) $\frac{10}{11}$ m/s , $\frac{50}{11}$ m/s (B) $\frac{50}{11}$ m/s, $\frac{10}{11}$ m/s (C) $\frac{50}{11}$ m/s, 5 m/s (D) None of these

7. How many times can A roll the ball ?

(A) 6 (B) 5 (C) 7 (D) None of these

8. Where is the centre of mass of the system " A + B + ball" at the end of the nth trip? (Give the distance from the initail position of A)

(A) $\frac{10}{11}$ d (B) $\frac{10}{21}$ d (C) $\frac{50}{11}$ d (D) None of these

PHYSICS DPP

DAILY PRACTICE PROBLEMS

DPP No. 56

Total Marks : 23

Max. Time : 23 min.

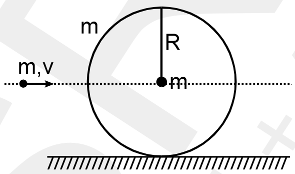
Topics : Work, Power and Energy, Center of Mass, Circular Motion

Type of Questions		M.M., Min.
Single choice Objective ('–1' negative marking) Q.1 to Q.4	(3 marks, 3 min.)	[12, 12]
Multiple choice objective ('–1' negative marking) Q.5 to Q.6	(4 marks, 4 min.)	[8, 8]
Assertion and Reason (no negative marking) Q. 7	(3 marks, 3 min.)	[3, 3]

1. A stone of mass M is tied at the end of a string, is moving in a circle of radius R, with a constant angular velocity ω. The total work done on the stone, in any half circle, is :

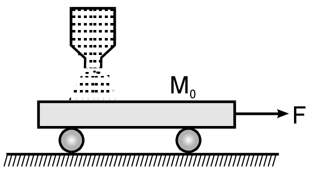
(A) $\pi MR^2\omega^2$ (B) $2\ MR^2\omega^2$ (C) $MR^2\omega^2$ (D) 0

2. A hollow sphere of mass 'm' and radius R rests on a smooth horizontal surface. A simple pendulum having string of length R and bob of mass m hangs from top most point of the sphere as shown. A bullet of mass 'm' and velocity 'v' partially penetrates the left side of the sphere and stick to it. The velocity of the sphere just after collision with bullet is.



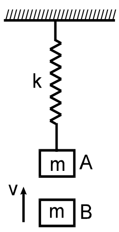
(A) $\frac{v}{2}$ (B) $\frac{v}{3}$ (C) $\frac{2v}{3}$ (D) $\frac{3v}{5}$

3. In the fig. shown a cart moves on a smooth horizontal surface due to an external constant force of magnitude F. The initial mass of the cart is M_0 and velocity is zero. Sand falls on to the cart with negligible velocity at constant rate μ kg/s and sticks to the cart. The velocity of the cart at time t is :



(A) $\frac{Ft}{M_0+\mu t}$ (B) $\frac{Ft}{M_0}e^{\mu t}$ (C) $\frac{Ft}{M_0}$ (D) $\frac{Ft}{M_0+\mu t}e^{\mu t}$

4. Block 'A' is hanging from a vertical spring and is at rest. Block 'B' strikes the block 'A' with velocity 'v' and sticks to it. Then the value of 'v' for which the spring just attains natural length is:



(A) $\sqrt{\frac{60\ mg^2}{k}}$ (B) $\sqrt{\frac{6\ mg^2}{k}}$

(C) $\sqrt{\frac{10\ mg^2}{k}}$ (D) none of these

5. A strip of wood of mass M and length ℓ is placed on a smooth horizontal surface. An insect of mass m starts at one end of the strip and walks to the other end in time t moving with a constant speed.

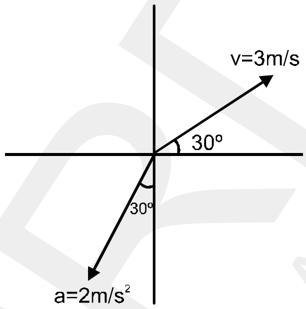
(A) the speed of insect as seen from the ground is $< \frac{\ell}{t}$

(B) the speed of the strip as seen from the ground is $\frac{\ell}{t}\left(\frac{M}{M+m}\right)$

(C) the speed of the insect as seen from the ground is $\frac{\ell}{t}\left(\frac{M}{M+m}\right)$

(D) the total kinetic energy of the system is $\frac{1}{2}(m+M)\left(\frac{\ell}{t}\right)^2$.

6. Initial velocity and acceleration of a particle are as shown in the figure. Acceleration vector of particle remain constant. Then radius of curvature of path of particle :



(A) is 9m initially

(B) is $\frac{9}{\sqrt{3}}$ m initially

(C) will have minimum value of $\frac{9}{8}$ m

(D) will have minimum value $\frac{3}{8}$ m

7. **STATEMENT-1 :** A sphere of mass m moving with speed u undergoes a perfectly elastic head on collision with another sphere of heavier mass M at rest (M > m), then direction of velocity of sphere of mass m is reversed due to collision [no external force acts on system of two spheres]

STATEMENT-2 : During a collision of spheres of unequal masses, the heavier mass exerts more force on lighter mass in comparison to the force which lighter mass exerts on heavier mass.

(A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.
(B) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1
(C) Statement-1 is True, Statement-2 is False
(D) Statement-1 is False, Statement-2 is True

PHYSICS DPP
DAILY PRACTICE PROBLEMS

DPP No. 57

Total Marks : 24

Max. Time : 25 min.

Topics : Rigid Body Dynamics, Newton's Law of Motion, Circular Motion, Center of Mass

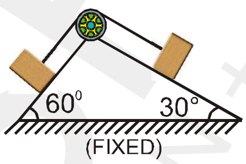
Type of Questions		M.M., Min.
Single choice Objective ('–1' negative marking) Q.1 to Q.4	(3 marks 3 min.)	[12, 12]
Multiple choice objective ('–1' negative marking) Q.5 to Q.6	(4 marks 4 min.)	[8, 8]
Subjective Questions ('–1' negative marking) Q.7	(4 marks 5 min.)	[4, 5]

1. The moment of inertia of a door of mass m, length 2ℓ and width ℓ about its longer side is

(A) $\frac{11m\ell^2}{24}$ (B) $\frac{5m\ell^2}{24}$

(C) $\frac{m\ell^2}{3}$ (D) none of these

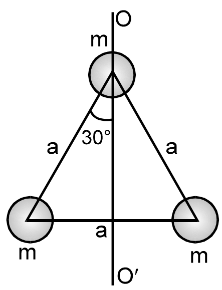
2. Two blocks of equal mass are ties with a light string which passes over a massless pulley as shown in figure. The magnitude of acceleration of centre of mass of both the blocks is (neglect friction everywhere):



(A) $\frac{\sqrt{3}-1}{4\sqrt{2}}g$ (B) $(\sqrt{3}-1)g$

(C) $\frac{g}{2}$ (D) $\left(\frac{\sqrt{3}-1}{\sqrt{2}}\right)g$

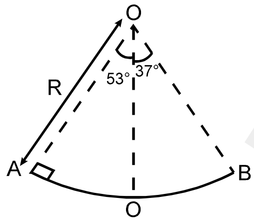
3. Three point masses are arranged as shown in the figure. Moment of inertia of the system about the axis OO' is : (passing through its plane)



(A) $2ma^2$ (B) $\frac{ma^2}{2}$

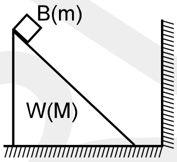
(C) ma^2 (D) none of these

4. A section of fixed smooth circular track of radius R in vertical plane is shown in the figure. A block is released from position A and leaves the track at B. The radius of curvature of its trajectory when it just leaves the track at B is:



(A) R (B) $\frac{R}{4}$ (C) $\frac{R}{2}$ (D) none of these

5. In the figure, the block B of mass m starts from rest at the top of a wedge W of mass M. All surfaces are without friction. W can slide on the ground. B slides down onto the ground, moves along ground with a speed υ, has an elastic collision with the wall, and climbs back onto W.



(A) B will reach the top of W again

(B) from the beginning, till the collision with the wall, the centre of mass of 'B + W' is stationary in horizontal direction

(C) after the collision the centre of mass of 'B + W' moves with the velocity $\frac{2m\upsilon}{m+M}$

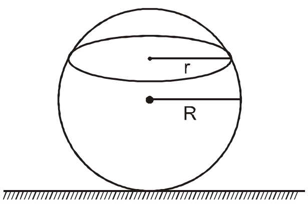
(D) when B reaches its highest position on W, the speed of W is $\frac{2m\upsilon}{m+M}$

6. In a free space a rifle of mass M shoots a bullet of mass m at a stationary block of mass M distance D away from it. When the bullet has moved through a distance d towards the block the centre of mass of the bullet-block system is at a distance of :

(A) $\frac{(D-d)\,m}{M+m}$ from the block (B) $\frac{md+MD}{M+m}$ from the rifle

(C) $\frac{2\,dm+DM}{M+m}$ from the rifle (D) $(D-d)\frac{M}{M+m}$ from the bullet

7. A uniform circular chain of radius r and mass m rests over a sphere of radius R as shown in figure. Friction is absent everywhere and system is in equilibrium. Find the tension in the chain.



