GGSRDN

Educational Services Private Limited

9th, 10th, NEET, JEE(Main/Advanced)

अभ्यास ही सबसे बड़ा गुरू है।

CLASS : XI (PHYSICS)

DPP

DAILY PRACTICE PROBLEM

DPP-61 TO 70

DPP 61 : **Center of Mass, Work, Power and Energy, Rigid Body Dynamics**
DPP 62 : **Friction, Rigid Body Dynamics, Center of Mass**
DPP 63 : **Rigid Body Dynamics, Work, Power and Energy, Circular Motion, Center of Mass**
DPP 64 : **Center of Mass, Newton's law of Motion, Relative Motion, Rigid Body Dynamics, Friction**
DPP 65 : **Rigid Body Dynamics**
DPP 66 : **Rigid Body Dynamics, Center of Mass**
DPP 67 : **Rigid Body Dynamics, Center of Mass, Rotation**
DPP 68 : **Work, Power and Energy, Rigid Body Dynamics, Center of Mass**
DPP 69 : **Rigid Body Dynamics, Center of Mass, Circular Motion**
DPP 70 : **Rigid Body Dynamics, Simple Harmonic Motion**

PHYSICS
DPP
DAILY PRACTICE PRACTICE PROBLEMS

DPP No. 61

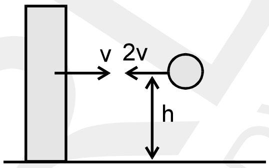
Total Marks : 29

Max. Time : 31 min.

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

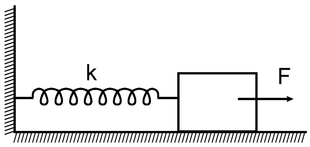
Type of Questions		M.M., Min.
Single choice Objective ('–1' negative marking) Q.1 to Q.4	(3 marks, 3 min.)	[12, 12]
Subjective Questions ('–1' negative marking) Q.5 to Q.6	(4 marks, 5 min.)	[8, 10]
Assertion and Reason (no negative marking) Q.7 to Q.9	(3 marks, 3 min.)	[9 , 9]

1. A ball collides elastically with a massive wall moving towards it with a velocity of v as shown. The collision occurs at a height of h above ground level and the velocity of the ball just before collision is 2v in horizontal direction. The distance between the foot of the wall and the point on the ground where the ball lands, at the instant the ball lands, will be :



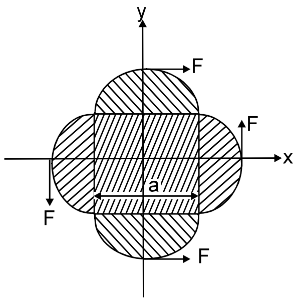
(A) $v\sqrt{\frac{2h}{g}}$ (B) $2v\sqrt{\frac{2h}{g}}$ (C) $3v\sqrt{\frac{2h}{g}}$ (D) $4v\sqrt{\frac{2h}{g}}$

2. A block attached to a spring, pulled by a constant horizontal force, is kept on a smooth surface as shown in the figure. Initially, the spring is in the natural state. Then the maximum positive work that the applied force F can do is : [Given that spring does not break]



(A) $\frac{F^2}{K}$ (B) $\frac{2F^2}{K}$ (C) ∞ (D) $\frac{F^2}{2K}$

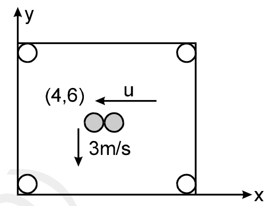
3. A planar object made up of a uniform square plate and four semicircular discs of the same thickness and material is being acted upon by four forces of equal magnitude as shown in figure. The coordinates of point of application of forces is given by



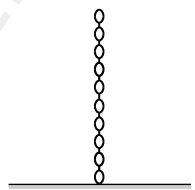
(A) (0, a) (B) (0, –a)
(C) (a, 0) (D) (–a, 0)

4. The angular velocity of a rigid body about any point of that body is same:
(A) only in magnitude
(B) only in direction
(C) both in magnitude and direction necessarily
(D) both in magnitude and direction about some points but not about all points.

5. On a smooth carrom board, a coin located at (4, 6) is moving in negative y–direction with speed 3 m/s is being hit at that point by a striker moving along negative x-axis. The line joining centre of the coin and striker just before the collision is parallel to x-axis. After collision the coin goes into the hole located at origin. Mass of the striker and the coin is equal. Considering the collision to be elastic, find the velocity (in vector form) of the striker before the collision and after the collision.



6. A uniform chain of mass m and length ℓ hangs on a thread and touches the surface of a table by its lower end. Find the force exerted by the table on the chain when half of its length has fallen on the table. The fallen part does not form heap.



COMPREHENSION

A smooth rope of mass m and length L lies in a heap on a smooth horizontal floor, with one end attached to a block of mass M. The block is given a sudden kick and instantaneously acquires a horizontal velocity of magnitude V_0 as shown in figure 1. As the block moves to right pulling the rope from heap, the rope being smooth, the heap remains at rest. At the instant block is at a distance x from point P as shown in figure-2 (P is a point on the rope which has just started to move at the given instant) , choose correct options for next three question.

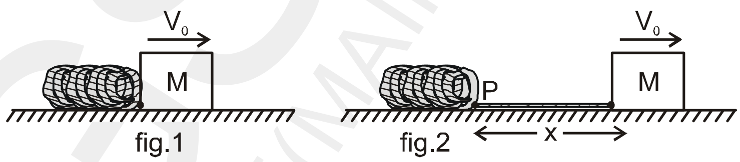


fig.1 fig.2

7. The speed of block of mass M is

(A) $\frac{mV_0}{(M+\frac{m}{L}x)}$ (B) $\frac{MV_0}{(M+\frac{m}{L}x)}$ (C) $\frac{m^2V_0}{M(M+\frac{m}{L}x)}$ (D) $\frac{M^2V_0}{m(M+\frac{m}{L}x)}$

8. The magnitude of acceleration of block of mass M is

(A) $\frac{m^3}{L}\frac{V_0^2}{(M+\frac{m}{L}x)^3}$ (B) $\frac{mM^2}{L}\frac{V_0^2}{(M+\frac{m}{L}x)^3}$ (C) $\frac{m^4}{ML}\frac{V_0^2}{(M+\frac{m}{L}x)^3}$ (D) $\frac{M^2}{L}\frac{V_0^2}{(M+\frac{m}{L}x)^3}$

9. The tension in rope at point P is

(A) $\frac{mM^2}{L}\frac{V_0^2}{(M+\frac{m}{L}x)^2}$ (B) $\frac{m^2M}{L}\frac{V_0^2}{(M+\frac{m}{L}x)^2}$ (C) $\frac{m^3}{L}\frac{V_0^2}{(M+\frac{m}{L}x)^2}$ (D) $\frac{M^3}{L}\frac{V_0^2}{(M+\frac{m}{L}x)^2}$

PHYSICS

DPP

DAILY PRACTICE PROBLEMS

DPP No. 62

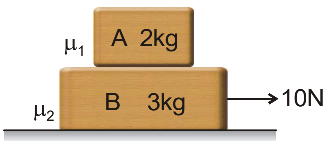
Total Marks : 30

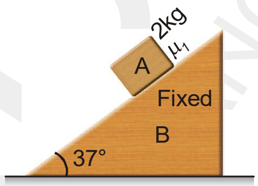
Max. Time : 33 min.

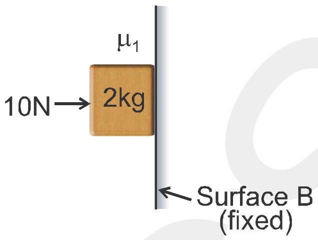
Topics : Friction, Rigid Body Dynamics, Center of Mass

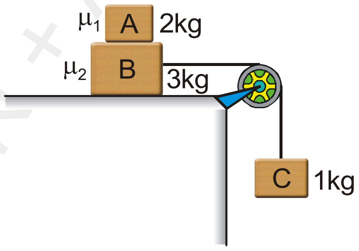
Type of Questions		M.M., Min.
Single choice Objective ('–1' negative marking) Q.1 to Q.3	(3 marks, 3 min.)	[9, 9]
Subjective Questions ('–1' negative marking) Q.4	(4 marks, 5 min.)	[4, 5]
Comprehension ('–1' negative marking) Q.5 to Q.7	(3 marks, 3 min.)	[9, 9]
Match the Following (no negative marking) (2 × 4) Q.8	(8 marks, 10 min.)	[8, 10]

1. In which of the following cases the friction force between'A' and 'B' is maximum. In all cases μ_1=0.5,μ_2 = 0.

(A)


(B)


(C)


(D)


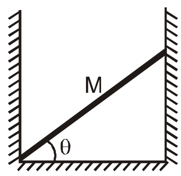
2. A uniform stick of mass M is placed in a frictionless well as shown. The stick makes an angle θ with the horizontal. Then the force which the vertical wall exerts on right end of stick is :

(A) $\frac{Mg}{2\cot\theta}$

(B) $\frac{Mg}{2\tan\theta}$

(C) $\frac{Mg}{2\cos\theta}$

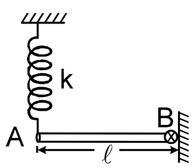
(D) $\frac{Mg}{2\sin\theta}$



3. Two small spheres of equal mass, and heading towards each other with equal speeds, undergo a head-on collision (no external force acts on system of two spheres). Then which of the following statement is correct?

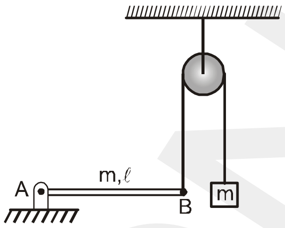
(A) Their final velocities must be zero.
(B) Their final velocities may be zero.
(C) Each must have a final velocity equal to the other's initial velocity.
(D) Their velocities must be reduced in magnitude

4. In the figure shown a uniform rod of mass 'm' and length 'ℓ' is hinged at one end and the other end is connected to a light vertical spring of spring constant 'k' as shown in figure. The spring has extension such that rod is in equilibrium when it is horizontal. The rod can rotate about horizontal axis passing through end 'B'. Neglecting friction at the hinge find
a) extension in the spring (b) the force on the rod due to hinge.



COMPREHENSION

Uniform rod AB is hinged at the end A in a horizontal position as shown in the figure (the hinge is frictionless, that is, it does not exert any friction force on the rod). The other end of the rod is connected to a block through a massless string as shown. The pulley is smooth and massless. Masses of the block and the rod are same and are equal to 'm'.



5. Then just after release of block from this position, the tension in the thread is

(A) $\frac{mg}{8}$ (B) $\frac{5mg}{8}$ (C) $\frac{11mg}{8}$ (D) $\frac{3mg}{8}$

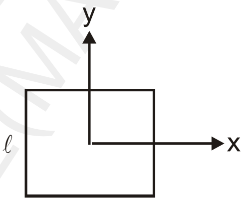
6. Then just after release of block from this position, the angular acceleration of the rod is

(A) $\frac{g}{8\ell}$ (B) $\frac{5g}{8\ell}$ (C) $\frac{11g}{8\ell}$ (D) $\frac{3g}{8\ell}$

7. Then just after release of block from this position, the magnitude of reaction exerted by hinge on the rod is

(A) $\frac{3mg}{16}$ (B) $\frac{5mg}{16}$ (C) $\frac{9mg}{16}$ (D) $\frac{7mg}{16}$

8. Four identical rods, each of mass m and length l are joined to form a rigid square frame. The frame lies in the X-Y plane, with its centre at the origin and the sides parallel to the x and y axis. it's moment of inertia about



Column I	Column II
(A) An axis parallel to z-axis and passing through a corner	(p) 5/3 $m\ell^2$
(B) One side	(q) 2/3 $m\ell^2$
(C) The x-axis	(r) 4/3 $m\ell^2$
(D) The z-axis	(s) 10/3 $m\ell^2$

DPP No. 63

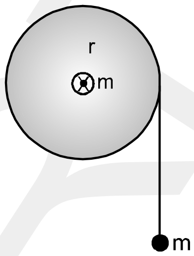
Total Marks : 27

Max. Time : 29 min.

