



GGSRDN

Educational Services Private Limited

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

अभ्यास ही सबसे बड़ा गुरु है।

CLASS : XI (PHYSICS)

D P P P

DAILY PRACTICE PROBLEM

DPP-31 TO 50

- | | |
|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------|
| DPP 31 : Newton's Law of Motion, Projectile Motion, Friction | DPP 41 : Work, Power and Energy, Circular Motion |
| DPP 32 : Friction, Newton's Law of Motion | DPP 42 : Work, Power and Energy, Circular Motion |
| DPP 33 : Projectile Motion, Friction, Newton's Law of Motion. | DPP 43 : Work, Power and Energy |
| DPP 34 : Friction, Work, Power and Energy , Relative Motion, Newton's Law of Motion | DPP 44 : Circular Motion, Center of Mass, Work, Power and Energy, Friction |
| DPP 35 : Friction, Work, Power and Energy, Newton's Law of Motion | DPP 45 : Circular Motion, Center of Mass, Newton's Law of Motion, Work , Power and Energy |
| DPP 36 : Friction, Work, Power and Energy, Relative Motion | DPP 46 : Center of Mass, Work, Power and Energy, Friction |
| DPP 37 : Work, Power and Energy, Friction | DPP 47 : Center of Mass, Circular Motion, Work, Power and Energy |
| DPP 38 : Relative Motion, Work, Power and Energy, Friction | DPP 48 : Center of Mass, Circular Motion, Work, Power and Energy, Friction |
| DPP 39 : Relative Motion, Work, Power and Energy | DPP 49 : Circular Motion, Work, Power and Energy, Center of Mass |
| DPP 40 : Relative Motion, Work, Power and Energy, Projectile Motion | DPP 50 : Work, Power and Energy, Circular Motion, Center of Mass, Relative Motion |

Topics : Newton's Law of Motion, Projectile Motion, Friction

Type of Questions

Single choice Objective ('-1' negative marking) Q.1 to Q.6

(3 marks, 3 min.)

M.M., Min.

[18, 18]

Multiple choice objective ('-1' negative marking) Q.7

(4 marks, 4 min.)

[4, 4]

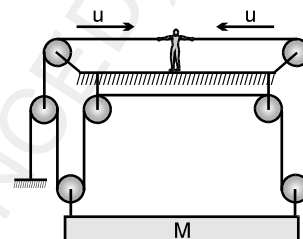
1. System is shown in the figure and man is pulling the rope from both sides with constant speed 'u'. Then the speed of the block will be:

(A) $\frac{3u}{4}$

(B) $\frac{3u}{2}$

(C) $\frac{u}{4}$

(D) none of these



2. Hailstones falling vertically with a speed of 10 m/s, hit the wind screen (wind screen makes an angle 30° with the horizontal) of a moving car and rebound elastically. The velocity of the car if the driver finds the hailstones rebound vertically after striking is :

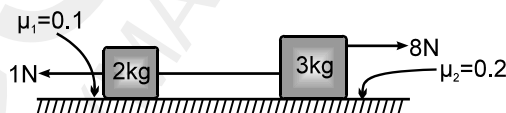
(A) $10\sqrt{3}$ m/s

(B) $20\sqrt{3}$ m/s

(C) 10 m/sec

(D) $\frac{10}{\sqrt{3}}$ m/sec

3. In the shown arrangement if f_1 , f_2 and T be the frictional forces on 2 kg block, 3kg block & tension in the string respectively, then their values are:



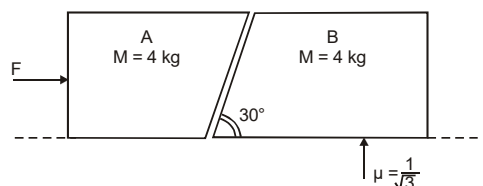
(A) 2 N, 6 N, 3.2 N

(B) 2 N, 6 N, 0 N

(C) 1 N, 6 N, 2 N

(D) data insufficient to calculate the required values.