PHYSICS
DPP
DAILY PRACTICE PROBLEMS

DPP No. 58

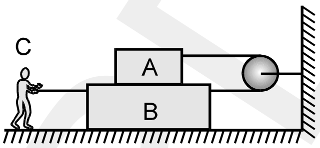
Total Marks : 31

Max. Time : 35 min.

Topics : Friction, Center of Mass, Rigid Body Dynamics, Rotation

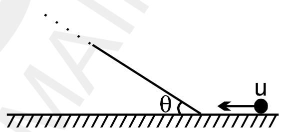
Type of Questions		M.M., Min.
Single choice Objective ('–1' negative marking) Q .1 to Q.4	(3 marks, 3 min.)	[12, 12]
Subjective Questions ('–1' negative marking) Q.5 to Q.8	(4 marks, 5 min.)	[16, 20]
Assertion and Reason (no negative marking) Q. 9	(3 marks, 3 min.)	[3 , 3]

1. In the figure $m_A = m_B = m_C = 60$ kg. The co-efficient of friction between C and ground is 0.5, B and ground is 0.3, A & B is 0.4. C is pulling the string with the maximum possible force without moving. Then tension in the string connected to A will be:



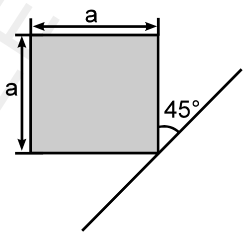
(A) 120 N
(B) 60 N
(C) 100 N
(D) zero

2. A particle of mass m is given initial speed u as shown in the figure. It move to the fixed inclined plane without a jump, that is, its trajectory changes sharply from the horizontal line to the inclined line. All the surfaces are smooth and $90° \geq \theta > 0°$. Then the height to which the particle shall rise on the inclined plane (assume the length of the inclined plane to be very large)



(A) increases with increase in θ
(B) decreaseswith increase in θ
(C) is independent of θ
(D) data insufficient

3. The moment of inertia of a thin sheet of mass M of the given shape about the specified axis is (axis and sheet both are in same plane:)



(A) $\frac{7}{12}Ma^2$
(B) $\frac{5}{12}Ma^2$
(C) $\frac{1}{3}Ma^2$
(D) $\frac{1}{12}Ma^2$

4. A man stands at one end of a boat which is stationary in water. Neglect water resistance. The man now moves to the other end of the boat and again becomes stationary. The centre of mass of the 'man plus boat' system will remain stationary with respect to water.

(A) in all cases

(B) only when the man is stationary initially and finally

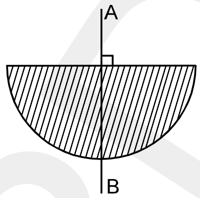
(C) only if the man moves without acceleration on the boat

(D) only if the man and the boat have equal masses.

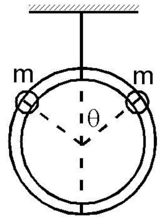
5. A uniform semicircular disc of mass ‘m’ and radius ‘R’ is shown in the figure. Find out its moment of inertia about

(a) axis ‘AB’ (shown in the figure) which passes through geometrical centre and lies in the plane of the disc

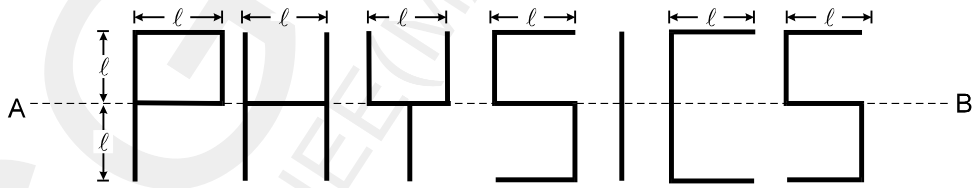
(b) axis ‘CD’ which passes through its centre of mass and it is perpendicular to the plane of the disc.



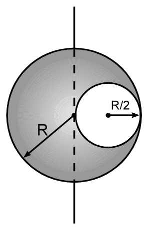
6. A massless ring hangs from a thread and two beads of mass m slide on it without friction. The beads are released simultaneously from the top of the ring and slide down along opposite sides. Find the angle from vertical at which the ring will start to rise.



7. Find out the moment of inertia of the following structure (written as PHYSICS) about axis AB made of thin uniform rods of mass per unit length λ.



8. A spherical cavity is formed from a solid sphere by removing mass from it. The resultant configuration is shown in figure. Find out the moment of inertia of this configuration about the axis through centre of the solid sphere as shown. Take mass M (uniform) for the configuration and radius R for solid sphere and radius R/2 for cavity.



9. **STATEMENT-1 :** Two spheres undergo a perfectly elastic collision. The kinetic energy of system of both spheres is always constant. [There is no external force on system of both spheres].

STATEMENT-2 : If net external force on a system is zero, the velocity of centre of mass remains constant.

(A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.

(B) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1

(C) Statement-1 is True, Statement-2 is False

(D) Statement-1 is False, Statement-2 is True

PHYSICS

DPP

DAILY PRACTICE PROBLEMS

DPP No. 59

Total Marks : 25

Max. Time : 26 min.

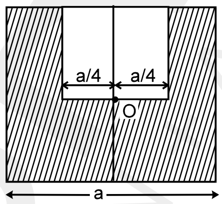
Topics : Rigid Body Dynamics, Circular Motion

Type of Questions		**M.M., Min.**
Single choice Objective ('–1' negative marking) Q.1 to Q.4	**(3 marks, 3 min.)**	**[12, 12]**
Subjective Questions ('–1' negative marking) Q.5	**(4 marks, 5 min.)**	**[4, 5]**
Comprehension ('–1' negative marking) Q.6 to Q.8	**(3 marks, 3 min.)**	**[9, 9]**

1. A uniform disc of radius R lies in the x-y plane, with its centre at origin. its moment of inertia about z-axis is equal to its moment of inertia about line y = x + c. The value of c will be

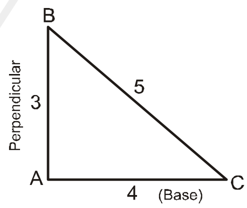
(A) $-\frac{R}{2}$ (B) $\pm\frac{R}{\sqrt{2}}$ (C) $\frac{+R}{4}$ (D) –R

2. A square plate of edge a/2 is cut out from a uniform square plate of edge 'a' as shown in figure. The mass of the remaining portion is M. The moment of inertia of the shaded portion about an axis passing through 'O' (centre of the square of side a) and perpendicular to plane of the plate is :



(A) $\frac{9}{64}Ma^2$ (B) $\frac{3}{16}Ma^2$ (C) $\frac{5}{12}Ma^2$ (D) $\frac{Ma^2}{6}$

3. Moment of inertia of uniform triangular plate about axis passing through sides AB, AC, BC are I_P, I_B & I_H respectively & about an axis perpendicular to the plane and passing through point C is I_C. Then :



(A) $I_C > I_P > I_B > I_H$ (B) $I_H > I_B > I_C > I_P$

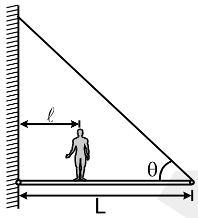
(C) $I_P > I_H > I_B > I_C$ (D) $I_H > I_B = I_C > I_P$

4. Moment of inertia of a uniform quarter disc of radius R and mass M about an axis through its centre of mass and perpendicular to its plane is :

(A) $\frac{MR^2}{2} - M\left(\frac{4R}{3\pi}\right)^2$ (B) $\frac{MR^2}{2} - M\left(\sqrt{2}\,\frac{4R}{3\pi}\right)^2$

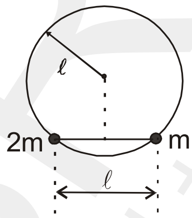
(C) $\frac{MR^2}{2} + M\left(\frac{4R}{3\pi}\right)^2$ (D) $\frac{MR^2}{2} + M\left(\sqrt{2}\,\frac{4R}{3\pi}\right)^2$

5. A uniform horizontal beam of length L and mass M is attached to a wall by a pin connection. Its far end is supported by a cable that makes an angle θ with the horizontal. If a man of mass 'm' stands at a distance ℓ from the wall, find the tension in the cable in equilibrium.



COMPREHENSION

Two beads of mass 2m and m, connected by a rod of length ℓ and of negligible mass are free to move in a smooth vertical circular wire frame of radius ℓ as shown. Initially the system is held in horizontal position (Refer figure)



6. The velocity that should be given to mass 2m (when rod is in horizontal position) in counter-clockwise direction so that the rod just becomes vertical is :

(A) $\sqrt{\frac{5g\ell}{3}}$ (B) $\sqrt{\left(\frac{3\sqrt{3}-1}{3}\right)g\ell}$ (C) $\sqrt{\frac{3}{2}g\ell}$ (D) $\sqrt{\frac{5}{2}g\ell}$

7. The minimum velocity that should be given to the mass 2m in clockwise direction to make it vertical is:

(A) $\sqrt{\frac{5g\ell}{3}}$ (B) $\sqrt{\frac{7g\ell}{3}}$ (C) $\sqrt{\left(\frac{3\sqrt{3}+1}{3}\right)g\ell}$ (D) None of these

8. If the rod is replaced by a massless string of length ℓ and the system is released when the string is horizontal then :
(A) Mass 2m will arrive earlier at the bottom.
(B) Mass m will arrive earlier at the bottom.
(C) Both the masses will arrive together but with different speeds.
(D) Both the masses will arrive together with same speeds.