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

Type of Questions		M.M., Min.
Single choice Objective ('–1' negative marking) Q.1 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]

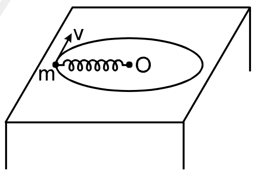
1. A uniform disc of mass m and radius r and a point mass m are arranged as shown in the figure. The acceleration of point mass is: (Assume there is no slipping between pulley and thread and the disc can rotate smoothly about a fixed horizontal axis passing through its centre and perpendicular to its plane)



(A) $\frac{g}{2}$ (B) $\frac{g}{3}$

(C) $\frac{2g}{3}$ (D) none of these

2. Mass m is connected with an ideal spring of natural length ℓ whose other end is fixed on a smooth horizontal table. Initially spring is in its natural length ℓ. Mass m is given a velocity 'v' perpendicular to the spring and released. The velocity perpendicular to the spring when its length is ℓ + x, will be



(A) $\frac{2v\ell}{\ell+x}$ (B) $\frac{2v^2\ell}{\ell+x}$

(C) $\frac{v\ell}{\ell+x}$ (D) zero

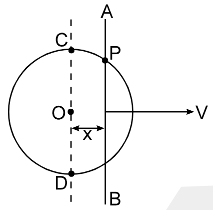
3. A ball of mass m is attached to the lower end of a light vertical spring of force constant k. The upper end of the spring is fixed. The ball is released from rest with the spring at its normal (unstretched) length, and comes to rest again after descending through a distance x.

(A) $x = \frac{mg}{k}$ (B) $x = \frac{2mg}{k}$

(C) the ball will have no acceleration at the position where it has descended through $\frac{x}{2}$

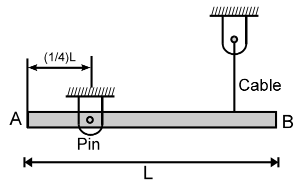
(D) the ball will have an upward acceleration equal to g at its lowermost position.

4. A rod AB is moving on a fixed circle of radius R with constant velocity 'v' as shown in figure. P is the point of intersection of the rod and the circle. At an instant the rod is at a distance $x = \frac{3R}{5}$ from centre of the circle. The velocity of the rod is perpendicular to the rod and the rod is always parallel to the diameter CD.



(a) Find the speed of point of intersection P.
(b) Find the angular speed of point of intersection P with respect to centre of the circle.

5. A uniform beam of length L and mass 'm' is supported as shown. If the cable suddenly breaks, determine; immediately after the release.
(a) the acceleration of end B.
(b) the reaction at the pin support.



COMPREHENSION

A smooth ball 'A' moving with velocity 'V' collides with another smooth identical ball at rest. After collision both the balls move with same speed with angle between their velocities 60°. No external force acts on the system of balls.

6. The speed of each ball after the collision is

(A) $\frac{V}{2}$ (B) $\frac{V}{3}$ (C) $\frac{V}{\sqrt{3}}$ (D) $\frac{2V}{\sqrt{3}}$

7. If the kinetic energy lost is fully converted to heat then heat produced is

(A) $\frac{1}{3}mV^2$ (B) $\frac{2}{3}mV^2$ (C) 0 (D) $\frac{1}{6}mV^2$

8. The value of coefficient of restitution is

(A) 1 (B) $\frac{1}{3}$ (C) $\frac{1}{\sqrt{3}}$ (D) 0

PHYSICS

DPP

DAILY PRACTICE PROBLEMS

DPP No. 64

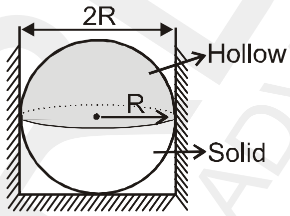
Total Marks : 27

Max. Time : 29 min.

Topics : Center of Mass, Newton's law of Motion, Relative Motion, Rigid Body Dynamics, Friction

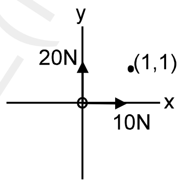
Type of Questions		M.M., Min.
Single choice Objective ('–1' negative marking) Q.1 to Q.2	(3 marks, 3 min.)	[6, 6]
Multiple choice objective ('–1' negative marking) Q.3	(4 marks, 4 min.)	[4, 4]
Subjective Questions ('–1' negative marking) Q.4 to Q.5	(4 marks, 5 min.)	[8, 10]
Comprehension ('–1' negative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

1. A compound sphere is made by joining a hemispherical shell and a solid hemisphere of same radius R and same mass as shown in figure. This system is kept between two smooth parallel walls and a smooth floor with the hollow hemisphere on the top as shown in figure. The maximum angular velocity of the compound sphere when the system is slightly disturbed is (all surfaces are smooth)



(A) $\sqrt{\frac{15g}{64R}}$ (B) $\sqrt{\frac{15g}{32R}}$ (C) $\sqrt{\frac{15g}{16R}}$ (D) $\sqrt{\frac{15g}{8R}}$

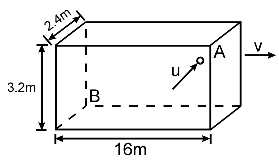
2. A particle is placed at the origin of the coordinate system. Two forces of magnitude 20 N & 10 N act on it as shown in figure. It is found that it starts moving towards the point (1,1). The net unknown force acting on the particle at this position can be :



(A) $15\sqrt{2}$ at angle 45° with positive x axis (B) $5\sqrt{2}$ at angle 135° with positive x axis

(C) $5\sqrt{2}$ at angle -45° with positive x axis (D) None of these

3. A railway compartment is 16 m long, 2.4 m wide and 3.2 m high. It is moving with a velocity V. A particle moving horizontally with a speed u, perpendicular to the direction of V enters through a hole at an upper corner A and strikes the diagonally opposite corner B. Assume g = 10 m/s^2.



(A) υ = 20 m/s
(B) u = 3 m/s
(C) to an observer inside the compartment the path of the particle is a parabola
(D) to a stationary observer outside the compartment the path of the particle is a parabola

4. In the figure (i) a disc of mass M (kg) and radius R (m) is rotating smoothly about a fixed vertical axis AB with angular speed 26 rad/s. A rod CD of length $\frac{R}{2}$ (m) and mass M (kg) is hinged at one end at point 'D' on the disc. The rod remains in vertical position and rotates along with the disc about axis AB. At some moment the rod CD gets a very small impulse at point 'C' due to air due to which the rod falls on the disc along one radius and sticks to the disc as shown in figure (ii). Now find the angular velocity of the disc in rad/s.

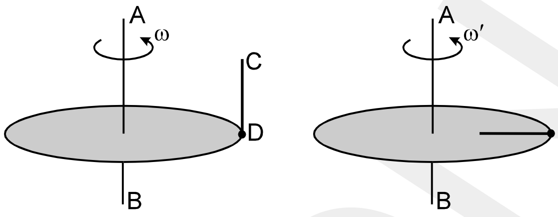
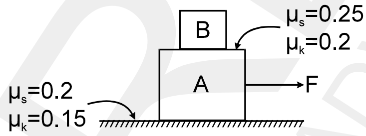


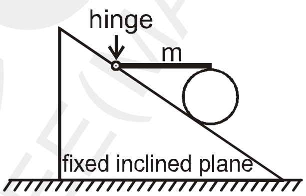
Figure (i) Figure (ii)

5. Block B of mass 2 kg rests on block A of mass 10 kg. All surfaces are rough with the value of coefficient of friction as shown in the figure. Find the minimum force F that should be applied on block A to cause relative motion between A and B. (g = 10 m/s^2)



COMPREHENSION

A horizontal uniform rod of mass 'm' has its left end hinged to the fixed incline plane, while its right end rests on the top of a uniform cylinder of mass 'm' which in turn is at rest on the fixed inclined plane as shown. The coefficient of friction between the cylinder and rod, and between the cylinder and inclined plane, is sufficient to keep the cylinder at rest.



6. The magnitude of normal reaction exerted by the rod on the cylinder is

(A) $\frac{mg}{4}$ (B) $\frac{mg}{3}$ (C) $\frac{mg}{2}$ (D) $\frac{2mg}{3}$

7. The ratio of magnitude of frictional force on the cylinder due to the rod and the magnitude of frictional force on the cylinder due to the inclined plane is:

(A) 1 : 1 (B) $2 : \sqrt{3}$ (C) 2 : 1 (D) $\sqrt{2} : 1$

8. The magnitude of normal reaction exerted by the inclined plane on the cylinder is:

(A) mg (B) $\frac{3mg}{2}$ (C) 2mg (D) $\frac{5mg}{4}$

PHYSICS

DPP

DAILY PRACTICE PROBLEMS

DPP No. 65

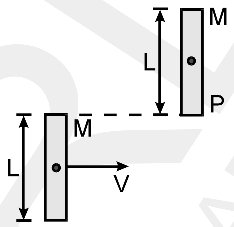
Total Marks : 26

Max. Time : 27 min.

Topic : Rigid Body Dynamics

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

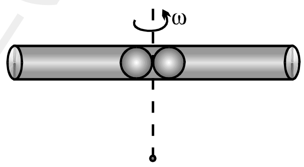
1. A bar of mass M and length L is in pure translatory motion with its centre of mass velocity V. It collides with and sticks to a second identical bar which is initially at rest. (Assume that it becomes one composite bar of length 2L). The angular velocity of the composite bar will be



(A) $\frac{3}{4}\frac{V}{L}$ clockwise (B) $\frac{4}{3}\frac{V}{L}$ clockwise

(C) $\frac{3}{4}\frac{V}{L}$ counterclockwise (D) $\frac{V}{L}$ counterclockwise

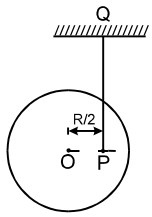
2. A smooth tube of certain mass is rotated in gravity free space. The two balls shown in the figure move towards ends of the tube. For the whole system which of the following quantity is not conserved.



(A) Angular momentum (B) Linear momentum

(C) Kinetic energy (D) Angular speed

3. A uniform disc of mass M and radius R is released from the shown position. PQ is a string, OP is a horizontal line, O is the centre of the disc and distance OP is R/2. Then tension in the string just after the disc is released will be:



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

4. Which of the following statements is/are true

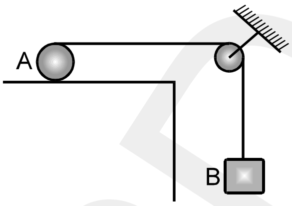
(A) work done by kinetic friction on an object may be positive.