4. Two blocks A and B are placed in contact on a horizontal surface. Faces of blocks A and B, which are in contact, are inclined at 30° with the horizontal, as shown. There is no friction between block A and any surface which is in contact with this whereas friction coefficient between block B and the surface is $\frac{1}{\sqrt{3}}$. A force F is applied in horizontal direction on block A. What is the minimum value of F at which the block B just start moving rightwards?



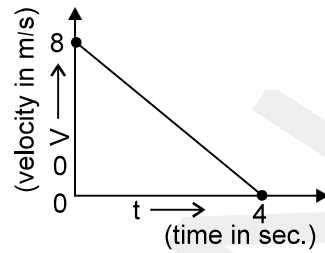
(A) $\frac{40}{\sqrt{3}}$ N

(B) $\frac{80}{\sqrt{3}}$ N

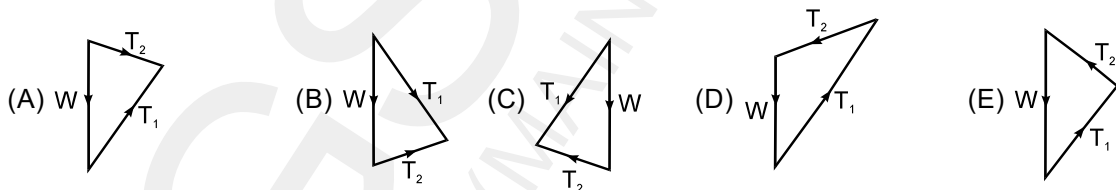
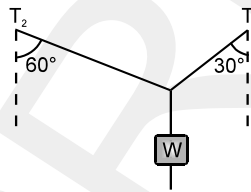
(C) 100 N

(D) For any value of F, motion will not start

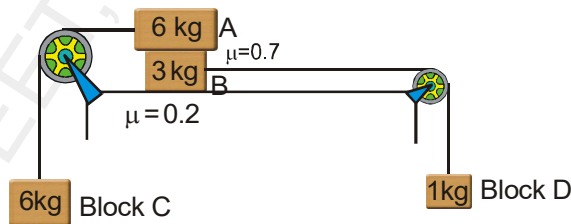
5. A block of mass 2 kg is given a push for a moment horizontally and then the block starts sliding over a horizontal plane. The graph shows the velocity-time graph of the motion. The co-efficient of sliding friction between the plane and the block is:



- (A) 0.02 (B) 0.20
 (C) 0.04 (D) 0.40
6. A weight W is supported by two strings inclined at 60° and 30° to the vertical. The tensions in the strings are T_1 & T_2 as shown. If these tensions are to be determined in terms of W using a triangle of forces, which of these triangles should you draw? (block is in equilibrium)



7. An arrangement of the masses and pulleys is shown in the figure. Strings connecting masses A and B with pulleys are horizontal and all pulleys and strings are light. Friction coefficient between the surface and the block B is 0.2 and between blocks A and B is 0.7. The system is released from rest. (use $g = 10 \text{ m/s}^2$)



- (A) The magnitude of acceleration of the system is 2 m/s^2 and there is no slipping between block A and block B.
 (B) The magnitude of friction force between block A and block B is 42 N.
 (C) Acceleration of block C is 1 m/s^2 downwards.
 (D) Tension in the string connecting block B and block D is 12 N.

PHYSICS
DPP
 DAILY PRACTICE PROBLEMS

DPP No. 32

Total Marks : 25
Max. Time : 25 min.

Topics : Friction, Newton's Law of Motion

Type of Questions

Single choice Objective ('-1' negative marking) Q.1 to Q.7

(3 marks, 3 min.)

M.M., Min.

[21, 21]

Multiple choice objective ('-1' negative marking) Q.8

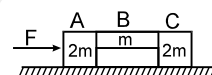
(4 marks, 4 min.)