PHYSICS

DPP
DAILY PRACTICE PROBLEMS

DPP No. 60

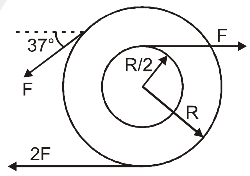
Total Marks : 28

Max. Time : 30 min.

Topics : Rigid Body Dynamics, Work ,Power and Energy, Center of Mass, Friction

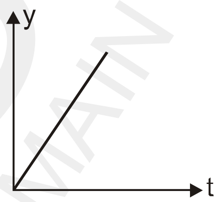
Type of Questions		M.M., Min.
Single choice Objective ('–1' negative marking) Q.1	(3 marks, 3 min.)	[3, 3]
Multiple choice objective ('–1' negative marking) Q.2 to Q.3	(4 marks, 4 min.)	[8, 8]
Subjective Questions ('–1' negative marking) Q.4 to Q. 5	(4 marks, 5 min.)	[8, 10]
Comprehension ('–1' negative marking) Q.6 to Q.8	(3 marks, 3 min.)	[9, 9]

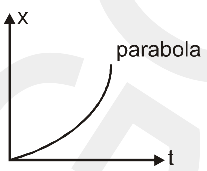
1. On a disc of radius R a concentric circle of radius R/2 is drawn.The disc is free to rotate about a frictionless fixed axis through its center and perpendicular to plane of the disc. All three forces (in plane of the disc) shown in figure are exerted tangent to their respective circular periphery. The magnitude of the net torque (about centre of disc) acting on the disc is:

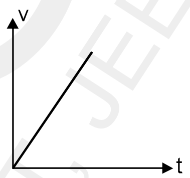


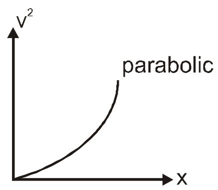
(A) 1.5 FR (B) 1.9 FR (C) 2.3 FR (D) 2.5 FR

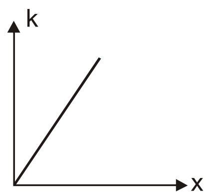
2. A particle starts moving from rest from the origin & moves along positive x-direction. Its rate of change of kinetic energy with time shown on y-axis varies with time t as shown in the graph. If position, velocity, acceleration & kinetic energy of the particle at any time t are x, v, a & k respectively then which of the option (s) may be correct ?



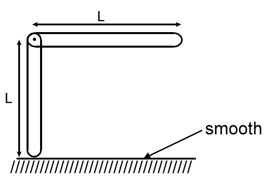
(A) 

(B) 

(C) 

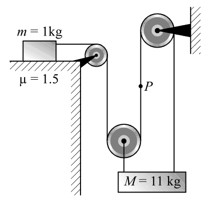
(D) 

3. Two identical rods are joined at one of their ends by a pin. Joint is smooth and rods are free to rotate about the joint. Rods are released in vertical plane on a smooth surface as shown in the figure. The displacement of the joint from its initial position to the final position is (i.e. when the rods lie straight on the ground)

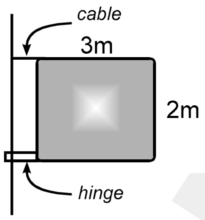


(A) $\frac{L}{4}$ (B) $\frac{\sqrt{17}}{4}$ L (C) $\frac{\sqrt{5}L}{2}$ (D) none of these

4. Figure shows an ideal pulley block of mass m = 1 kg, resting on a rough ground with friction coefficient μ = 1.5. Another block of mass M = 11 kg is hanging as shown. When system is released it is found that the magnitude of acceleration of point P on string is a. Find value of 4a in m/s^2.
(Use g = 10 m/s^2)

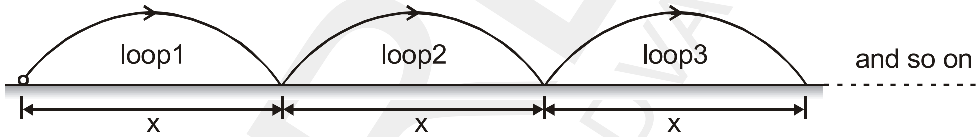


5. In figure the uniform gate weighs 300 N and is 3 m wide & 2 m high. It is supported by a hinge at the bottom left corner and a horizontal
cable at the top left corner, as shown. Find :
(a) the tension in the cable and
(b) the force that the hinge exerts on the gate (magnitude & direction).

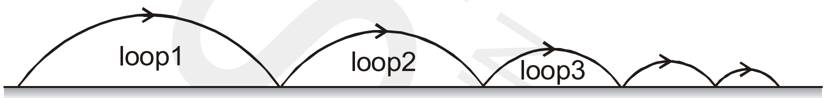


COMPREHENSION

A ball is projected on a very long floor. There may be two conditions
(i) floor is smooth & (ii) the collision is elastic
If both are considered then the path of ball is as follows.



Now if collision is inelastic and surface is rough then the path is as follows.



Successive range is decreasing.
Roughness of surface decreases the horizontal component of ball during collision and inelastic nature of collision decreases the vertical component of velocity of ball. In first case both components remain unchanged in magnitude and in second case both the components of the velocity will change.
Let us consider a third case here surface is rough but the collision of ball with floor is elastic. A ball is projected with speed u at an angle 30° with horizontal and it is known that after collision with the floor its speed becomes $\frac{u}{\sqrt{3}}$. Then answer the following questions.

6. The angle made by the resultant velocity vector of the ball with horizontal after first collision with floor is :
(A) 30° (B) 60° (C) 90° (D) 45°

7. The ratio of maximum height reached by ball in first loop and second loop $\left(\frac{H_1}{H_2}\right)$ is :
(A) $\frac{1}{4}$ (B) $\frac{1}{2}$ (C) 1 (D) $\frac{1}{\sqrt{3}}$

8. If the ball after first collision with the floor had rebounded vertically then the speed of the ball just after the collision with the floor would have been :
(A) u (B) u/2 (C) $\frac{\sqrt{3}}{2}$u (D) None of these

DPP 51 TO 100 (ANSWER KEY)

DPP NO. - 51

1. (B) **2.** (B) **3.** (C)
4 (D) **5.** (A) **6.** (B)
7. R/3 **8.** (A) q (B) q (C) r (D) q

DPP NO. - 52

1. (C) **2.** (D) **3.** (C)
4. (C) **5.** (A), (C) **6.** (A), (B), (C)
7. $\frac{1}{4}\ k\ x_0^2$

DPP NO. - 53

1. (C) **2.** (B), (C) **3.** (A), (B), (C)
4. $\frac{\sqrt{13}\,\ell}{4}$ **5.** $\frac{mv^2}{3}$
6. (A) p (B) q (C) q, s (D) r

DPP NO. - 54

1. (A) **2.** (D) **3.** (A), (B), (C)
4. Kinetic energy of m_1 > initial mechanical energy of system
5. 5 cm **6.** (A) **7.** (B) **8.** (C)

DPP NO. - 55

1. (B) **2.** (D) **3.** (B) **4.** (A) **5.** (C)
6. (C) **7.** (A) **8.** (B)

DPP NO. - 56

1. (D) **2.** (A) **3.** (A) **4.** (B)
5. (A), (C) **6.** (A), (C) **7.** (C)

DPP NO. - 57

1. (C) **2.** (A) **3.** (B) **4.** (C)
5. (B), (C), (D) **6.** (A), (D)
7. $T = \frac{mg}{2\pi}\frac{r}{\sqrt{R^2 - r^2}}$

DPP NO. - 58

1. (D) **2.** (B) **3.** (A) **4.** (A)
5. (a) $I_{AB} = \frac{1}{4}mR^2$

(b) $I_{CD} = \frac{1}{2}mR^2 - m\left(\frac{4R}{3\pi}\right)^2$ by parallel axis Theorem

6. $\cos^{-1}\left(\frac{2}{3}\right)$ **7.** $13\,\lambda\ell^3$ **Ans.**

8. $I = \frac{57}{140}MR^2$ **9.** (D)

DPP NO. - 59

1. (B) **2.** (B) **3.** (A) **4.** (B)
5. $T = \frac{2mg\ell + MgL}{2L\sin\theta}$ **6.** (B) **7.** (C)
8. (D)

DPP NO. - 60

1. (A) **2.** (A,B,D) **3.** (B,D) **4.** 13
5. (a) T = 225N, (b) F_X = 225N, F_Y = 300N
6. (B) **7.** (C) **8.** (B)

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CLASS : XI (PHYSICS)

DPP

DAILY PRACTICE PROBLEM

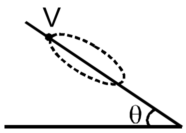
Solutions

DPP-51 TO 60

DPP 51 : **Circular Motion, Center of Mass**
DPP 52 : **Center of Mass, Work, Power and Energy**
DPP 53 : **Center of Mass, Work, Power and Energy, Circular Motion**
DPP 54 : **Center of Mass, Circular Motion**
DPP 55 : **Center of Mass**
DPP 56 : **Work, Power and Energy, Center of Mass, Circular Motion**
DPP 57 : **Rigid Body Dynamics, Newton's Law of Motion, Circular Motion, Center of Mass**
DPP 58 : **Friction, Center of Mass, Rigid Body Dynamics, Rotation**
DPP 59 : **Rigid Body Dynamics, Circular Motion**
DPP 60 : **Rigid Body Dynamics, Work ,Power and Energy, Center of Mass, Friction**

DPP NO. - 51

1. The side view of circular motion is as shown :



$$T + mg\sin\theta = \frac{mv^2}{R}$$

and by energy conservation :

$$\frac{1}{2}mv_i^2 = \frac{1}{2}mv^2 + mg2R(\sin\theta)$$

for v_i to be minimum, v is minimum and hence
T = 0

$\Rightarrow \quad v_i^2 = 5gR.\sin\theta$

$\Rightarrow \quad v_i)_{min} = \sqrt{\frac{5g\ell}{2}}$ **Ans.**

2. Friction force between wedge and block is internal i.e. will not change motion of COM. Friction force on the wedge by ground is external and causes COM to move towards right. Gravitational force (mg) on block brings it downward hence COM comes down.