(B) A rigid body rolls up an inclined plane without sliding. The friction force on it will be upwards. (only contact force and gravitational force is acting)

(C) A rigid body rolls down an inclined plane without sliding. The friction force on it will be upwards. (only contact force and gravitational force is acting)

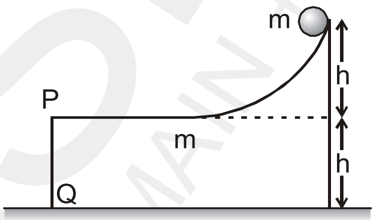
(D) A rigid body is left from rest and having no angular velocity from the top of a rough inclined plane. It moves down the plane with slipping. The friction force on it will be upwards.

5. Find the acceleration of solid right circular roller A, weighing 12 kg when it is being pulled by another weight B (6 kg) along the horizontal plane as in figure (pulley is massless). The weight B is attached to the end of a string wound around the circumference of roller. Assume there is no slipping of the roller and the string is inextensible.



COMPREHENSION

A small ball (uniform solid sphere) of mass m is released from the top of a wedge of the same mass m. The wedge is free to move on a smooth horizontal surface. The ball rolls without sliding on the wedge. The required height of the wedge are mentioned in the figure.



6. The speed of the wedge when the ball is just going to leave the wedge at point 'P' of the wedge is

(A) $\sqrt{\frac{5gh}{9}}$ (B) $\sqrt{gh}$ (C) $\sqrt{\frac{5gh}{6}}$ (D) None of these

7. The total kinetic energy of the ball just before it falls on the ground

(A) 2 mgh (B) mgh (C) $\frac{13}{18}$mgh (D) None of these

8. The horizontal separation between the ball and the edge 'PQ' of wedge just before the ball falls on the ground is

(A) $\frac{3\sqrt{10}}{2}h$ (B) $\frac{2\sqrt{10}}{3}h$ (C) 2 h (D) None of these

PHYSICS

DPP

DAILY PRACTICE PROBLEMS

DPP No. 66

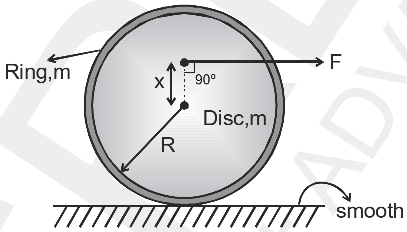
Total Marks : 23

Max. Time : 24 min.

Topics : Rigid Body Dynamics, Center of Mass

Type of Questions		M.M., Min.
Single choice Objective ('–1' negative marking) Q.1 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	(4 marks, 5 min.)	[4, 5]
Comprehension ('–1' negative marking) Q.5 to Q.7	(3 marks, 3 min.)	[9, 9]

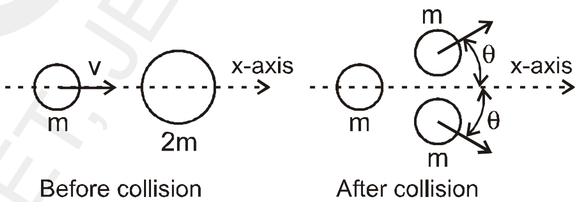
1. A ring and a disc of same mass m and same radius R are joined concentrically. This system is placed on a smooth plane with the common axis parallel to the plane as shown in figure. A horizontal force F is applied on the system at a point which is at a distance x from the centre. The value of x so that it starts pure rolling is



(A) $\frac{R}{2}$ (B) $\frac{3R}{4}$

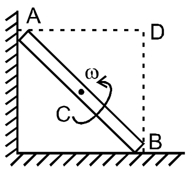
(C) R (D) Pure rolling is not possible as the floor is smooth.

2. A particle of mass m is moving along the x-axis with speed v when it collides with a particle of mass 2m initially at rest. After the collision, the first particle has come to rest, and the second particle has split into two equal-mass pieces that are shown in the figure. Which of the following statements correctly describes the speeds of the two pieces
? ($\theta > 0$)



(A) Each piece moves with speed v.
(B) Each piece moves with speed v/2.
(C) One of the pieces moves with speed v/2, the other moves with speed greater than v/2
(D) Each piece moves with speed greater than v/2.

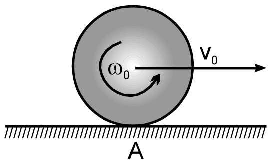
3. A thin uniform rod AB is sliding between two fixed right angled surfaces. At some instant its angular velocity is ω. If I_x represent moment of inertia of the rod about an axis perpendicular to the plane and passing through the point X (A, B, C or D), the kinetic enegy of the rod is



(A) $\frac{1}{2}I_A\omega^2$ (B) $\frac{1}{2}I_B\omega^2$

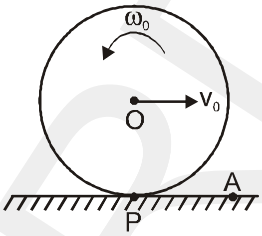
(C) $\frac{1}{2}I_C\omega^2$ (D) $\frac{1}{2}I_D\omega^2$

4. A solid sphere of mass m and radius r is given an initial angular velocity ω_0 and a linear velocity $v_0 = \lambda r \omega_0$ from a point A on a rough horizontal surface. It is observed that the ball turns back and returns to the point A after some time if λ is less than a certain maximum value λ_0. Find λ_0.



COMPREHENSION

A wheel is released on a rough horizontal floor after imparting it an initial horizontal velocity v_0 and angular velocity ω_0 as shown in the figure below. Point O is the centre of mass of the wheel and point P is its instantaneous point of contact with the ground. The radius of wheel is r and its radius of gyration about O is k. Coefficient of friction between wheel and ground is μ. A is a fixed point on the ground.



5. Which of the following is conserved ?
(A) linear momentum of wheel
(B) Angular momentum of wheel about O
(C) Angular momentum of wheel about A
(D) none of these

6. If the wheel comes to permanent rest after sometime, then :

(A) $v_0 = \omega_0 r$ (B) $v_0 = \frac{\omega_0 k^2}{r}$ (C) $v_0 = \frac{\omega_0 r^2}{R}$ (D) $V_0 = \omega_0\left(r + \frac{k^2}{r}\right)$

7. In above question, distance travelled by centre of mass of the wheel before it stops is -

(A) $\frac{v_0^2}{2\mu g}\left(1+\frac{r^2}{k^2}\right)$ (B) $\frac{v_0^2}{2\mu g}$ (C) $\frac{v_0^2}{2\mu g}\left(1+\frac{k^2}{r^2}\right)$ (D) None of these

PHYSICS

DPP

DAILY PRACTICE PROBLEMS

DPP No. 67

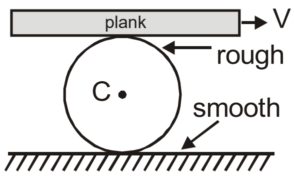
Total Marks : 31

Max. Time : 32 min.

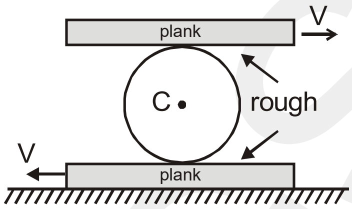
Topics : Rigid Body Dynamics, Center of Mass, Rotation

Type of Questions		M.M., Min.
Single choice Objective ('–1' negative marking) Q.1	(3 marks, 3 min.)	[3, 3]
Subjective Questions ('–1' negative marking) Q.2	(4 marks, 5 min.)	[4, 5]
Comprehension ('–1' negative marking) Q.3 to Q.9	(3 marks, 3 min.)	[21, 21]
Assertion and Reason (no negative marking) Q. 10	(3 marks, 3 min.)	[3, 3]

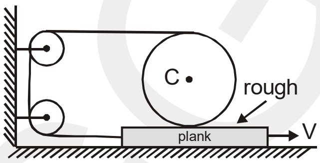
1. There are four arrangements of a solid cylinder and a plank as shown in the figures. Some surfaces are smooth and some are rough as indicated. There is no slipping at each rough surface. The plank and/or centre of cylinder are given a horizontal constant velocity as shown in each of the situations. Using this information fill in the blanks.

(i) 

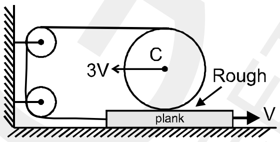
The speed of center of mass of the cylinder is ___________.

(ii) 

The angular velocity of the cylinder is __________.

(iii) 

The speed of center of mass of the cylinder is _________ .

(iv) 

The angular velocity of the cylinder is ____________ .

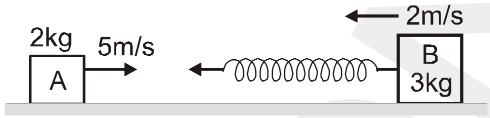
(a) V
(b) V/R
(c) 2V/R
(d) 4V/R
(e) cannot be determined from the given information
(f) Zero.

(A) (i) d (ii) b (iii) f (iv) c
(B) (i) e (ii) b (iii) f (iv) b
(C) (i) e (ii) d (iii) f (iv) c
(D) (i) e (ii) b (iii) f (iv) a
(E) (i) e (ii) b (iii) f (iv) d

2. A student throws a horizontal stick of length L up into the air. At the moment it leaves her hand the speed of stick's closest end is zero . The stick completes N turns just as it is caught by the student at the initial release point . Find the height h to which the centre of mass of the rod rises .

COMPREHENSION

In figure, a block A of mass 2kg is moving to the right with a speed 5m/s on a horizontal frictionless surface. Another block B of mass 3 kg with a massless spring of spring constant 222 N/m attached to it, is moving to the left on the same surface and with a speed 2 m/s. Let us take the direction to the right as the positive X–direction. At some instant, block A collides with the spring attached to block B. At some other instant, the spring has maximum compression and then, finally, the blocks move with their final velocities. Assuming that (i) the spring force is conservative and so there is no conversion of kinetic energy to internal energy and (ii) no sound is made when block A hits the spring, answer the following questions.



3. Velocity of centre of mass of the system of blocks A and B, before collision is :

(A) zero (B) $-0.6\hat{i}$ m/s (C) $+0.8\hat{i}$ m/s (D) $1.4\hat{i}$ m/s

4. In the collision process, while the spring is getting compressed :
(A) both linear momentum and kinetic energy are conserved
(B) both linear momentum and mechanical energy are conserved
(C) linear momentum is conserved but mechanical energy is not conserved
(D) Neither the linear momentum nor the mechanical energy remain conserved

5. Final velocity of block A will be :

(A) $2.5\hat{i}$ m/s (B) $-1.8\hat{i}$ m/s (C) $3.6\hat{i}$ m/s (D) $-3.4\hat{i}$ m/s

6. Final velocity of centre of mass of the system of blocks A and B will be :

(A) zero (B) $0.6\hat{i}$ m/s (C) $0.8\hat{i}$ m/s (D) $-1.4\hat{i}$ m/s

7. When the blocks are yet to attain their final velocities, in this situation at any instant when block A is moving with a velocity $4\hat{i}$ m/s, velocity of block B will then be :

(A) $-1.33\hat{i}$ m/s (B) $-2.67\hat{i}$ m/s (C) $1.67\hat{i}$ m/s (D) $3.77\hat{i}$ m/s

8. In previous question, at the given instant, compression of the spring is nearly :
(A) 16 cm (B) 24 cm (C) 33 cm (D) 52 cm

9. Maximum compression of the spring in the collision will be nearly
(A) 30 cm (B) 50 cm (C) 72 cm (D) 36 cm

10. **STATEMENT-1 :** The net momentum of a system of two moving particles is zero. Then at a particular instant of time, the net angular momentum of system of given two particle is same about any point.