[4, 4]

1. The system is pushed by a force F as shown in figure. All surfaces are smooth except between B and C. Friction coefficient between B and C is μ . Minimum value of F to prevent block B from downward slipping is

(A) $\left(\frac{3}{2\mu}\right) mg$

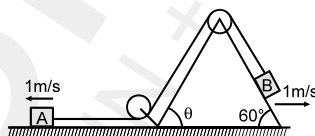
(B) $\left(\frac{5}{2\mu}\right) mg$



(C) $\left(\frac{5}{2}\right) \mu mg$

(D) $\left(\frac{3}{2}\right) \mu mg$

2. A system is shown in the figure. Block A is moving with 1 m/s towards left. Wedge is moving with 1 m/s towards right. Then speed of the block B will be:



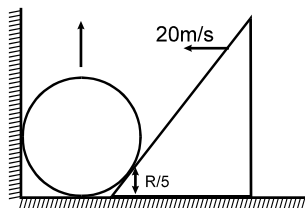
(A) 1 m/s

(B) 2 m/s

(C) $\sqrt{3}$ m/s

(D) none of these

3. A sphere of radius R is in contact with a wedge. The point of contact is $R/5$ from the ground as shown in the figure. Wedge is moving with velocity 20 m/s, then the velocity of the sphere at this instant will be



(A) 20 m/s

(B) 15 m/s

(C) 5 m/s

(D) 10 m/s

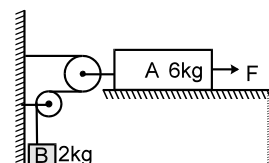
4. The system starts from rest and A attains a velocity of 5 m/s after it has moved 5 m towards right. Assuming the arrangement to be frictionless every where and pulley & strings to be light, the value of the constant force F applied on A is :

(A) 50 N

(B) 75 N

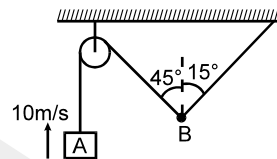
(C) 100 N

(D) 96 N

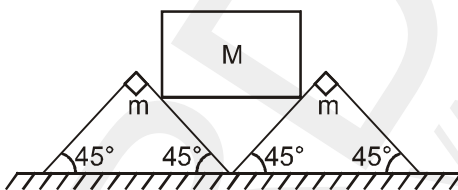


5. A system is shown in the figure. Block A moves with velocity 10 m/s. The speed of the mass B will be:

- (A) $10\sqrt{2}$ m/s
- (B) $5\sqrt{3}$ m/s
- (C) $\frac{20}{\sqrt{3}}$ m/s
- (D) 10 m/s

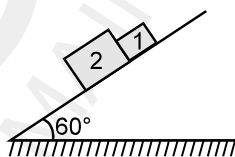


6. Two wedges, each of mass m , are placed next to each other on a flat horizontal floor. A cube of mass M is balanced on the wedges as shown in figure. Assume no friction between the cube and the wedges, but a coefficient of static friction $\mu < 1$ between the wedges and the floor. What is the largest M that can be balanced as shown without motion of the wedges ?



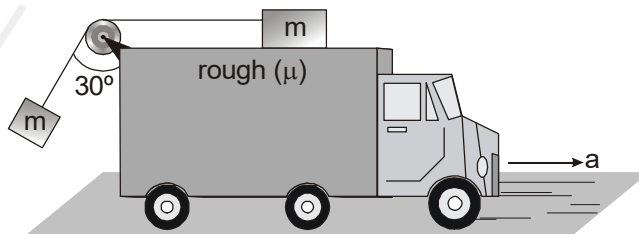
- (A) $\frac{m}{\sqrt{2}}$
- (B) $\frac{\mu m}{\sqrt{2}}$
- (C) $\frac{\mu m}{1-\mu}$
- (D) $\frac{2\mu m}{1-\mu}$

7. In the figure shown if friction co-efficient of block 1 and 2 with inclined plane is $\mu_1 = 0.5$ and $\mu_2 = 0.4$ respectively, then find out the correct statement.