3. After 3 sec. height of COM. is $50 + ut - \frac{1}{2}gt^2$

$= 50 + 10 \times 3 - \frac{1}{2} \times 10 \times 3^2$

= 35 m

$$H_{C.M.} = \frac{m_1H_1 + m_2H_2 + m_3H_3}{m_1 + m_2 + m_3}$$

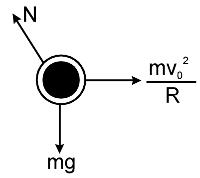
$$35 = \frac{2\times 0 + 1\times 40 + 1\times H_3}{4}$$

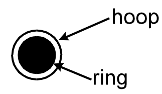
H_3 = 100 m

4 The free body daigram of hoop is

$\therefore$ The normal reaction $\quad N = \sqrt{m^2g^2 + \frac{m^2v_0^4}{r^2}}$

$\therefore$ Frictional force $= \mu_k N = \mu_k\sqrt{m^2g^2 + \frac{m^2v_0^4}{r^2}}$





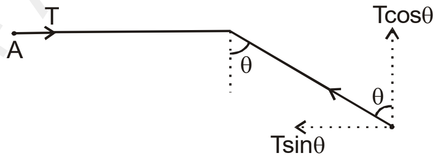
$\therefore$ tangential acceleration $= \frac{\mu_k N}{m}$

$$= \mu_k\sqrt{g^2 + \frac{v_0^4}{r^2}}$$

5. $\left|\Delta\vec{V}\right| = \sqrt{v^2 + v^2 - 2v^2\cos 60^\circ} \quad = v$

$\vec{a}_{avg} = \frac{|\Delta\vec{v}|}{\Delta t} = \frac{v}{t} = \frac{3v^2}{\pi R} \Rightarrow a_i = \frac{v^2}{R}$; $\frac{a_i}{a_{av}} = \frac{v^2\pi R}{R\times 3v^2} = \frac{\pi}{3}$

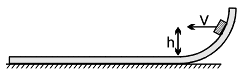
6.



T $\sin\theta$ < T

$\therefore \quad t_A < t_B$

7. Let v be the final speed of block when it is at maximum height h. At that instant the speed of circular track shall also be v.



From conservation of momentum

$m\sqrt{2gR} = (m + 2m)\,v \qquad$ ....(1)

From conservation of energy

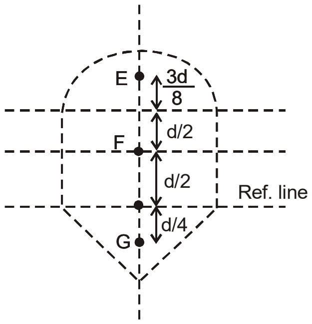
$\frac{1}{2}m(2gR) = \frac{1}{2}(m + 2m)v^2 + 2mgh$ ....(2)

solving (1) and (2) we get

$2h = \frac{2}{3}R$ **Ans. R/3**

8. Replacing the three bodies by their Com at E, F & G. Let ρ be their common density.

$$X_{cm} = \frac{\left[\rho\left(\frac{1}{3}\pi d^3\right)\right]\left[\frac{-d}{4}\right] + \left[\rho(\pi d^3)\right]\left[\frac{d}{2}\right] + \left[\rho\left(\frac{2}{3}\pi d^3\right)\right]\left[\frac{11}{8}d\right]}{\rho\left(\frac{1}{3}\pi d^3\right) + \rho(\pi d^3) + \rho\left(\frac{2}{3}\pi d^3\right)}$$



where, $\rho\left(\frac{1}{3}\pi d^3\right)$ is the mass of cone,

$\rho(\pi d^3)$ is the mass of cylinder

& $\rho\left(\frac{2}{3}\pi d^3\right)$ is the mass of hemisphere.

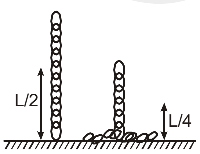
DPP NO. - 52

1. $7M(x\hat{i} + y\hat{j} + z\hat{k}) = M\left(\frac{\ell}{2}\hat{i} + \frac{\ell}{2}\hat{j} + \frac{\ell}{2}\hat{j}\right)$

Shifting = $\sqrt{x^2 + y^2 + z^2} = \sqrt{3} \cdot \frac{\ell}{\sqrt{14}}$

2. Path of Q and R will intersect and will be on opposite to that of P .
Since there is no friction, the centre of mass will fall vertical downward. When the rod falls on the ground, it is shown as a dotted.

3. **(C)** The work done by man is negative of magnitude of decrease in potential energy of chain



$\Delta U = mg\frac{L}{2} - \frac{m}{2}g\frac{L}{4} = 3\,mg\frac{L}{8}$

$\therefore \quad W = -\frac{3mg\ell}{8}$

4. $\vec{f} = -\frac{\partial U}{\partial x}\hat{i} - \frac{\partial U}{\partial y}\hat{j} = -[6\hat{i}] + [8]\hat{j}$

$= -6\hat{i} + 8\hat{j}$

$\therefore \vec{a} = -3\hat{i} + 4\hat{j}$ has same direction as that of

$\vec{u} = \frac{-3\hat{i} + 4\hat{j}}{2} = \left(\frac{\vec{a}}{2}\right)$

$|\vec{a}| = 5$

$|\vec{u}| = 5/2$

Since $\vec{u}$ and $\vec{a}$ are in same direction, particle will move along a straight line

$\therefore S = \frac{5}{2} \times 2 + \frac{1}{2} \times 5 \times 2^2$

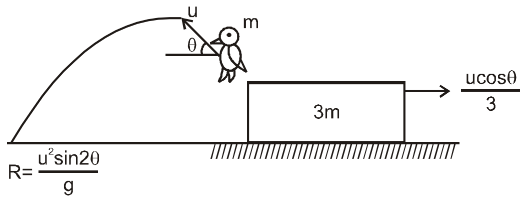
$= 5 + 10 = 15$ m. **15 m. Ans**

5. (A) $S_m = \frac{m_1S_1 + m_2S_2}{m_1 + m_2}$

$0 = \frac{(3m)(-x) + (m)(\ell - n)}{3m + m}$

$x = \frac{\ell}{4}$

(C)



$T = \frac{2u\sin\theta}{g}$

Displacement of sled in this time =

$\left(\frac{u\cos\theta}{3}\right)\left(\frac{2u\sin\theta}{g}\right) = \frac{1}{3}\left(\frac{u^2\sin2\theta}{g}\right)$

Total distance $= \frac{4}{3}\left(\frac{u^2\sin2\theta}{g}\right)$

6. Maximum extension will be at the moment when both masses stop momentarily after going down. Applying W-E theorem from starting to that instant.

$k_f - k_i = W_{gr.} + W_{sp} + W_{ten}.$

$0 - 0 = 2\,M.g.x + \left(-\frac{1}{2}Kx^2\right) + 0$

$x = \frac{4Mg}{K}$

System will have maximum KE when net force on the system becomes zero. Therefore

$2\,Mg = T$ and $T = kx$

$\Rightarrow x = \frac{2Mg}{K}$

Hence KE will be maximum when 2M mass has gone down by $\frac{2Mg}{K}$.

Applying W/E theorem

$k_f - 0 = 2Mg.\frac{2Mg}{K} - \frac{1}{2}K.\frac{4M^2g^2}{K^2}$

$k_f = \frac{2M^2g^2}{K^2}$

Maximum energy of spring $= \frac{1}{2}K.\left(\frac{4Mg}{K}\right)^2$

$= \frac{8M^2g^2}{K}$

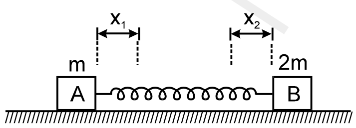
Therefore Maximum spring energy = 4 × maximum K.E.

When K.E. is maximum $x = \frac{2Mg}{K}$.

Spring energy $= \frac{1}{2}.K.\frac{4M^2g^2}{K^2} = \frac{2M^2g^2}{K^2}$

i.e. (D) is wrong.

7.