STATEMENT-2 : If net momentum of a system of two moving particle is zero, then angular momentum of system of given two particles is zero about any point.
(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. 68

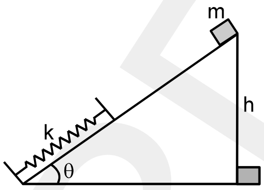
Total Marks : 22

Max. Time : 24 min.

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

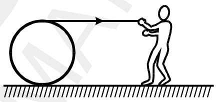
Type of Questions		M.M., Min.
Single choice Objective ('–1' negative marking) Q.1 to Q.3	(3 marks, 3 min.)	[6, 6]
Multiple choice objective ('–1' negative marking) Q.4 to Q.5	(4 marks, 4 min.)	[8, 8]
Subjective Questions ('–1' negative marking) Q.6 to Q.7	(4 marks, 5 min.)	[8, 10]

1. A body of mass m released from a height h on a smooth inclined plane that is shown in the figure. The following can be true about the velocity of the block knowing that the wedge is fixed.



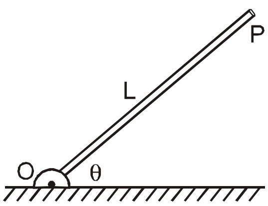
(A) v is highest when it just touches the spring
(B) v is highest when it compresses the spring by some amount
(C) v is highest when the spring comes back to natural position
(D) none of these

2. A man pulls a solid cylinder (initially at rest) horizontally by a massless string. The string is wrapped on the cylinder and the cylinder performs pure rolling. Mass of the cylinder is 100 kg, radius is π metre & tension in string is 100 N. Then the angular speed of the cylinder after one revolution will be :



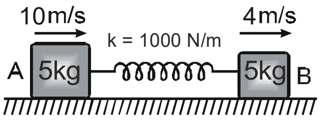
(A) 4 rad /sec
(B) $\frac{4}{\sqrt{3}}$ rad/ sec
(C) $\frac{4}{3}$ rad/ sec
(D) none of these

3. A uniform pole of length L and mass M is pivoted on the ground with a frictionless hinge O. The pole is free to rotate without friction about an horizontal axis passing through O and normal to plane of the page.The pole makes an angle θ with the horizontal. The pole is released from rest in the position shown, then linear acceleration of the free end (P) of the pole just after its release would be :



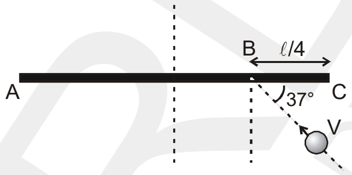
(A) $\frac{2}{3}$ g $\cos\theta$
(B) $\frac{2}{3}$ g
(C) g
(D) $\frac{3}{2}$ g $\cos\theta$

4. Two blocks A (5kg) and B(5kg) attached to the ends of a spring constant 1000 N/m are placed on a smooth horizontal plane with the spring undeformed. Simultaneously velocities of 10m/s and 4 m/s along the line of the spring in the same direction are imparted to A and B then



(A) when the extension of the spring is maximum the velocities of A and B are same.
(B) the maximum extension of the spring is 30cm.
(C) the first maximum compression occurs $\pi/56$ seconds after start.
(D) maximum compression and maximum extension occur alternately.

5. A rod AC of length ℓ and mass m is kept on a horizontal smooth plane. It is free to rotate and move. A particle of same mass m moving on the plane with velocity v strikes rod at point B making angle 37^0 with the rod. The collision is elastic. After collision :



(A) The angular velocity of the rod will be $\frac{72}{55}\frac{v}{\ell}$

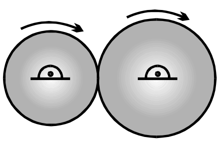
(B) The centre of the rod will travel a distance $\frac{\pi \ell}{3}$ in the time in which it makes half rotation

(C) Impulse of the impact force is $\frac{24mV}{55}$

(D) None of these

6. A block of dimensions a × a × 2a is kept on an inclined plane of inclination 37°. The longer side is perpendicular to the plane. The co-efficient of friction between the block and the plane is 0.8. By numerical analysis find whether the block will topple or not.

7. Two separate cylinders of masses m (= 1 kg) & 4 m & radii R (= 10 cm) and 2 R rotating in clockwise direction with ω_1 = 100 rad/sec. and ω_2 = 200 rad/sec respectively. Now they are held in contact with each other as in figure. Determine their angular velocities after the slipping between the cylinders stops.



PHYSICS

DPP

DAILY PRACTICE PROBLEMS

DPP No. 69

Total Marks : 20

Max. Time : 22 min.

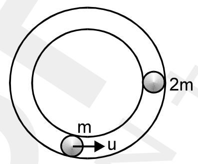
Topics : Rigid Body Dynamics, Center of Mass, Circular Motion

Type of Questions		M.M., Min.
Single choice Objective ('–1' negative marking) Q.1 to Q.3	(3 marks, 3 min.)	[3, 3]
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 disk of mass 300kg is rotating freely about a vertical axis through its centre with constant angular velocity ω. A boy of mass 30kg starts from the centre and moves along a radius to the edge of the disk. The angular velocity of the disk now is

(A) $\frac{\omega_0}{6}$ (B) $\frac{\omega_0}{5}$ (C) $\frac{4\omega_0}{5}$ (D) $\frac{5\omega_0}{6}$

2. Two masses ' m ' and ' 2 m ' are placed in fixed horizontal circular smooth hollow tube as shown. The mass ' m ' is moving with speed 'u' and the mass ' 2 m ' is stationary. After their first collision, the time elapsed for next collision. (coefficient of restitution e = 1/2)



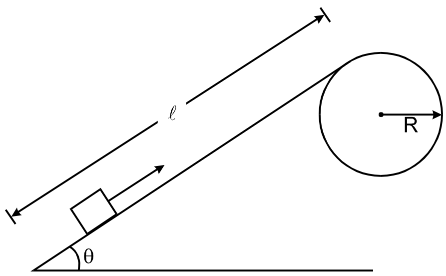
(A) $\frac{2\pi r}{u}$ (B) $\frac{4\pi r}{u}$

(C) $\frac{3\pi r}{u}$ (D) $\frac{12\pi r}{u}$

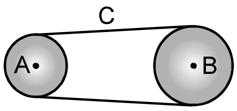
3. A solid homogeneous cylinder of height h and base radius r is kept vertically on a conveyer belt moving horizontally with an increasing velocity v = a + bt^2. If the cylinder is not allowed to slip then the time when the cylinder is about to topple, will be equal to

(A) $\frac{rg}{bh}$ (B) $\frac{2rg}{bh}$ (C) $\frac{2bg}{rh}$ (D) $\frac{rg}{2bh}$

4. Figure shows a smooth track which consists of a straight inclined part of length ℓ joining smoothly with the circular part. A particle of mass m is projected up the inlcine from its bottom. (a) Find the minimum projection - speed v_0 for which the particle reaches the top of the track. (b) Assuming that the projection - speed is $2v_0$ and that the block does not lose contact with the track before reaching its top, find the force acting on it when it reaches the top. (c) Assuming that the projection-speed is only slightly greater than v_0, where will the block lose contact with the track?

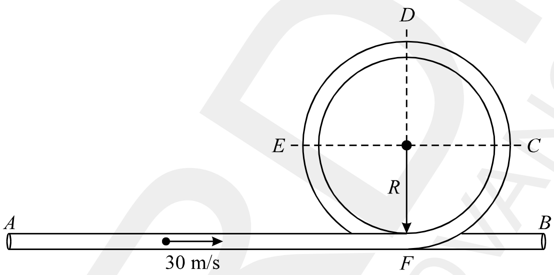


5. Wheel A of radius r_A = 10cm is coupled by a belt C to another wheel of radius r_B = 25 cm as in the figure. The wheels are free to rotate and the belt does not slip. At time t = 0 wheel A increases it's angular speed from rest at a uniform rate of $\pi/2$ rad/sec^2. Find the time in which wheel B attains a speed of 100 rpm **[Hint: $v_A = v_B$]**



COMPREHENSION

A smooth horizontal fixed pipe is bent in the form of a vertical circle of radius 20 m as shown in figure. A small glass ball is thrown in horizontal portion of pipe at speed 30 m/s as shown from end *A*. (Take *g* = 10 m/s^2)



6. Which of the following statement is/are correct :
(i) ball will not come out from end *B*.
(ii) ball will come out from end *B*.
(iii) At point D speed of ball will be just more than zero.
(iv) At point E and C the ball will have same speed.
(A) only (i) (B) (ii) and (iv) (C) (ii), (iii) and (iv) (D) only (ii)

7. At which angle from vertical from bottom most point *F*. The normal reaction on ball due to pipe will change its direction (in terms of radially outwards and inwards) :

(A) $\theta = 180°$ (B) $\theta = \cos^{-1}\left(-\frac{2}{3}\right)$ (C) $\theta = \cos^{-1}\left(-\frac{5}{6}\right)$ (D) None of these

8. With what speed ball will come out from point *B* :

(A) 30 m/s (B) $20\sqrt{2}$ m/s (C) $10\sqrt{5}$ m/s (D) None of these

PHYSICS

DPP

DAILY PRACTICE PROBLEMS

DPP No. 70

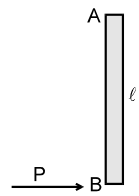
Total Marks : 22

Max. Time : 22 min.

Topics : Rigid Body Dynamics, Simple Harmonic Motion

Type of Questions		M.M., Min.
Single choice Objective ('–1' negative marking) Q.1 to Q.6	(3 marks, 3 min.)	[18, 18]
Multiple choice objective ('–1' negative marking) Q.7	(4 marks, 4 min.)	[4, 4]

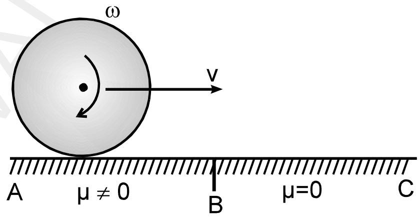
1. A uniform rod AB of mass m and length l at rest on a smooth horizontal surface. An impulse P is applied to the end B. The time taken by the rod to turn through a right angle is:



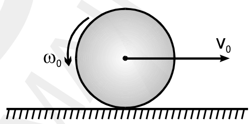
(A) $\frac{2\pi ml}{P}$ (B) $\frac{\pi m l}{3P}$ (C) $\frac{\pi ml}{12P}$ (D) $\frac{2\pi ml}{3P}$

2. As shown in the figure, a disc of mass m is rolling without slipping a angular velocity ω. When it crosses point B disc will be in:

(A) translational motion only
(B) pure rolling motion
(C) rotational motion only
(D) none of these



3. A uniform circular disc placed on a horizontal rough surface has initially a velocity v_0 and an angular velocity ω_0 as shown in the figure. The disc comes to rest after moving some distance in the direction of motion. Then v_0/ω_0 is:



(A) r/2 (B) r (C) 3r/2 (D) 2

4. The equation of motion of a particle of mass 1 gm is $\frac{d^2x}{dt^2} + \pi^2 x = 0$ where x is displacement (in m) from mean position. The frequency of oscillation is (in Hz):

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

5. A man of mass 60 kg standing on a platform executing S.H.M. in the vertical plane. The displacement from the mean position varies as $y = 0.5 \sin(2\pi ft)$. The value of f, for which the man will feel weightlessness at the highest point is: (y is in metres)

(A) $\frac{g}{4\pi}$ (B) $4\pi g$ (C) $\frac{\sqrt{2g}}{2\pi}$ (D) $2\pi\sqrt{2g}$

6. A particle executes SHM in a straight line. In the first second starting from rest it travels a distance 'a' and in the next second a distance 'b' in the same direction. The amplitude of S.H.M will be