- (A) both block will move together
- (B) both block will move separately
- (C) there is a non-zero contact force between two blocks
- (D) none of these

8. In the figure a truck is moving on a horizontal surface with acceleration a . Two blocks of equal masses m are supported on the truck as shown in figure. Given that when the block at the top surface is just about to slide, other block remains hanging at 30° from the vertical. In this system.

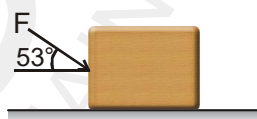


- (A) $a = \frac{g}{\sqrt{3}}$
- (B) $T = \frac{2}{\sqrt{3}} mg$
- (C) $\mu = \frac{5-\sqrt{3}}{3\sqrt{3}}$
- (D) $T = \frac{\sqrt{3}}{2} mg$

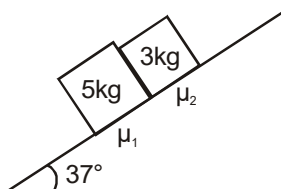
Topics : Projectile Motion, Friction, Newton's Law of Motion.

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 to Q.6	(4 marks, 4 min.)	[12, 12]
Subjective Questions ('-1' negative marking) Q.7 to Q.8	(4 marks, 5 min.)	[8, 10]

- Two stones are projected simultaneously from a tower at different angles of projection with same speed 'u'. The distance between two stones is increasing at constant rate 'u'. Then the angle between the initial velocity vectors of the two stones is :
 (A) 30° (B) 60° (C) 45° (D) 90°
- A block is placed on an inclined plane and has to be pushed down. The angle of inclination of the plane is:
 (A) equal to angle of repose (B) more than angle of repose
 (C) less than the angle of repose (D) equal to angle of friction
- A block of mass 20 kg is acted upon by a force $F = 30\text{ N}$ at an angle 53° with the horizontal in downward direction as shown. The coefficient of friction between the block and the horizontal surface is 0.2. The friction force acting on the block by the ground is ($g = 10\text{ m/s}^2$)

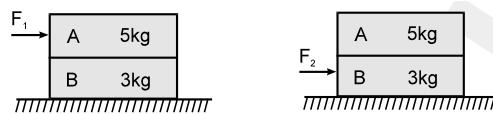


- (A) 40.0 N (B) 30.0 N (C) 18.0 N (D) 44.8 N
- Two blocks of masses 5 kg and 3 kg are placed in contact over a fixed inclined surface of angle 37° , as shown. μ_1 is friction coefficient between 5 kg block and the surface of the incline and similarly, μ_2 is friction coefficient between the 3 kg block and the surface of the incline. After the release of the blocks from the inclined surface,

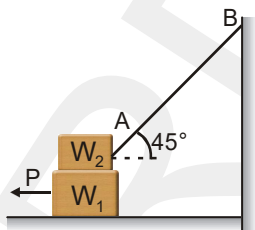


- (A) if $\mu_1 = 0.5$ and $\mu_2 = 0.3$ then 5 kg block exerts 3N force on the 3 kg block
 (B) if $\mu_1 = 0.5$ and $\mu_2 = 0.3$ then 5 kg block exerts 8 N force on the 3 kg block
 (C) if $\mu_1 = 0.3$ and $\mu_2 = 0.5$ then 5 kg block exerts 1 N force on the 3 kg block.
 (D) if $\mu_1 = 0.3$ and $\mu_2 = 0.5$ then 5 kg block exerts no force on the 3 kg block.

5. A block A (5 kg) rests over another block B (3 kg) placed over a smooth horizontal surface. There is friction between A and B. A horizontal force F_1 gradually increasing from zero to a maximum is applied to A so that the blocks move together without relative motion. Instead of this another horizontal force F_2 , gradually increasing from zero to a maximum is applied to B so that the blocks move together without relative motion. Then

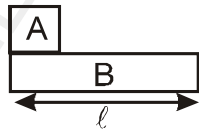


- (A) F_1 (max) = F_2 (max)
 (B) F_1 (max) > F_2 (max)
 (C) F_1 (max) < F_2 (max)
 (D) F_1 (max) : F_2 (max) = 5 : 3
6. In the arrangement shown, $W_1 = 200$ N, $W_2 = 100$ N, $\mu = 0.25$ for all surfaces in contact. The block W_1 just slides under the block W_2 .