Let the block A shift to left by x_1 and block B shift to right by x_2. The centre of mass of the two block system is at rest

Hence $mx_1 = 2mx_2$

or $x_2 = \frac{x_1}{2}$ ....(1)

and the spring force on either block is k $(x_0 - [x_1 + x_2])$, where x_0 is the initial compression in the spring

Let the block A shift further left by dx_1

$\therefore$ work done on block by spring is

$dW = k\,(x_0 - x_1 - x_2)\,dx_1$ ....(2)

$= k\left(x_0 - x_1 - \frac{x_1}{2}\right)dx_1$

$dW = k\left(x_0 - \frac{3}{2}x_1\right)dx_1$

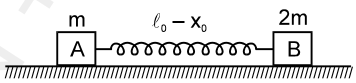
$\therefore$ Net work done

$\int dW = \int_{x_1=0}^{x_0/3} k\left(x_0 - \frac{3}{2}x_1\right)dx_1 = \frac{k\,x_0^2}{4}$

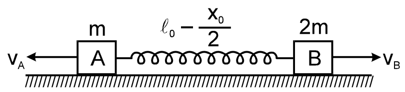
Ans. $\frac{1}{4}\,k\,x_0^2$

ALTERNATIVE SOLUTION

Let the speeds of blocks A and B at the instant compression is $\frac{x_0}{2}$ be v_A and v_B as shown in figure [ℓ_0 = natural length of spring]



Initial state



Final state

No external forces act on the system in the horizontal direction

Applying conservation of momentum in horizontal direction

initial momentum = final momentum

$0 = m(-v_A) + 2m\,v_B$

or $v_A = 2\,v_B$ ....(1)

from conservation of energy

$\frac{1}{2}k\,x_0^2 = \frac{1}{2}\,k\left(\frac{x_0}{2}\right)^2 + \frac{1}{2}\,m\,v_A^2 + \frac{1}{2}\,2m\,v_B^2$

..........(2)

from (1) and (2) we get

$\frac{1}{2}\,m\,v_A^2 = \frac{1}{4}\,k\,x_0^2$

work done on block A by spring = change in kinetic energy of block A

$= \frac{1}{2} m v_A^2 = \frac{1}{4} k x_0^2$

DPP NO. - 53

1. By linear momentum conservation in horizontal direction = for (bob + string + cart)

$mV_0 = (m + m)v$

$v = \frac{V_0}{2}$

By mechanical energy conservation for (bob + string + cart + earth)

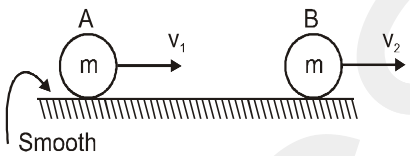
$\frac{1}{2} mV_0^2 + 0 + 0 = \frac{1}{2}(2m)v^2 + mgh + 0$

$\frac{1}{2} mV_0^2 - \frac{1}{2}(2m)\frac{V_0^2}{4} = mgh$

Solving it,

$h = \frac{V_0^2}{4g}$.

2. after collision



By momentum conservation in horizontal direction

$V = V_1 + V_2$ ....(i)

and $e = \frac{V_2 - V_1}{V} = \frac{1}{2}$ ....(ii)

By (i) and (ii) $V_2 = \frac{3V}{4}$

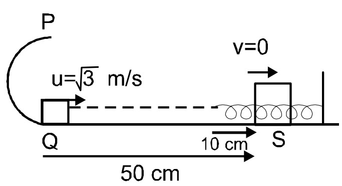
So impulse on B

$= m\left(\frac{3V}{4}\right)$

and loss in K.E.

$= \frac{3}{16} mV^2$

3.



$Q \rightarrow S$

$-\mu mg \times S = 0 + \frac{1}{2}k(0.1)^2 - \frac{1}{2} \times 1 \times (\sqrt{3})^2$

$-0.1 \times 1 \times 10 \times 0.5 = \frac{k}{200} - \frac{3}{2}$

$k = 200$ N/m

$Q \rightarrow S \rightarrow Q$

$-\mu mg \times 0.5 \times 2 = \frac{1}{2} mv_Q^2 - \frac{1}{2} mu^2$

$-1 = \frac{1}{2} \times 1 \times v_Q^2 - \frac{1}{2} \times 1 \times 3$

$v_Q = 1$ m/s

$Q \rightarrow P$

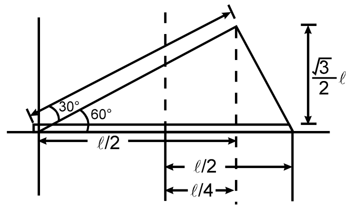
$v_P^2 = v_Q^2 - 2(g)(2r)$

$v_P = \sqrt{1^2 - 4 \times 10 \times \frac{0.9}{100}} = \frac{8}{10} = 0.8$ m/s

$N_P = \frac{mv_P^2}{r} - mg = \frac{1 \times 64 \times 100}{100 \times 0.9} - 10 = \frac{55}{0.9}$ N.

4. Displacement $= \sqrt{\frac{3}{4}\ell^2 + \frac{\ell^2}{16}}$

$= \frac{1}{2}\sqrt{3 + \frac{1}{4}} = \frac{\sqrt{13}\,\ell}{4}$



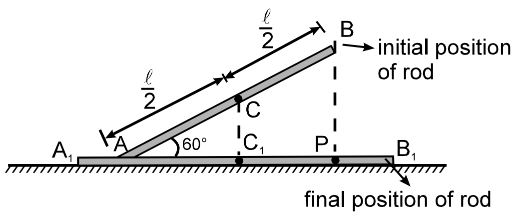
Alternate solution

Initially the rod is at rest

$\therefore u_{cm}$ of rod $= 0$

All forces on rod, act in vertical direction. Hence acceleration of centre of mass is vertically downwards.

$\therefore$ centre of mass of rod moves vertically down wards.



$BP = \ell \sin 60° = \frac{\sqrt{3}}{2}\ell$; $C_1P = \frac{\ell}{2}\cos 60°$

$\therefore PB_1 = B_1C_1 - C_1P = \frac{\ell}{2}(1 - \cos 60°) = \frac{\ell}{4}$

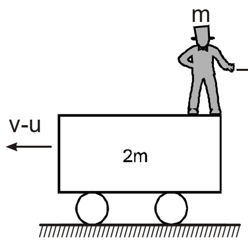
$\therefore$ Displacement of end B is BB_1

$$= \sqrt{BP^2 + PB_1^2} = \sqrt{\left(\frac{\sqrt{3}}{2}\ell\right)^2 + \left(\frac{\ell}{4}\right)^2} = \frac{\sqrt{13}\,\ell}{4}$$

5. Let the velocity of man after jumping be 'u' towards right. Then speed of cart is v-u towards left. From conservation of momentum mu = 2m(v – u)

$\therefore \; u = \frac{2v}{3}$

hence work done by man = change in K.E. of system



$$= \frac{1}{2}mu^2 + \frac{1}{2}2m(v-u)^2$$

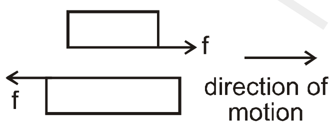
$$= \frac{1}{2}m\left(\frac{2v}{3}\right)^2 + \frac{1}{2}2m\left(\frac{v}{3}\right)^2 = \frac{mv^2}{3}$$ **Ans.**

6. (A) p (B) q (C) q, s (D) r

Sol. **(Moderate)** The FBD of block and plank and are shown. Work done on block by friction is positive

Work done on plank by friction is negative.

Work done by friction on plank plus block is zero



when there is no relative motion between them.

Since there is no rubbing between block and plank, mechanical energy is not lost. (i.e., heat and allied losses are not produced).

Work done by friction on plank + block is negative when there is relative motion between block and plank. This work done is equal loss in mechanical energy of block + plank system.

DPP NO. - 54

1. The centre of mass of man + disc shall always remain at rest. Since the man is always at periphery of disc, the centre of disc shall always be at distance R/3 from centre of mass of two body system. Hence centre of disc moves in circle of radius R/3.

2. It can be shown that

$K_0 = K_{cm} + \frac{1}{2}MV_{cm}^2$ where M is the total mass of the system and V_{cm} is velocity of centre of mass with respect to ground.

Due to internal changes K_{cm} can change but V_{cm} will remain same. Hence only K_{CM} portion of kinetic energy can be transformed to some other form of energy. Thus D is the wrong statement.