(A) $\frac{2a^2}{3a - b}$ (B) a – b (C) 2a – b (D) a / b

7. A particle performing S.H.M. undergoes displacement of A/2 (where A = amplitude of S.H.M.) in one second. At t = 0 the particle was located at either extreme position or mean position. The time period of S.H.M. can be : (consider all possible cases)

(A) 12s (B) 2.4 (C) 6s (D) 1.2s

DPP 61 TO 70 (ANSWER KEY)

DPP NO. - 61

1. (C) **2.** (B) **3.** (B) **4.** (C)

5. (2,0) **6.** $\frac{3}{2}$ **7.** (B) **8.** (B)

9. (A)

DPP NO. - 62

1. (B) **2.** (B) **3.** (B) **4.(a)** $\frac{mg}{2k}$ **(b)** $\frac{mg}{2}$

5. (B) **6.** (D) **7.** (C)

8. A – s , B – p, C – q , D – r

DPP NO. - 63

1. (C) **2.** (C) **3.** (B)(C)(D)

4. (a) $V_P = \frac{5}{4}V$ (b) V cosec θ

5. (a) $\frac{9g}{7}\downarrow$ (b) $\frac{4w}{7}\uparrow$ **6.** (C) **7.** (D)

8. (B)

DPP NO. - 64

1. (B) **2.** (C) **3.** (A) (B) (C) (D)

4. 36 **5.** 48 N **6.** (C) **7.** (A) **8.** (B)

DPP NO. - 65

1. (C) **2.** (D) **3.** (C) **4.** (A)(B) (C)(D)

5. $a = \frac{20}{7}$ or $\frac{2g}{7}$ **6.** (A) **7.** (D) **8.** (B)

DPP NO. - 66

1. (B) **2.** (D) **3.** (A)(B)(D) **4.** $\lambda_0 = 2/5$

5. (C) **6.** (B) **7.** (B)

DPP NO. - 67

1. (E) **2.** $\frac{\pi NL}{4}$ **3.** (C) **4.** (B)

5. (D) **6.** (C) **7.** (A) **8.** (C)

9. (B) **10.** (C)

DPP NO. - 68

1. (B) **2.** (B) **3.** (D) **4.** (A), (B), (D)

5. (A), (B), (C)

6. Since torque is not balanced, it will topple.

7. 300rad/sec., 150 rad/sec

DPP NO. - 69

1. (D) **2.** (B) **3.** (A)

4. (a) $\sqrt{2g[R(1-\cos\theta)+\ell\sin\theta]}$

(b) 6 mg $\left(1-\cos\theta+\frac{\ell}{R}\sin\theta\right)$

(c) The radius through the particle makes an angle $\cos^{-1}(2/3)$ with the vertical **5.** 50/3 sec.

6. (B) **7.** (C) **8.** (A)

DPP NO. - 70

1. (C) **2.** (B) **3.** (A) **4.** (A) **5.** (C)

6. (A) **7.** (A) (B) (C) (D)

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CLASS : XI (PHYSICS)

DPP

DAILY PRACTICE PROBLEM

Solutions

DPP-61 TO 70

DPP 61 : **Center of Mass, Work, Power and Energy, Rigid Body Dynamics**
DPP 62 : **Friction, Rigid Body Dynamics, Center of Mass**
DPP 63 : **Rigid Body Dynamics, Work, Power and Energy, Circular Motion, Center of Mass**
DPP 64 : **Center of Mass, Newton's law of Motion, Relative Motion, Rigid Body Dynamics, Friction**
DPP 65 : **Rigid Body Dynamics**
DPP 66 : **Rigid Body Dynamics, Center of Mass**
DPP 67 : **Rigid Body Dynamics, Center of Mass, Rotation**
DPP 68 : **Work, Power and Energy, Rigid Body Dynamics, Center of Mass**
DPP 69 : **Rigid Body Dynamics, Center of Mass, Circular Motion**
DPP 70 : **Rigid Body Dynamics, Simple Harmonic Motion**

DPP NO. - 61

1. Solve in the reference frame fixed to the wall.

Before collision, velocity of ball = 3v towards it.

$\therefore$ After elastic collision of ball = 3v away from it

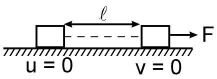
Time of flight = $\sqrt{\frac{2h}{g}}$

$\therefore$ distance between wall and ball

$= 3v.\sqrt{\frac{2h}{g}}$.

(Here no pseudo force is applied since the wall keeps on moving with constant velocity w.r.t ground, it being very heavy.)

2. **(B)** Applying work energy theorem on block



$F\ell - \frac{1}{2}k\ell^2 = 0 \therefore \ell = \frac{2F}{k}$

or work done I = $F\ell = \frac{2F^2}{k}$

3. **(B)** The two forces along y-direction balance each other.

Hence, the resultant force is 2F along x-direction

Let the point of application of force be at (0, y).

(By symmetry x-coordinate will be zero).

For rotational equilibrium :

$F(a) + F(a) + F(a + y) - F(a - y) = 0$

$\Rightarrow y = -a$ Hence (B).

$F(a) + F(a) + F(a + y) - F(a - y) = 0$

$\Rightarrow y = -a$ Hence (B).

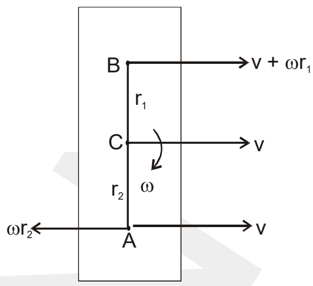
Alternate :

Torque will only be produced by the two forces along y–direction in anti-clockwise direction. To balance this torque we should apply a force 2F in order to produce a torque in the clockwise direction, which is only possible if we apply a force at a point below the x-axis.

Then , $\tau = F(a) + F(a) - 2F \times y = 0$

$\Rightarrow y = a$ Hence (B).

4. Suppose a rod is having angular velovity ω about point C .



Choose two points A and B as shown in the fig. velocity of B w.r.t A = $(v + \omega r_1) - (v - \omega r_2)$

$\Rightarrow V_{BA} = \omega(r_1 + r_2)$

Angular velocity of B w.r.t A = $\frac{V_{BA}}{AB}$

$= \frac{\omega(r_1 + r_2)}{r_1 + r_2} = \omega$ **Ans (C)**

5. The line of impact for duration of collision is parallel to x-axis.

The situation of striker and coin just before the collision is given as

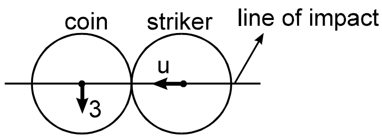


Figure (A) before collision

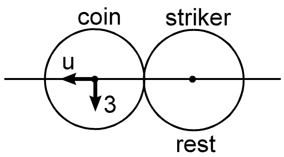
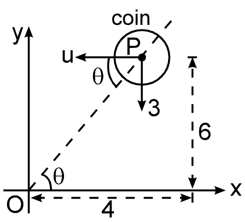


Figure (B) after collision

Because masses of coin and striker are same, their components of velocities along line of impact shall exchange. Hence the striker comes to rest and the x-y component of velocities of coin are u and 3 as shown in figure.



For coin to enter hole,

its velocity must be along PO

$\therefore \quad \tan\theta = \frac{6}{4} = \frac{3}{u}$

or $u = 2$ m/s **Ans. (2, 0)**

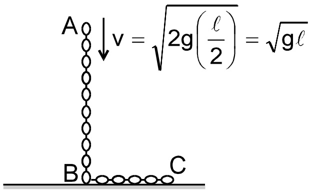
6. 1. Weight of the portion BC of the chain lying on the table, $W = \frac{mg}{2}$ (downwards) Using $v = \sqrt{2gh}$

2. Thrust force $F_t = v_r\left(\frac{dm}{dt}\right)$

$v_r = v$

$\frac{dm}{dt} = \lambda v$

$F_t = \lambda v^2$



(where, $\lambda = \frac{m}{\ell}$, is mass per unit length of chain)

$v^2 = \left(\sqrt{g\ell}\right)^2 = g\ell$

$\therefore \quad F_t = \left(\frac{m}{\ell}\right)(g\ell) = mg$ (downwards)

$\therefore$ Net force exerted by the chain on the table is

$F = W + F_t = \frac{mg}{2} + mg = \frac{3}{2}mg$

So, from Newton's third law the force exerted by the table on the chain will be $\frac{3}{2}$ mg (vertically upwards).

7.to 9 The mass of moving material is $M + \frac{m}{L}x$.

From conservation of momentum MV_0

$= (M + \frac{m}{L}x)V$

$\therefore$ velocity of moving block and moving rope is

$V = \frac{MV_0}{(M + \frac{m}{L}x)}$

8. **(B)** The acceleration of moving block is

$a = -v\frac{dv}{dx} = -\frac{MV_0}{(M + \frac{m}{L}x)^2} \times \frac{m}{L}\frac{dx}{dt}$

$= -\frac{m}{L}\frac{M^2V_0^2}{(M + \frac{m}{L}x)^3}$

9. **(A)** The tension at point P is what gives momentum to next tiny piece (to left of P) that starts moving. The speed of this piece increases from 0 to V in time dt.

$\Rightarrow dp = dmV$

or $F = \frac{dP}{dt} = \frac{dm}{dt}V = \frac{\frac{m}{L}dx}{dt}V = \frac{m}{L}V^2$

$\therefore \quad F_p = \frac{m}{L}\frac{M^2V_0^2}{(M + \frac{m}{L}x)^2}$

DPP NO. - 62

1. (d) (i) If both moves together $a = 2\text{m/s}^2$

Force required for A = 4N

Max. frictionforce = 10 N

Hence there will be no slipping and friction force willbe 4 N.

(ii) Max. Friction force = $\mu mg\cos\theta$ = 8 N

Force along incline = $mg\sin\theta$ = 12 N

Hence block will move and friction force will be 8 N.

(iii) Max. friction force = μN = 5N

Downward force = 20 N

Block will slip and friction force will be 5 N

(iv) Acceleration of the system = $\frac{10}{6}\text{m/s}^2$

Force required for A = $\frac{20}{6}$N

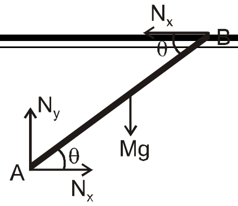
Max. friction force = 10 N

Hence A and B will move together and friction force will be $\frac{20}{6}$N.

2. The free body diagram of rod is Where N_x and N_y are horizontal and vertical components of reaction exerted by wall on rod. Net torque on rod about left end A is zero

$\therefore \quad Mg\frac{\ell}{2}\cos\theta = N_x \, \ell \sin\theta$

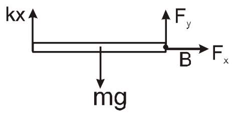
$\Rightarrow N_x = \dfrac{Mg}{2\tan\theta}$.



3. **(Easy)** Nothing is mentioned about coefficient of restitution. Hence the only true statement is 'their final velcities may be zero.'

4. (a) net torque about B = 0

$$\Rightarrow mg \cdot \frac{\ell}{2} = kx.\ell \quad \text{or} \quad x = \frac{mg}{2k}.$$



(b) For the rod to be in equilibrium net force on it = 0

$\Rightarrow F_x = 0$

$kx + F_y = mg$

$$\Rightarrow F_y = \frac{mg}{2}$$

Ans. **(a)** $\dfrac{mg}{2k}$ **(b)** $\dfrac{mg}{2}$

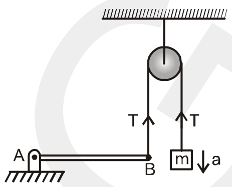
5, 6 & 7.