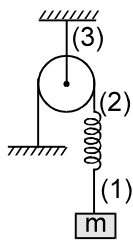


- (A) A pull of 50 N is to be applied on W_1
 (B) A pull of 90 N is to be applied on W_1
 (C) Tension in the string AB is $10\sqrt{2}$ N
 (D) Tension in the string AB is $20\sqrt{2}$ N

7. Figure shows a small block A of mass m kept at the left end of a plank B of mass $M = 2m$ and length ℓ . The system can slide on a horizontal road. The system is started towards right with the initial velocity v . The friction coefficients between the road and the plank is $1/2$ and that between the plank and the block is $1/4$. Find



- (a) the time elapsed before the block separate from the plank.
 (b) displacement of block and plank relative to ground till that moment.
8. Find the tensions in the strings (1), (2) and (3) and the acceleration of the mass 'm' just after (initially system is in equilibrium and at rest, pulley, string, spring are light):



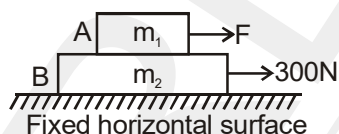
- (a) string (1) is cut (b) string (2) is cut (c) string (3) is cut

Topics : Friction, Work, Power and Energy , Relative Motion, Newton's Law of Motion

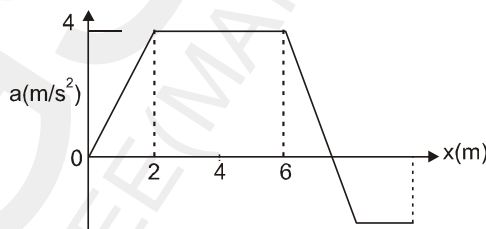
Type of Questions

		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	(4 marks, 4 min.)	[4, 4]
Comprehension ('-1' negative marking) Q.6 to Q.8	(3 marks, 3 min.)	[9, 9]

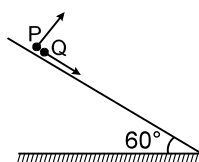
1. The coefficient of friction between block A of mass $m_1 = 5$ kg and block B of mass $m_2 = 10$ kg is $\mu = 0.5$. There is no friction force between block B and fixed horizontal surface. A force of 300 N acts on block B in horizontal direction and a horizontal force of magnitude F acts on block A as shown, both towards right. Initially there is no relative motion between the blocks. The minimum value of F such that relative motion starts between A and B is :



- (A) 200N
 (B) 187.5N
 (C) 150 N
 (D) 0
2. Graph shows the acceleration of a 3 kg particle as an applied force moves it from rest along x axis. The total work done by the force on the particle by the time the particle reaches $x = 6$ m, is equal to

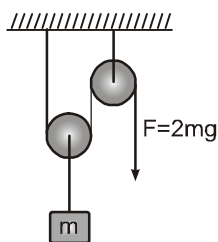


- (A) 20 J
 (B) 30 J
 (C) 40 J
 (D) 60 J
3. A particle P is projected from a point on the surface of long smooth inclined plane (see figure). Simultaneously another particle Q is released on the smooth inclined plane from the same position. P and Q collide after $t = 4$ second. The speed of projection of P is



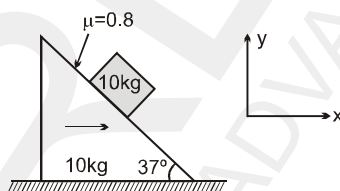
- (A) 5 m/s
 (B) 10 m/s
 (C) 15 m/s
 (D) 20 m/s

4. In the shown mass pulley system, pulleys and string are massless. The one end of the string is pulled by the force $F = 2mg$. The acceleration of the block will be