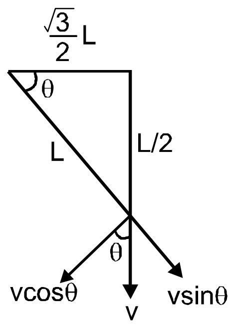
3. By conservation of energy

$$\frac{1}{2}mv^2 = mg\frac{L}{2}$$

$$v = \sqrt{gL}$$

After jerk vsinθ becomes zero

Impulse applied by string = mv sin θ



$$= 0.2\sqrt{gL}\;\frac{1}{2} = \frac{\sqrt{gL}}{10}$$

velocity of ball after jerk

$$v\cos\theta = \sqrt{gL}\;\frac{\sqrt{3}}{2} = \frac{\sqrt{3gL}}{2}.$$

4. If velocity of m_2 is zero then by momentum conservation

$m_1v' = m_2v$

$$v' = \frac{m_2 v}{m_1}$$

Now kinetic energy of m_1

$$= \frac{1}{2} m^1 v'^2 = \frac{1}{2} m_1 \left(\frac{m_2}{m_1}\right)^2 v^2$$

$$= \frac{1}{2}\left(\frac{m_2}{m_1}\right) m_2 v^2 = \left(\frac{m_2}{m_1}\right)\frac{1}{2} m_2 v^2 = \frac{m_2}{m_1}$$

× initial Kinetic energy

Kinetic energy of m_1 > initial mechanical energy of system

Hence proved

5. $a = \mu g = (.2)(10) = 2\ m/s^2$.

$$v^2 = 1^2 - 2(2)\left(\frac{16}{100}\right) = 1 - \frac{16}{25} = \frac{9}{25}$$

$\therefore$ v = 3/5 m/s

cons. of linear momentum $\Rightarrow 2(3/5) = 2(v_1) + 4 v_2$

$\therefore v_1 + 2v_2 = 3/5$ .... (1)

$e = 1 \Rightarrow 3/5 = v_2 - v_1$ .... (2)

(1) and (2) $\Rightarrow 3v_2 = 6/5$

$\Rightarrow v_2 = 2/5$ m/s.

and $v_1 = v_2 - 3/5 = \frac{2}{5} - \frac{3}{5} = -\frac{1}{5}$ m/s

x_2 = Distance covered by 4 kg block = $\frac{(2/5)^2}{2(2)}$

$= \frac{4}{100}$ m = 4 cm

x_1 = Distance covered by 2 kg block in left direction

$= \frac{1}{100}$ m = 1 cm.

Hence $X = x_1 + x_2 = 5$ cm.

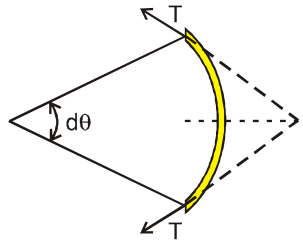
6. to 8 As the small element ($dm = a.\rho.d\ell$) is rotating in the circle, centripetal force

$F_C = dm\omega^2 R = a\rho d\ell.\omega^2 R$

7. $2T \sin\frac{d\theta}{2} = F_c = a\rho\, d\ell\, \omega^2 R$

As $d\theta$ is small $\sin\frac{d\theta}{2} = \frac{d\theta}{2}$

$2T.\frac{d\theta}{2} = a\rho\,(Rd\theta)\,\omega^2 R$



$\Rightarrow T = a\rho R^2 \omega^2$

8. $T = a\rho R^2\omega^2 = \frac{m}{2\pi} R\omega^2 \propto R$

Radius is doubled, tension is doubled. (2 T)

$T = a\rho R^2\omega^2 = \frac{m}{2\pi} R\omega^2 \propto R$

DPP NO. - 55

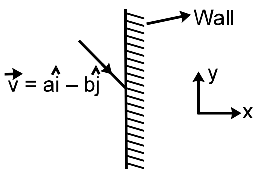
1. A collision which is not elastic changes only the normal component of velocity.

Here the normal component is – b. Hence it become (+eb)

after collision keeping the x-component (tangential)

as before collision.

$\Rightarrow \vec{v}_f = a\hat{i} + eb\hat{j}$.



Hence (B).

2. Velocity along the plane does not change

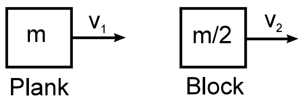
So $\sqrt{3}$ Sin f o° = V_1 sin 30°

$\Rightarrow V_1 = 3$ m/s > $\sqrt{3}$ m/s

Which in impossible $\therefore$ **Ans. (D)**

3. Let the velocities of plank and body of mass $\frac{m}{2}$ move with speed v_1 and v_2 after collision as shown.

From conservation of momentum.



$$mv - \frac{m}{2} 2v = mv_1 + \frac{m}{2} v_2$$

or $2v_1 + v_2 = 0$ ....(1)

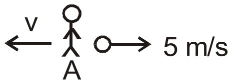
From equation of coefficient of restitution.

$$e = 1 = \frac{v_2 - v_1}{v + 2v}$$

$\Rightarrow\ v_2 - v_1 = 3v$ ....(2)

Solving 1 and 2 we get

$v_1 = -v$

4 to 8 (A) 

from linear momentum conservation

$$M_A V = m_b 5 \Rightarrow v = \frac{4 \times 5}{40} = 0.5 \text{ m/s Ans.}$$

5. $m_A\, 0.5 + m_b\, 5 = (M_A + m_b)\, V_1 \quad V_1$

$$= \frac{40 \times 0.5 + 4 \times 5}{44} = \frac{40}{44} = \frac{10}{11} \text{m/s} \quad \textbf{Ans.}$$

6. after throught the ball velocity of man A is 0.5 m/s

For man B $4 \times 5 = 40\, v_2 - 4 \times 5$

$\Rightarrow v_2 = 1$ m/s

velocity B is 1 m/s after through the ball

after through the ball second time, velocity of man A is

$4 \times 5 + 40 \times 0.5 = 40 \times v_3 - 4 \times 5$

$v_3 = 1.5$ m/s

similarly for man B $v_4 = 2$ m/s

after 5 round trip and man A hold the ball velocity of man B is 5 m/s

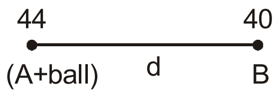
velocity of man A

$4.5 \times 40 + 4 \times 5 = (40 + 4)v_5$

$$v_5 = \frac{50}{11} \text{ m/s} \quad \textbf{Ans.}$$

7. When man through the ball 6 times it velocity is greater than 5 m/s and velocity of B is 5 m/s therefor maximum number of times man A can through the ball is 6 .

8. $F_{ext} = 0$, Centre of mass of system cannot move Initial position of centre of mass from A.



$$X_{cm} = \frac{40\, d}{44 + 40} = \frac{10}{21}\, d$$

DPP NO. - 56

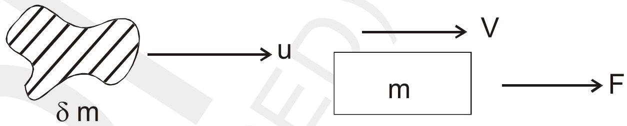
1. **(Easy)** Since there is no change in kinetic energy of stone, the total work done on stone in any duration is zero.

2. For the duration of collision the pendulum does not exert any force on the sphere in the horizontal direction. Hence the horizontal momentum of bullet + sphere is conserved for the duration of collision. Let v′ be the velocity of bullet and sphere just after the collision.

$\therefore$ from conservation of momentum

$(m + m)\, v' = mv$

or $v' = \dfrac{v}{2}$

3. 

Formula $F = m\dfrac{dv}{dt} + (V - u)\dfrac{dm}{dt}$

Here u = velocity of sand = O

$m = M_o + \mu t$ = mas at time t

and $\dfrac{dm}{dt} = \mu$

$\therefore\ F = (M_o + \mu t)\dfrac{dm}{dt} + v\mu$

$(F - \mu v)\, dt = (M_o + \mu t)\, dv$

$$\int_o^t \frac{dt}{M_o + \mu t} = \int_o^v \frac{dv}{F - \mu v}$$

$$\frac{1}{\mu}\left[\log(M_o + \mu t)\right]_o^t = \frac{1}{\mu}\left[\log(F - \mu v)\right]_o^v$$

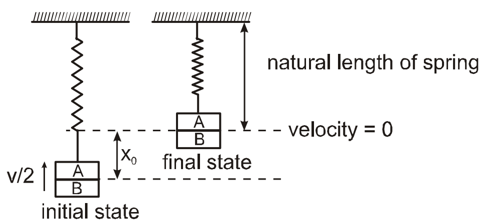
$$\log\frac{(M_o + \mu t)}{M_o} = \log\left(\frac{F}{F - \mu v}\right)$$

$$F - \mu v = \frac{M_o F}{M_o + \mu t} \quad \Rightarrow \quad v = \frac{Ft}{M_o + \mu t}$$

4. **(B)** The initial extension in spring is $x_0 = \dfrac{mg}{k}$

Just after collision of B with A the speed of combined mass is $\dfrac{v}{2}$.

For the spring to just attain natural length the c ombined mass must rise up by $x_0 = \dfrac{mg}{k}$(sec fig.) and comes to rest.



Applying conservation of energy between initial and final states

$$\frac{1}{2}\,2m\left(\frac{v}{2}\right)^2 + \frac{1}{2}\,k\left(\frac{mg}{k}\right)^2 = 2mg\left(\frac{mg}{k}\right)$$

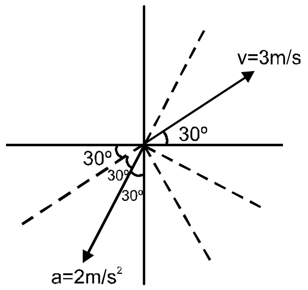
Solving we get $v = \sqrt{\dfrac{6mg^2}{k}}$

5. From linear momentum conservation
v & v' are speed of strip and insect w.r.t. ground
$Mv = mv'$

$$v + v' = \frac{\ell}{t} \;\Rightarrow\; v'\left(1+\frac{m}{M}\right) = \frac{\ell}{t}$$

$$v' = \left(\frac{M}{m+M}\right)\frac{\ell}{t}\,.$$

6. Initially ROC $= \dfrac{v^2}{a\sin 30^\circ} = \dfrac{9}{1}\,m$

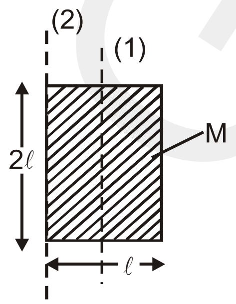


For minimum ROC $= \dfrac{(v\sin 30^\circ)^2}{a} = \dfrac{9}{8}\,m.$

7. Statement-2 contradicts Newton's third law and hence is false.

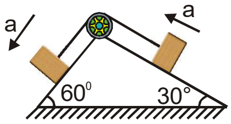
DPP NO. - 57

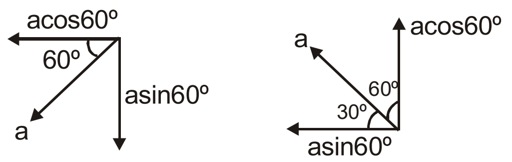
1.