Let α be the angular acceleration of rod and a be acceleration of block just after its release.

$\therefore mg - T = ma$ ..... (1)

$T\ell - mg\dfrac{\ell}{2} = \dfrac{m\ell^2}{3}\alpha$ .... (2)

and $a = \ell\alpha$ .... (3)

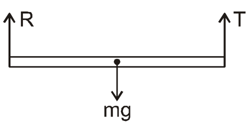


Solving we get

$T = \dfrac{5mg}{8}$ and $\alpha = \dfrac{3g}{8\ell}$

Now from free body diagram of rod, let R be the reaction by hinge on rod

$$R + T - mg = m\,a_{cm} = m\,\frac{1}{2}\alpha$$



Solving we get $R = \dfrac{9mg}{16}$

8. Ans. A – s, B – p, C – q, D – r

DPP NO. - 63

2. since torque about O is zero,

angular momentum of mass m is conserved

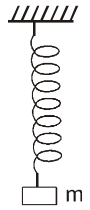
$$\therefore \quad m v\ell = m v_\perp (\ell + x) \;;\; v_\perp = \frac{v\ell}{\ell + x}$$

3. initial velocity = final velocity = 0

from energy conservation

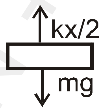
$$mgx - \frac{1}{2}kx^2 = 0$$

$$x = \frac{2mg}{k}$$



(at Natural length)

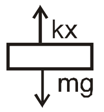
at deseended length = $\dfrac{x}{2}$



$$\frac{kx}{2} = k \cdot \frac{2mg}{2k} = mg$$

Net force = 0

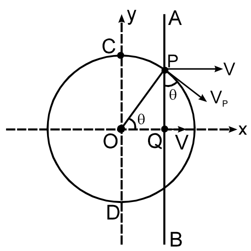
$\Rightarrow$ a = 0 at lower most position



$$\text{force} = Kx - mg = K\frac{2mg}{K} - mg = mg$$

$\Rightarrow a = g \uparrow$

4.



As a rod AB moves, the point 'P' will always lie on the circle.

$\therefore$ its velocity will be along the circle as shown by 'V_P' in the figure. If the point P has to lie on the rod 'AB' also then it should have component in 'x' direction as 'V'.

$\therefore \quad V_P \sin\theta = V$

$\Rightarrow \quad V_P = V \operatorname{cosec}\theta$

here $\cos\theta = \frac{x}{R} = \frac{1}{R} \cdot \frac{3R}{5} = \frac{3}{5}$

$\therefore \quad \sin\theta = \frac{4}{5} \quad \therefore \quad \operatorname{cosec}\theta = \frac{5}{4} \quad \therefore \quad V_P = \frac{5}{4} V$

...Ans.

$\omega = \frac{V_P}{R} = \frac{5V}{4R}$

ALTERNATIVE SOLUTION :

Sol. (a) Let 'P' have coordinate (x, y)

$x = R\cos\theta,\ y = R\sin\theta.$

$V_X = \frac{dx}{dt} = -R\sin\theta \frac{d\theta}{dt} = V \quad \Rightarrow \quad \frac{d\theta}{dt} = \frac{-V}{R\sin\theta}$

$V_Y = R\cos\theta \frac{d\theta}{dt} = R\cos\theta\left(-\frac{V}{R\sin\theta}\right) =$

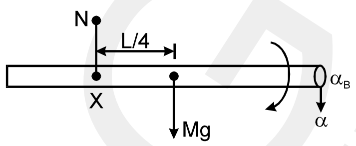
$-V\cot\theta$

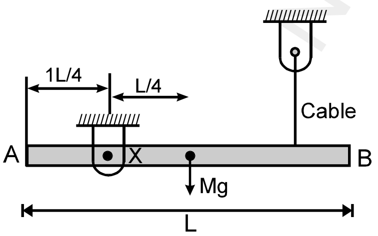
$\therefore \quad V_P = \sqrt{V_x^2 + V_y^2} = \sqrt{V^2 + V^2\cot^2\theta}$

$= V\operatorname{cosec}\theta$ **...Ans.**

Sol. (b) $\omega = \frac{V_P}{R} = \frac{5V}{4R}$

5. Taking torques w.r.t 'x'





M.I. of the rod w.r.t axis of rotation

$I_x = I_{cm} + \frac{ML^2}{16}$

$= \frac{ML^2}{12} + \frac{ML^2}{16} = \frac{7ML^2}{48}$

(i) $Mg.\frac{L}{4} = I.\alpha$

$Mg.\frac{L}{4} = \frac{7ML^2}{48}.\alpha$

$\Rightarrow \alpha = \frac{12g}{7L} \qquad a_B = R\alpha$

$= \frac{3L}{4} \cdot \frac{12g}{7L} = \frac{9g}{7}\downarrow$

(ii) $a_{cm} = \frac{L}{4}.\alpha = \frac{3g}{7}$

also apply equation of motion on COM

$Mg - N = M.\frac{3g}{7}$

$N = Mg - \frac{3Mg}{7} = \frac{4Mg}{7}\uparrow$

[Ans.: (a) $\frac{9g}{7}\downarrow$ **(b)** $\frac{4w}{7}\uparrow$ **]**

6.to 8 From conservation of momentum

$mv = mv'\cos 30° + mv'\cos 30°$

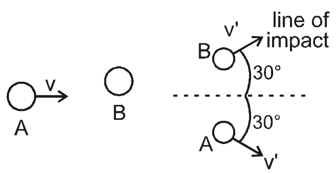
$\therefore v' = \frac{v}{2\cos 30°} = \frac{v}{\sqrt{3}}$

7. Loss in kinetic energy

$= \frac{1}{2}mv^2 - 2 \times \frac{1}{2}m\left(\frac{v}{\sqrt{3}}\right)^2 = \frac{1}{6}mv^2$

8. Initially B was at rest, therefore line of impact is along final velocity of B.

$\therefore\ e = \frac{v' - v'\cos 60°}{v\cos 30} = \frac{\frac{1}{2}\frac{v}{\sqrt{3}}}{v \times \frac{\sqrt{3}}{2}} = \frac{1}{3}$



DPP NO. - 64

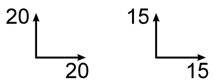
1. Change in PE = Increase in K.E.

$$Mg\left[\frac{R}{2}2-\frac{3R}{8}2\right] = \frac{1}{2}\left[\frac{2}{5}MR^2+\frac{2}{3}MR^2\right]\omega^2 \qquad \frac{g}{4}$$

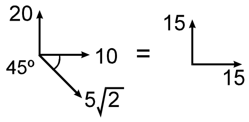
$$= \frac{2}{2}\left[\frac{1}{5}+\frac{1}{3}\right] R\omega^2 \qquad \sqrt{\frac{15g}{32R}} = \omega$$

2. Check the options so that the resultant force comes towards (1, 1). i.e. $F_{xnet} = F_{ynet}$

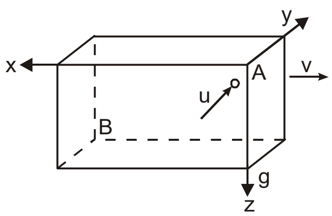
(There exist infinite solutions because the accel-eration is not given, for example



etc.)



3. Time of flight



$$\Rightarrow t = \sqrt{\frac{2h}{g}} = \sqrt{\frac{2\times 3.2}{10}} = 0.8 \text{ sec.}$$

$y = V_y t$

$\Rightarrow$ 2.4 = U× 0.8 U = 3 m/s

$x = V_x t$

$\Rightarrow$ 16 = V × 0.8 V = 20 m/s

Angle between $\vec{a}$ & $\vec{v}$ is other then 0° or 180°, and $\vec{a}$ is constant. So the path will be parabola.

4. MI of the system when rod is vertical

$$I = \frac{1}{2} m R^2 + m R^2$$

MI of system when rod is horizontal

$$I' = \frac{1}{2} m R^2 + \left[\frac{m\left(\frac{R}{2}\right)^2}{12} + m\left(\frac{3R}{4}\right)^2\right]$$

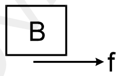
$$= \frac{13}{12} m R^2$$

from conservation of angular momentum of system about axis AB is

$I\omega = I'\omega'$

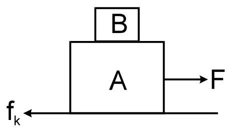
$$\text{or} \quad \omega' = \frac{\frac{3}{2}mR^2\omega}{\frac{13}{12}mR^2} = \frac{18}{13}\omega$$

5. FBD of B



$$(a_B)_{max} = \frac{f_{max}}{m_B} = \mu_S g = 2.5 \text{ m/s}^2$$

FBD of combined system



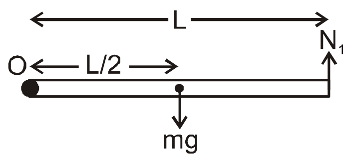
f_k = 0.15 (2 + 10) g = 18 N

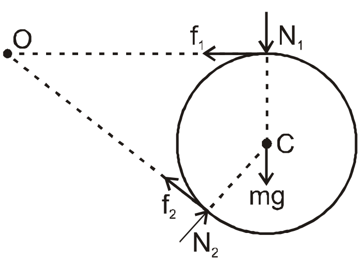
$F_{max} - f_k = (m_A + m_B)(a_B)_{max}$

$\Rightarrow F_{max} = f_k$ + 12 × 2.5 = 48 N.**Ans. 48 N.**

Sol. 6 to 8.

FBD of rod and cylinder is as shown.





Net torque on rod about hinge 'O' = 0

$\therefore N_1 \times L = mg \times \frac{L}{2}$ or $\boxed{N_1 = \frac{mg}{2}}$

Net torque on cylinder about its centre C is zero. $\therefore f_1R = f_2R$ or $\boxed{f_1 = f_2}$

Net torque on cylinder about hinge O is zero.

$\therefore N_2 \times L = N_1 \times L + mgL$

or $N_2 = \boxed{\frac{3mg}{2}}$

DPP NO. - 65

1. Cons. of ang. momentum about P gives

$$MV\frac{L}{2} = \frac{(2M)(2L)^2}{12}\omega$$

$$\frac{V}{2} = \frac{2L\omega}{3}$$

$\omega = \frac{3V}{4L}$, counterclockwise **Ans. (C)**

2. **(D)** As $\Sigma\tau = 0$; Angular momentum, linear momentum remains conserved.

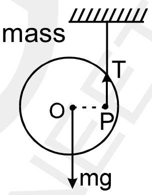
As the two balls will move radially out, I changes.In order to keep the angular momentum $(L = I\omega)$ conserved, angular speed (ω) should change Hence (D).