- (A) $g/2$ (B) 0
 (C) g (D) $3g$

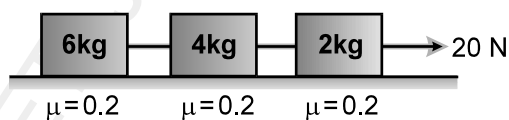
5. A wedge is moving rightwards on which a block of mass 10kg is placed on it. Friction coefficient between the wedge and the block is 0.8. [take $g = 10 \text{ m/s}^2$]. Select correct alternative(s) among the following options



- (A) If wedge is moving with constant velocity then friction acting on block is 64N.
 (B) If wedge is moving with constant velocity then acceleration of block is zero.
 (C) If wedge is moving with $\vec{a} = 2(\hat{i}) \text{ m/s}^2$ then friction acting on block is 44N.
 (D) If wedge is moving with $\vec{a} = 10(\hat{i}) \text{ m/s}^2$ then friction is 20N, downward on the wedge along the inclined.

COMPREHENSION

Three blocks of masses 6 kg, 4kg & 2 kg are pulled on a rough surface by applying a constant force 20N. The values of coefficient of friction between blocks & surface are shown in figure.



6. In the arrangement shown tension in the string connecting 4kg and 6kg masses is
 (A) 8N (B) 12N (C) 6N (D) 4N
7. Friction force on 4 kg block is
 (A) 4N (B) 6 N (C) 12 N (D) 8 N
8. Friction force on 6 kg block is
 (A) 12 N (B) 8 N (C) 6 N (D) 4 N

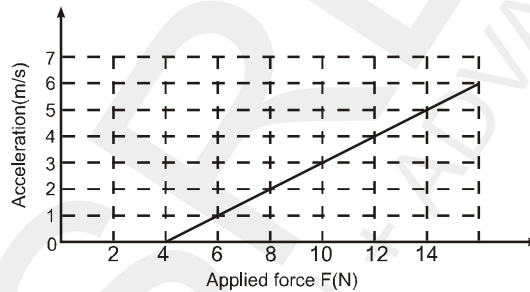
Topics : Friction, Work, Power and Energy, Newton's Law of Motion

Type of Questions

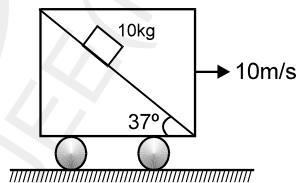
Type of Questions	M.M., Min.
Single choice Objective ('-1' negative marking) Q.1 to Q.3	(3 marks, 3 min.) [9, 9]
Subjective Questions ('-1' negative marking) Q.4 to Q.5	(4 marks, 5 min.) [8, 10]
Comprehension ('-1' negative marking) Q.6 to Q.8	(3 marks, 3 min.) [9, 9]

- Work done by static friction on an object:

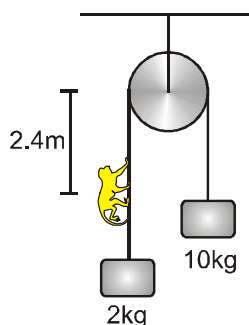
(A) may be positive (B) must be negative
 (C) must be zero (D) none of these
- A block of unknown mass is at rest on a rough, horizontal surface. A horizontal force F is applied to the block. The graph in the figure shows the acceleration of the block with respect to the applied force. The mass of the block is



- (A) 1.0 kg (B) 0.1 kg (C) 2.0 kg (D) 0.2 kg
- A block of mass 10 kg is released on a fixed wedge inside a cart which is moved with constant velocity 10 m/s towards right. Take initial velocity of block with respect to cart zero. Then work done by normal reaction (with respect to ground) on block in two second will be: ($g = 10 \text{ m/s}^2$).