$I_2 = \dfrac{m\ell^2}{3}\,.$

2. Accelerates of blocks





$$a = \frac{mg(\sin 60^\circ - \sin 30^\circ)}{m+m}$$

$$= \frac{g}{2}\left(\frac{\sqrt{3}}{2} - \frac{1}{2}\right) = \frac{g}{4}\left(\sqrt{3}-1\right)$$

$$\vec{a}_{cm} = \frac{m[a\cos 60^\circ(-\hat{i}) - a\sin 60^\circ\hat{j}] + ma\sin 60^\circ(-\hat{i}) + m(a\cos 60^\circ)\hat{j}}{m+m}$$

$$= \frac{ma}{2m}\left[\left[\frac{-1}{2} - \frac{\sqrt{3}}{2}\right]\hat{i} + \left(\frac{1}{2} - \frac{\sqrt{3}}{2}\right)\hat{j}\right] =$$

$$\frac{a}{4}\left[-(1+\sqrt{3})\,\hat{i} + (1-\sqrt{3})\,\hat{j}\right]$$

$$a_{cm} = \frac{a}{4}\sqrt{\left[(1+\sqrt{3})\,\hat{i} + (1-\sqrt{3})\,\hat{j}\right]} =$$

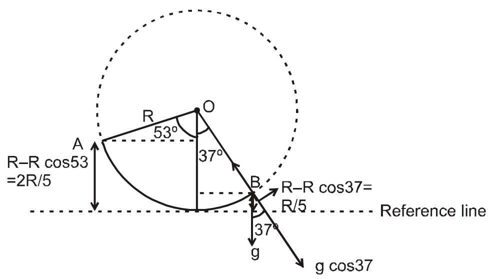
$$\frac{a}{4}\sqrt{1+3+2\sqrt{3}+1-2\sqrt{3}+3} = \frac{a}{4}\sqrt{8}$$

$$= \frac{a}{4}2\sqrt{2} = \frac{a}{\sqrt{2}} \qquad a_{cm} = \frac{g}{4\sqrt{2}}(\sqrt{3}-1)\,.$$

3. $0 + \dfrac{ma^2}{4} + \dfrac{ma^2}{4} = \dfrac{ma^2}{2}$

4. By energy conservation between A & B

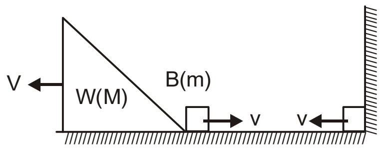
$$\Rightarrow Mg\,\frac{2R}{5} + 0 = \frac{MgR}{5} + \frac{1}{2}MV^2$$



$$V = \sqrt{\frac{2gR}{5}}$$

Now, radius of curvature r

$= \frac{V_{\perp}^2}{a_r} = \frac{2gR/5}{g\cos 37} = \frac{R}{2}$

5. 

From linear conservation

mv = MV

$V = \frac{mV}{M}$

After the elastic collision with wall speed of the block B remain same in the direction V

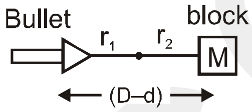
$V_{cm} = \frac{m(v) + M\left(\frac{mv}{M}\right)}{m + M}$

$= \frac{2mV}{m+M}$

When block B will reach at maximum height on wedge From momentum conservation

$\frac{mv}{M}.M + mv = (m + M)\,V_C$

$V_C = \frac{2mv}{(M+m)}$.

6. 

centre of mass is localed at distance r_2 from block

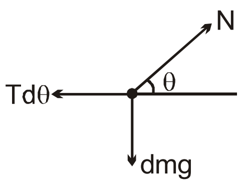
$Mr_2 = mr_1 \quad Mr_2 = m\,(D - d - r_2)$

$r_2 = \frac{m(D-d)}{M+m}$

also $M\,(D - d - r_1) = mr_1$

so $r_1 = \frac{M(D-d)}{(M+m)}$ distance of COM from bullet.

7. Consider the dm mass of chain subtending angle at dα centre



N sinθ = dmg

N cosθ = T dα

$\tan\theta = \frac{dm}{d\alpha}.\frac{g}{T}$

$\tan\theta = \frac{m}{2\pi}.\frac{g}{T}$; $\tan\theta = \frac{\sqrt{R^2 - r^2}}{r} = \frac{m}{2\pi}\;\frac{g}{T}$

$T = \frac{mg}{2\pi}\frac{r}{\sqrt{R^2 - r^2}}$ **Ans.**

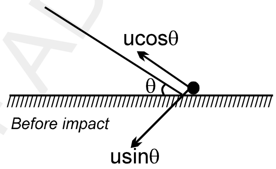
DPP NO. - 58

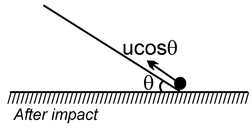
1. Maximum frictional force between C and ground = 300 Nt

Max. frictional force between B and ground = 360 Nt

So man is unable to pull B Hence T = 0

2. Just before the particle transfers to inclined surface, we resolve its velocity along and normal to the plane.

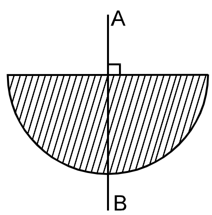




For the trajectory of the particle to sharply change from the horizontal line to the inclined line, the impact of the particle with inclined plane should reduce the usinθ component of velocity to zero. Hence the particle moves up the incline with speed u cosθ.

Hence as θ increases, the height to which the particle rises shall decrease.

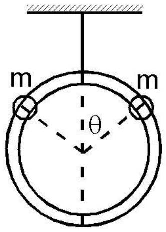
4. F_{ext} on system (man + boat) is zero and initially COM is at rest so that COM of system always remains at rest.

5. 

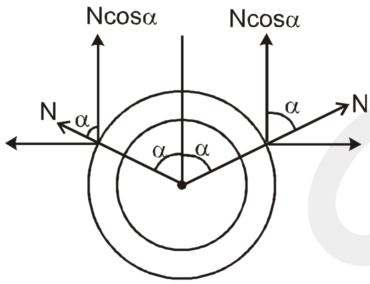
(a) $I_{AB} = \frac{1}{4}mR^2$ ....Ans. (b) $I_{CD} = \frac{1}{2}mR^2 - m\left(\frac{4R}{3\pi}\right)^2$

by parallel axis Theorem ....Ans.

6.



at $\alpha = \cos^{-1}\left(\frac{2}{3}\right)$ balls will leave contact with inner wall and came in contact with outer wall then force on ring will be $2N\cos\alpha$ in upward direction.



So ring will start rising as it is massless

7. The moment of inertia of all seven rods parallel to AB and not lying on AB is

$= 7 \times (\lambda\ell)\, \ell^2 = 7\, \lambda\, \ell^3$

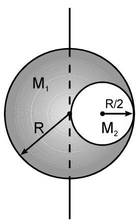
the moment of inertia of all five rods lying on AB = 0

The moment of inertia of all 18 rods perpendicular to AB is $= 18\, (\lambda\ell)\, \frac{\ell^2}{3} = 6\, \lambda\ell^3$

Hence net MI of rod about AB

$= 7\, \lambda\ell^3 + 6\, \lambda\ell^3 = \mathbf{13\, \lambda\ell^3}$ **Ans.**

8.



$$\rho = \frac{M}{(4/3)\pi R^3 - (4/3)\pi (R/2)^3}$$

$$I = \frac{2}{5}MR^2 - \left(\frac{2}{5}M_2\left(\frac{R}{2}\right)^2 + M_2\left(\frac{R}{2}\right)^2\right)$$

$$; I = \frac{57}{140}MR^2$$

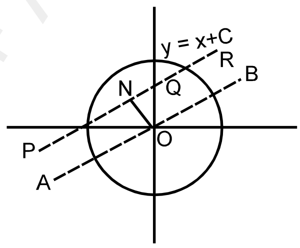
9. During colision KE of system is not constant, hence statement-1 is false.