3. **[C]**

Applying Newton's law on centre of mass O

$Mg - T = ma$ {a = acceleration of centre of mass}

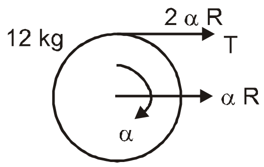
$\tau = I\alpha$, about centre of mass

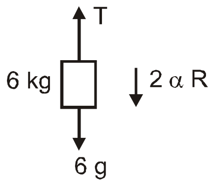


$$T\frac{R}{2} = \frac{MR^2}{2}\cdot\alpha$$

Also $a = \frac{R}{2}\alpha$ from above equations $T = \frac{2mg}{3}$

5.





$$T\,2R = \left[\frac{12R^2}{2} + 12R^2\right]\alpha$$

$T\,2R = 18R^2\alpha$

$6g - T = 6 \times 2\alpha R$

$T = 60 - 12\alpha R$

$T = 9\alpha R$

$9\alpha R = 60 - 12\alpha R$

$$\alpha R = \frac{60}{21} = \frac{20}{7}$$

$$a = \frac{20}{7} \text{ or } \frac{2g}{7}$$

6. to 8

$$mgh = \frac{1}{2}mv^2 + \frac{1}{2}mv^2 + \frac{1}{2}\cdot\frac{2}{5}mr^2\left(\frac{2v}{r}\right)^2$$

$$= \frac{1}{2}mv^2\left[1 + 1 + \frac{8}{5}\right] = \frac{1}{2}mv^2\frac{18}{5} = \frac{9mv^2}{5}$$

$$\Rightarrow v = \sqrt{\frac{5}{9}gh}$$

7. KE of the ball = mg 2h

$$-\frac{1}{2}m\left(\sqrt{\frac{5gh}{9}}\right)^2 = \frac{31}{18}mgh$$

$$= mg\,2h - \frac{1}{2}m\left(\sqrt{\frac{5gh}{9}}\right)^2 = \frac{31}{18}mgh$$

8. $X = 2vt = 2v\sqrt{\frac{2h}{g}} = 2.\sqrt{\frac{5}{9}gh}\sqrt{\frac{2h}{g}}$

$$= \frac{2\sqrt{10}}{3}h$$

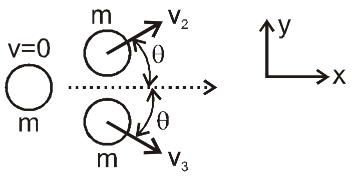
DPP NO. - 66

1. $a_{cm} = \frac{F}{2m}$ $\alpha = \frac{F.x}{\frac{mR^2}{2} + mR^2} = \frac{2F.x}{3mR^2}$

$a_{cm} = \alpha R$

$\frac{F}{2m} = \frac{2Fx}{3mR^2}.R \qquad x = \frac{3R}{4}.$

2. After collision by momentum conservation
Along y-axis



$0 = 0 + mv_2 \sin\theta - mv_3 \sin\theta$

$\Rightarrow v_2 = v_3$

Along x-axis

$mv = 0 + mv_2 \cos\theta + mv_3 \cos\theta$

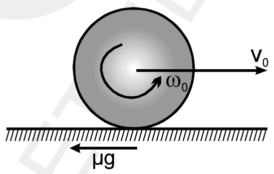
$mv = 2\,m\,v_2 \cos\theta$

$v_2 = \frac{v}{2}\frac{1}{\cos\theta} \qquad \text{so } v_2 = v_3 > \frac{v}{2} \qquad \because \cos\theta < 1$

3. **(Tough)** The point D is the instantaneous centre of rotation.

$K.E. = \frac{1}{2}I_D\omega^2 = \frac{1}{2}I_A\omega^2 = \frac{1}{2}I_B\omega^2$

4. Ball will comes back to the initial position if its angular velocity is greater than zero is the same direction (in which it was released) at the moment its' linear velocity becomes zero. In this condition ball would return back

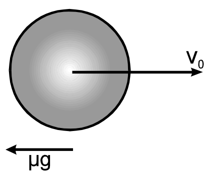


For linear motion

$0 = v_0 + (\mu g)\,t$

$t = \frac{v_0}{\mu g}$ (time when ball stops)

For rotation motion



$\tau = I\alpha$

$\Rightarrow \alpha = \frac{\tau}{I} = \frac{\mu mg \times R}{\frac{2}{5}MR^2} = \frac{5\mu g}{2R^2}$

using $\omega_f = \omega_0 - \alpha t$

$\omega_f > 0$

$\Rightarrow \omega_0 > \alpha t$

$\Rightarrow \frac{v_0}{\alpha R} > \frac{5\mu g}{2R} \cdot \frac{v_0}{\mu g}$ for limiting condition.

$\Rightarrow \lambda_0 = \frac{2}{5}$

5. to 7 Torque of friction about A is zero.

6. Angular momentum conservation about point A.

$L_{in} = mv_0 r - mk^2\omega$

$L_{fin} = 0$

$L_{fin} = L_{in}$

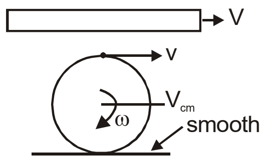
$\Rightarrow v_0 = \omega k^2/r.$

7. $a_{cm} = -\mu g$

$0^2 = v_0^2 - 2\mu gs \qquad \Rightarrow S = \frac{v_0^2}{2\mu g}$

DPP NO. - 67

1. (i)



$V_{cm} + \omega R = V \qquad V_{cm} = V - \omega R$

ω depends on value of friction between plank & cylinder, hence V_{cm} is undetermined.

(ii) $\omega = \frac{2v}{2R} = \frac{V}{R}$

(iii) $\omega = \frac{2V}{2R} = \frac{V}{R}$, hence $V_{cm} = 0$

(iv) $\omega_{A/C} = \frac{3V + V}{R} = \frac{4V}{R} \quad \Rightarrow \omega = \frac{4V}{R}$

2. $V_{cm} = \omega\frac{\ell}{2}$

$t = \frac{2V_{cm}}{g} = \frac{\omega\ell}{g}$ time of flight

$T = \frac{2\pi}{\omega}$ time period of one revolution

$t = NT \quad \frac{\omega \ell}{g} = N \frac{2\pi}{\omega}$

$\omega^2 \ell^2 = 2N\pi\ell g$

$H = \frac{V_{cm}^2}{2g} = \frac{\omega^2\ell^2}{4\times 2g} = \frac{2N\pi\ell g}{4\times 2g} = \frac{N\pi\ell}{4}$

3. $V_{CM} = \frac{m_1\vec{V}_1 + m_2\vec{V}_2}{m_1+m_2}$ ....(1)

$= \frac{(2\times5-3\times2)}{3+2} = +\frac{4}{5}\hat{i} = +.8\hat{i}$

5. $\frac{1}{2}\times 2\times 5^2 + \frac{1}{2}(3)2^2 = \frac{1}{2}\times 2\, V_1^2 + \frac{1}{2}\, 3$

$\times\, V_2^2$ ....(2)

$2(5) - 3(2) = 2V_1 + 3V_2$ ....(3)

$V_1 = -3.4\,\hat{i}$

6. $\vec{V}_{cm\,final} = 0.8\,\hat{i}$

7. $31 = \frac{1}{2}\, 2\times 4^2 + \frac{1}{2}\times(3)\,V_2^2$

$+\frac{1}{2}kx^2$ ....(4)

$(2)\,5 - 3(2) = 4\times 2 + 3V_2$ ....(5)

$4 - 8 = 3V_2 - \frac{4}{3} = V_2 \qquad \vec{V}_2 = -1.33\,\hat{i}$

put V_2 in equation (4)

8. x = 33 cm

9. for Max compression

$\frac{1}{2}(2)(5)^2 + \frac{1}{2}\,3\,(2)^2 = \frac{1}{2}(2+3)(.8)^2 + \frac{1}{2}Kx^2$

x = 50 cm

10. $\vec{L} = \vec{r}_1\times\vec{p}_1 + \vec{r}_2\times\vec{p}_2 \quad \because\ \vec{p}_1+\vec{p}_2 = 0$

$= \vec{r}_1\times(-\vec{p}_2) + \vec{r}_2\times\vec{p}_2$

$= (\vec{r}_2-\vec{r}_1)\times\vec{p}_2$

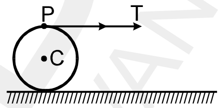
$\vec{L} = \vec{r}_{rel}\times\vec{p}_2$. Hence Statement-1 is True, Statement-2 is False

$\vec{L} = \vec{r}_{rel}\times\vec{p}_2$

DPP NO. - 68

1. Velocity is maximum when acceleration is zero. It means net force is zero. Net force is zero after some compression.

2. The cylinder rolls without slipping, hence no work is being done by friction. In one complete revolution the centre C of the cylinder moves by $2\pi R$ (R is radius of cylinder) and the top most point P of the cylinder moves by $4\pi R$.



$v_{cm} = R\omega$ (from constraint)

Applying work energy theorem

Work done by T= increase in kinetic energy of cylinder

$T\times 4\pi R = \frac{1}{2}I_{cm}\,\omega^2 + \frac{1}{2}mv_{cm}^2 = \frac{1}{2}\left(\frac{1}{2}mR^2\right)\omega^2 + \frac{1}{2}$

$mR^2\ \omega^2$

solving we get $\omega = \frac{4}{\sqrt{3}}$ rad/ sec

3. About point O

Torque $\tau = I\alpha$

$Mg\left(\frac{L}{2}\cos\theta\right) = \frac{ML^2}{3}\alpha \Rightarrow \frac{3}{2}\frac{g}{L}\cos\theta = \alpha$

Initially centripetal acceleration of point P is zero ($\because$

$a_c = \frac{v^2}{r} = \frac{0}{r} = 0$)

Acceleration of point P is $\sqrt{a_C^2 + a_t^2}$

$= a_t = L\alpha = \frac{3}{2}g\cos\theta$

4. $\frac{1}{2}\frac{m_1m_2}{m_1+m_2}(V_1 - V_2)^2 = \frac{1}{2}kx^2$

$\frac{1}{2}\frac{(5)(5)}{5+5}(10-4)^2 = \frac{1}{2}\times 1000\,x^2$

$2.5\,(36) = (1000)\,x^2$

$$\frac{(25)(36)\times 10^{-1}}{1000} = x^2$$

$$\frac{(25)(36)}{10000} = x^2$$

$$\frac{(5)(6)}{10} = x^2$$

x = 0.30 m

Also $\omega = \sqrt{\frac{k}{\mu}} = \sqrt{\frac{1000}{\frac{(5)(5)}{5+5}}}$

ω = 20 sec.

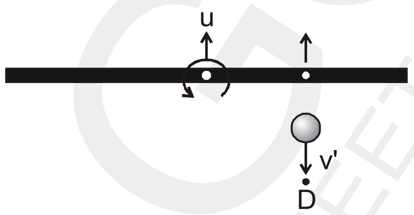
$$T = \frac{2\pi}{20} = \frac{\pi}{10}$$

The first maximum compression occurs $\frac{T}{4} = \frac{\pi}{40}$ sec. after start.

5. The ball has V', component of its velocity perpendicular to the length of rod immediately after the collision. u is velocity of COM of the rod and ω is angular velocity of the rod, just after collision. The ball strikes the rod with speed vcos53° in perpendicular direction and its component along the length of the rod after the collision is unchanged.

Using for the point of collision.

Velocity of separation = Velocity of approach



$$\Rightarrow \frac{3V}{5} = \left(\frac{\omega\ell}{4}+u\right) + V' \quad .... (1)$$

Conserving linear momentum (of rod + particle), in the direction $\perp$ to the rod.

$$mV.\frac{3}{5} = mu - mV' \quad ....(2)$$

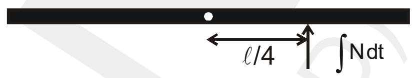
Conserving angular moment about point 'D' as shown in the figure

$$0 = 0 + \left[mu\frac{\ell}{4} - \frac{m\ell^2}{12}\omega\right] \Rightarrow u = \frac{\omega\ell}{3} \quad ....(3)$$

By solving

$$u = \frac{24V}{55},\ w = \frac{72V}{55\ell}$$

Time taken to rotate by π angle $t = \frac{\pi}{\omega}$



In the same time, distance travelled $= u_2.t = \frac{\pi\ell}{3}$

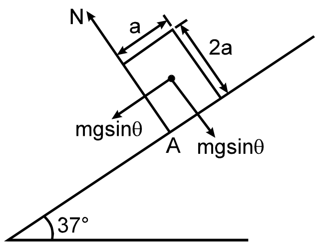
Using angulr impulse-angular momentum equation.

$$\int N.dt.\frac{\ell}{4} = \frac{m\ell^2}{4}.\frac{72V}{55\ell} \Rightarrow \int N.dt = \frac{24mV}{55}$$

or $\left\{\begin{array}{l}\text{using impulse – momentum equation on Rod}\\ \int Ndt = mu = \frac{24mv}{55}\end{array}\right.$

6. If ever it will topple, it will topple about A.It can be verified that the block is not sliding.

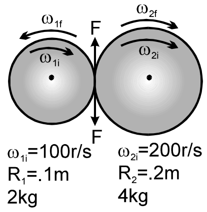
Now, $\tau_A = mg\sin\theta \times a - mg\cos\theta \times \frac{a}{2}$



$= \tau_A = \frac{m a g}{5}$ which is non–zero.

Since torque is not balanced, it will topple.

7. Final direction of motions are shown by ω_{1f} & ω_{2f}



Now,

$\alpha_1 = \dfrac{\omega_{f1} + \varepsilon_{i1}}{t} \qquad \alpha_2 = \dfrac{\omega_{i2} + \varepsilon_{f2}}{t}$

and $FR_1 + I_1\alpha_2$ (torque equation. of friction)

$FR_2 = I_2\alpha_2$

Dividing $\dfrac{R_1}{R_2} = \dfrac{\ell_1 \alpha_1}{\ell_2 \alpha_2}$

$\Rightarrow \dfrac{I_1}{I_2} \cdot \dfrac{\omega_{f_1} + \omega_{i_1}}{\omega_{i_2} - \omega_{f_2}} = \dfrac{R_1}{R_2}$

For pt. of contact when slipping stops

$R_1 \omega_{f_1} = R_2 \omega_{f_2}$

$$\frac{\mu_1 R_1^2 \ell_2}{\mu_2 R_2^2 \ell_2} \cdot \frac{\omega_{f_1} + \omega_{i_1}}{\omega_{i_2} - \dfrac{R}{R_2}} = \frac{R_1}{R_2}$$

$$\Rightarrow \omega_{f_1} = \frac{\mu_2 R_2 \omega_{i_2} - \mu_1 R_1 \omega_{i_1}}{\mu_2 R_1 + \mu_1 R_1}$$

$$= \frac{4 \times .2 \times 200 - 1 \times .1 \times 100}{.4 \times + .1} = 300 \text{ r/s}$$

$$\omega_{f_2} = \frac{R_1 \omega_{f_1}}{R_2} = \frac{R}{2R} \times 300 = 150 \text{ rad/sec.}$$

[Ans.: 300rad/sec., 150 rad/sec.]

DPP NO. - 69

1. As $\Sigma\tau = 0$, angular momentum remains conseved :

$\therefore \; L = \left(0 + \dfrac{300R^2}{2}\right)$

$\omega_0 = \left(\dfrac{300R^2}{2} + 30R^2\right).\omega$

$\Rightarrow \; 150\,\omega_0 = 180\,\omega$

$\Rightarrow \; \omega = 5/6\,\omega_0$ **Ans.**

2. **(B)** Let the speeds of balls of mass m and 2m after collision be v_1 and v_2 as shown in figure.

Applying conservation of momentum

$mv_1 + 2mv_2 = mu \quad$ and $-v_1 + v_2 = \dfrac{u}{2}$

solving we get $v_1 = 0$ and $v_2 = \dfrac{u}{2}$

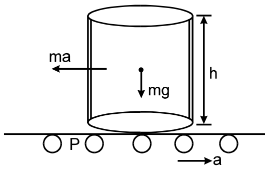
Hence the ball of mass m comes to rest and ball of mass 2m moves with speed $\dfrac{u}{2}$.

$t = \dfrac{2\pi r}{u/2} = \dfrac{4\pi r}{u}$

3. WRT to belt, pseudo force ma acts on cylinder at COM as shown about to cylinder will be just about to topple when torque to weight w.r.t. P.

$\dfrac{dv}{dt} = a = 2bt$

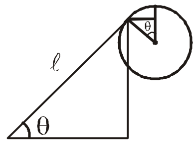
$m.2bt \,.\, \dfrac{h}{2} = mg.r$



$t = \dfrac{rg}{bh}$ **Ans.: gr/bh**

4. (a) $\dfrac{1}{2}mv_0^2 = mg\,\ell\sin\theta + mgR(1 - \cos\theta)$

$v_0 = \sqrt{2gR(1-\cos\theta) + 2g\ell\sin\theta}$



(b) C.O.E.

$= \dfrac{1}{2}m(2v_0)^2 - mg\,\ell\sin\theta - mg\,R(1 - \cos\theta) = \dfrac{1}{2}mv^2$

$= 2mv_0^2 - mg\ell\sin\theta - mgR(1 - \cos\theta) = \dfrac{1}{2}mv^2$

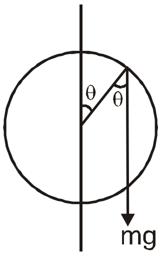
$= 4mgR\,(1 - \cos\theta) + 4\,mg\,\ell\sin\theta - mg\ell\sin\theta$

$- mgR(1 - \cos\theta) = \dfrac{1}{2}mv^2$

$= 6mgR(1 - \cos\theta) + 6mg\,\ell\sin\theta = mv^2$

$N = 6mg(1 - \cos\theta) + 6mg\frac{\ell}{R}\sin\theta$

$= 6mg[(1 - \cos\theta) + \frac{\ell}{R}\sin\theta]$.

(c) 

$mg\cos\theta = \frac{mv^2}{R}$

$= \frac{1}{2}mv^2 = \frac{1}{2}mg\,R\cos\theta$

$= mgR(1 - \cos\theta) = \frac{1}{2}mg\,R\cos\theta$

$\cos\theta = \frac{2}{3} \quad \theta = \cos^{-1}\left(\frac{2}{3}\right)$.

5. For no slipping condition

$r_A\alpha_A = r_B\alpha_B$

$\Rightarrow \alpha_B = \frac{r_A}{r_B}\alpha_A = \frac{10}{25} \times \frac{\pi}{2} = \frac{\pi}{5}$ rad/s²

$\omega_B = \frac{2\pi \times 100}{60} = \frac{10\pi}{3}$ rad/s

$\omega_B = \omega_{BO} + \alpha_B t$

$\frac{10\pi}{3} = 0 + \frac{\pi}{5}t \Rightarrow t = \frac{50}{3}$ sec

6. to 8 In the given situation if the speed becomes zero at the highest point then also the particle can complete the circle as there is no chance for the particle to loose contact in this case.

u_{min} = minimum speed required to complete vertical circle

$= \sqrt{4gR} = \sqrt{4 \times 10 \times 20} = \sqrt{800}$ m/s

$30 \text{ m/s} > \sqrt{800}$

so it can easily complete the vertical circle

Now, for point C

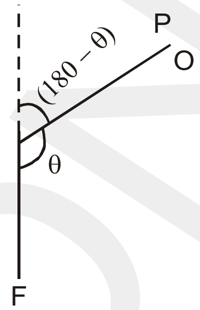
$k_f + p_f = p_i + k_i$

$\frac{1}{2}mv_c^2 + mgh_c = 0 + \frac{1}{2}m(30)^2$

$v_c^2 = (30)^2 - 2gh_c$

As $h_c = h_E = R$; heights of points C & E from reference

so $V_E = V_C$

7. 

$mg\cos(180 - \theta) = \frac{mv^2}{\ell}$ ..... (1)

Applying W – E theoren between points F & P :

$\frac{1}{2}mu^2 = \frac{1}{2}mv^2 + mg\ell(1 - \cos\theta)$

$v^2 = u^2 - 2g\ell(1 - \cos\theta)$ ..... (2)

on putting the value of v^2 from (2) in (1)

$mg\cos(180 - \theta) = \frac{m}{\ell}(u^2 - 2gl(1 - \cos\theta)]$

$-g\ell\cos\theta = u^2 - 2g\ell + 2g\ell\cos\theta$

$-3g\ell\cos\theta = 900 - 2 \times 10 \times 20$

$\cos\theta = -\frac{500}{3g\ell} = -\frac{500}{600}$

$\cos\theta = -5/6$

8. As there will be no energy dissipation, it will come out at the same speed at which it enters.

DPP NO. - 70

1. **(C)** Impulse = change in momentum

$\therefore P.\frac{\ell}{2} = \frac{m\ell^2}{12}.\omega$ (about centre of AB)

$\Rightarrow \omega = \frac{6P}{m\ell}$

For $\theta = \frac{\pi}{2}$ ds fy, ; $\frac{\pi}{2} = \omega t$

$\Rightarrow$ $t = \frac{\pi}{2\omega} = \frac{\pi m\ell}{2 \times 6p}$

$\Rightarrow$ $t = \frac{\pi m\ell}{12p}$ **Ans.**

3. $mV_0R - \frac{mR^2}{2}.\omega_0 = 0$

$\frac{V_0}{\omega_0} = \frac{R}{2}$

4. $\frac{d^2x}{dt^2} + \pi^2 x = 0$

$\Rightarrow$ Compare with $\frac{d^2x}{dt^2} + \omega^2 x = 0$

so $\omega = \pi$

so $f = \frac{\omega}{2\pi} = \frac{\pi}{2\pi} = \frac{1}{2}$ Hz **[Soln. made by SSI Sir]**

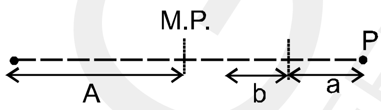
5. If he feels weightlessness then at the highest point, acceleration must be g.

$\Rightarrow$ $g = \omega^2 A$

$\Rightarrow$ $\omega = 2\pi f = \sqrt{2g}$

$\Rightarrow$ $f = \frac{\sqrt{2g}}{2\pi}$

6. x = A cos wt (as it starts from rest at t = 0)

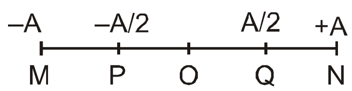


A – a = A cos w ....(1)

A – (a + b) = Acos2w ....(2)

Solving (1) and (2) for A we get $A = \frac{2a^2}{3a - b}$

7. It T be the time period ; time to go from O to Q is $\frac{T}{12}$ and from M to P is $\frac{T}{6}$.



The displacement is $\frac{A}{2}$ when particle goes from O to Q, from O to N to Q, from O to N to O to P, and so on

$\therefore$ $t = \frac{T}{12}$ or $t = \frac{T}{4} + \frac{T}{6} = \frac{5T}{12}$

or $t = \frac{T}{2} + \frac{T}{12} = \frac{7T}{12}$

Hence possible time period T is

T = 12 s or $T = \frac{12 \times 1}{5}$ = 2.4 s or $T = \frac{12 \times 1}{7}$ s

similarly displacement is $\frac{A}{2}$ when particle goes from M to P or M to N to P

Hence the possible time period T is

T = 1 × 6 = 6 s or $T = \frac{6 \times 1}{5}$ s = 1.2 s

Ans. T = 1.2 s, 6s, 2.4s, 12s