DPP NO. - 59

1. $I_{PQR} = I_{AOB} + M.(ON)^2$

$$I_{PQR} = \frac{1}{4}MR^2 + M.\left(\frac{C}{\sqrt{2}}\right)^2$$

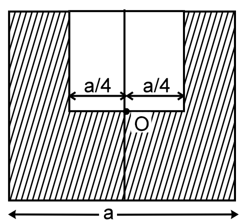
But $I_{PQR} = \frac{1}{2}MR^2$

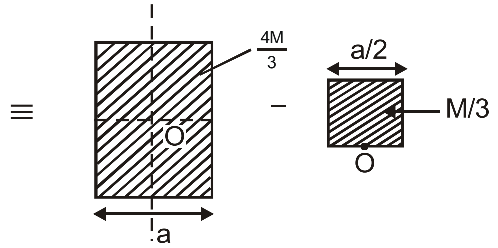


$\therefore\ C = \pm\frac{R}{\sqrt{2}}$.

Hence (B) is correct.

2.





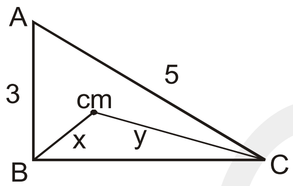
$$I_0 = \frac{(4/3)Ma^2}{6} - \left[\frac{(M/3)(a/2)^2}{6} + \frac{M}{3}\left(\frac{a}{4}\right)^2\right]$$

$$= Ma^2\left(\frac{2}{9} - \frac{1}{72} - \frac{1}{48}\right) = \frac{3Ma^2}{16} \quad \textbf{Ans.}$$

3. Moment of inertia is more when mass is farther from the axis. In case of axis BC, mass distribution is closest to it and in case of axis AB mass distribution is farthest .Hence

$I_{BC} < I_{AC} < I_{AB}$

$\Rightarrow \quad I_P > I_B > I_H$



$I_C = I_{CM} + my^2$

$= I_B^{\,1} - mx^2 + my^2$

$= I_B^{\,1} + m(y^2 - x^2)$

$= I_P + I_B + m(y^2 - x^2)$

$> I_P + I_B$

$> I_P$

Here $I_B^{\,1}$ is moment of inertia of the plate about an axis perpendicular to it and passing through B.

$\therefore \quad I_C > I_P > I_B > I_H$

4. M.I. about 'O' is $\frac{MR^2}{2}$

By parallel-axis theorem : $\frac{MR^2}{2}$

$= I_{cm} + M\left(\frac{4R}{3\pi}.\sqrt{2}\right)^2$

$\Rightarrow I_{cm} = \frac{MR^2}{2} - M\left(\sqrt{2}.\frac{4R}{3\pi}\right)^2$

5. For rotational equilibrium

Taking torques about A

(so that torque due hinge force on the rod about A = 0)

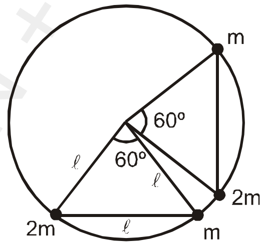
$mg.\ell + Mg.\frac{L}{2} = T\sin\theta.\,L$

$\Rightarrow$ **T =** $\frac{2mg\ell + MgL}{2L\sin\theta}$ **...Ans.**

6. to 8 The speeds given to 2m will also be possessed by m

$\therefore$ KE in horizontal position gets converted in PE in vertical position.

$\frac{1}{2}2mv^2 + \frac{1}{2}mv^2$ = change in PE in vertical position.



Δ PE $= 2\,mg\,[\ell\cos 30° - \ell\cos 60°] + mg$

$[\ell\cos 30° + \frac{\ell}{2}]$

$$2\,mg\left[\frac{\ell\sqrt{3}}{2} - \frac{\ell}{2}\right] + mg\left[\frac{\ell\sqrt{3}}{2} + \frac{\ell}{2}\right]$$

$$\therefore \quad mg\ell[\sqrt{3} - 1] - mg\ell\left[\frac{\sqrt{3}+1}{2}\right]$$

$$= mg\ell\left[\sqrt{3} - 1 + \frac{\sqrt{3}}{2} + \frac{1}{2}\right] = mg\ell\left[\frac{3\sqrt{3}}{2} - \frac{1}{2}\right]$$

$$\text{K.E.} = \frac{1}{2}3mv^2 = mg\ell\left[\frac{3\sqrt{3}-1}{2}\right]$$

$\therefore\ v = \sqrt{\left(\frac{3\sqrt{3}-1}{3}\right)g\ell}$ **Ans.**

7. ||y in anticlockwise direction we get

$$V = \sqrt{\left(\frac{3\sqrt{3}+1}{3}\right)g\,\ell}$$

8. Both the masses will have same magnitude of acceleration all the time.

$\therefore$ Their velocities and distance covered will be same.

Hence (D).

DPP NO. - 60

1. Torque $\tau = (2F)R + F\left(\frac{R}{2}\right) + FR(-1)$

$$= \frac{3FR}{2}$$

2. $\frac{dk}{dt} \propto t$

$\Rightarrow k \propto t^2$ ....(i)

$\Rightarrow v \propto t$ ....(ii)

$\Rightarrow$ v vs t : st. line

$\Rightarrow x \propto t^2$ ....(iii)

$\Rightarrow$ x vs t : parabola

(i) & (iii)

$\Rightarrow k \propto x$ ....(iv)

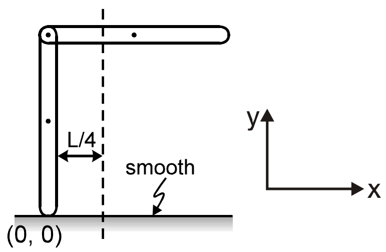
$\Rightarrow$ k vs x : st. line

(ii) $\Rightarrow$ a = constant

(ii) & (iii) $\Rightarrow v^2 \propto x$..............(v) v^2 vs x : st. line

3. Initially the centre of mass is at $\frac{L}{4}$ distance from the vertical rod.

$$\left(\text{As, } x_{cm} = \frac{m\left(\frac{1}{2}\right)+m(0)}{m+m} = \frac{L}{4}\right)$$



centre of mass does not move in x-direction as ΣF_x = 0.

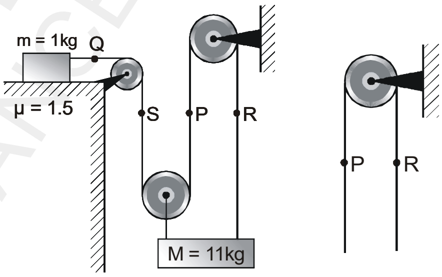
After they lie on the floor, the pin joint should be at L/4 distance from the origin shown inorder to keep the centre of mass at rest.

$\therefore$ Finally x-displacement of the pin is $\frac{L}{4}$ and y-displacement of the pin is obviously L.

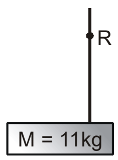
Hence net displacement = $\sqrt{L^2 + \frac{L^2}{16}} = \frac{\sqrt{17}L}{4}$

4. **Ans.** [13]

Sol.

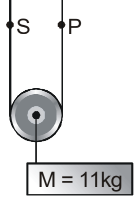


If the point P has an acceleration a upwards then the acceleration of point R will be a downwards.



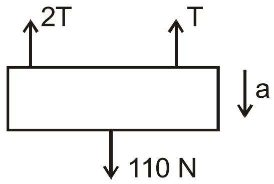
The point R has an acceleration a downwards

so the block will also have an acceleration a downwards.

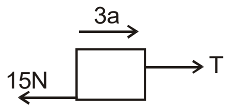


The point P has an acceleration a upwards, the block has an acceleration a downwards so the acceleration of S will be 3a downwards. (because $\frac{\vec{a}_S + \vec{a}_P}{2} = \vec{a}_{block}$).

The point Q will also have an acceleration 3a towards right.

The F.B.D. of 11kg block 

The F.B.D. of 1kg block



Using FBD of 11 kg block, which will have acceleration a downwards.

110 – 3T = 11a .... (1) (in downwards direction)

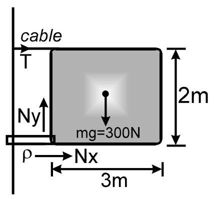
For 1 kg block, which will have acceleration 3a,

T – 15 = 3a (in horizontal direction)

or 3T – 45 = 9a .... (2)

on adding equation (1) & (2) we get

$20a = 65 \Rightarrow 4a = 13\ m/s^2$

5. 

From FBD

Equation in horizontal direction

T = Nx ....(1)

For Rotational equation about P

T. 2 = 1.5 × 300

T = 225 N

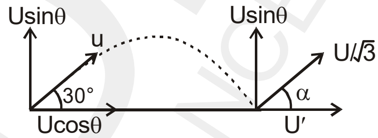
$N_x = 225$ N

$N_y = 300$ N

And   Ng = mg = 300 N

6.to 8 As the collision is elastic vertical component remains unchanged but the rough floor changes the horizontal component.

$$\therefore\ U'^2 = \left(\frac{U}{\sqrt{3}}\right)^2 - (U \sin 30°)^2 \quad \therefore\ U' = \frac{U}{2\sqrt{3}}$$



$$\text{Now } \tan\alpha = \left(\frac{U'}{U\sin\theta}\right)^{-1} = \sqrt{3} \qquad \therefore\ \alpha = 60°.$$

7. As the vertical components remain unchanged therefore the vertical height achieved will remain same.

$$\therefore\ \frac{H_1}{H_2} = 1$$

8. If it rebounded vertically then U′ would have been zero and vertical component velocity would only remain which is equal to $u \sin\theta = u \sin 30° = \frac{u}{2}$