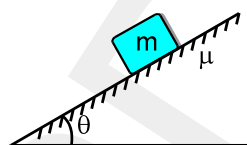
- (A) zero (B) 960 J
 (C) 1200 J (D) none of these
- Two blocks of mass 10 kg and 2 kg respectively are connected by an ideal string passing over a fixed smooth pulley as shown in figure. A monkey of mass 8 kg started climbing the string with a constant acceleration of 2 m/s^2 with respect to string at $t = 0$. Initially the system is in equilibrium and monkey is at a distance 2.4 from the pulley. Find the time taken by monkey to reach the pulley in sec.



5. The work done by a force $\vec{F} = -5\hat{k}$ as its point of application moves from the point (1, 1, 1) to the origin is equal to _____ .

COMPREHENSION

A block of mass m is placed on a rough inclined plane. The coefficient of friction between the block and the plane is μ and the inclination of the plane is θ . Initially $\theta = 0$ and the block will remain stationary on the plane. Now the inclination θ is gradually increased. The block presses the inclined plane with a force $mg\cos\theta$. So welding strength between the block and inclined is $\mu mg\cos\theta$, and the pulling forces is $mg\sin\theta$. As soon as the pulling force is greater than the welding strength, the welding breaks and the block starts sliding, the angle θ for which the block starts sliding is called angle of repose (λ). During the contact, two contact forces are acting between the block and the inclined plane. The pressing reaction (Normal reaction) and the shear reaction (frictional force). The net contact force will be resultant of both.



Answer the following questions based on above comprehension :

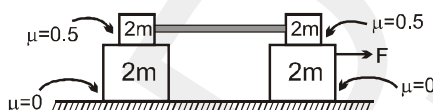
6. If the entire system, were accelerated upward with acceleration 'a', the angle of repose, would :
 (A) increase (B) decrease (C) remain same (D) increase of $a > g$
7. For what value of θ will the block slide on the inclined plane :
 (A) $\theta > \tan^{-1}\mu$ (B) $\theta < \tan^{-1}\mu$ (C) $\theta > \cot^{-1}\mu$ (D) $\theta < \cot^{-1}\mu$
8. If $\mu = 3/4$ then what will be frictional force (shear force) acting between the block and inclined plane when $\theta = 30^\circ$:
 (A) $\frac{3\sqrt{3}}{8} mg$ (B) $\frac{mg}{2}$ (C) $\frac{\sqrt{3}}{2} mg$ (D) zero

Topics : Friction, Work, Power and Energy, Relative Motion

Type of Questions

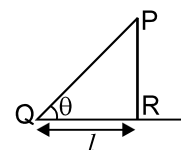
Type of Questions	M.M., Min.
Single choice Objective ('-1' negative marking) Q.1 to Q.4	(3 marks, 3 min.) [12, 12]
Multiple choice objective ('-1' negative marking) Q.5	(4 marks, 4 min.) [4, 4]
Comprehension ('-1' negative marking) Q.6 to Q.8	(3 marks, 3 min.) [9, 9]

1. Consider the arrangement shown in figure. Friction coefficient for all the surfaces are shown in the figure and the rod connecting two upper blocks is horizontal.



What is the minimum value F so that the rear two blocks start sliding with each other :

- (A) 100 N (B) 50 N
 (C) 150 N (D) For all values of F both the rear blocks will move together
2. A chain is held on a frictionless table with $L/4$ hanging over. Knowing total mass of the chain is M and total length is L , the work required to slowly pull hanging part back to the table is :
- (A) $\frac{MgL}{16}$ (B) $\frac{MgL}{8}$ (C) $\frac{MgL}{32}$ (D) $\frac{MgL}{24}$
3. An object is moving along a straight line path from P to Q under the action of a force $\vec{F} = (4\hat{i} - 3\hat{j} + 2\hat{k})$ N. If the co-ordinate of P & Q in metres are $(3, 2, -1)$ & $(2, -1, 4)$ respectively. Then the work done by the force is:
- (A) -15 J (B) $+15$ J (C) 1015 J (D) $(4\hat{i} - 3\hat{j} + 2\hat{k})$
4. A bucket tied to a string is lowered at a constant acceleration of $g/4$. If the mass of the bucket is M and is lowered by a distance d , the work done by the string on bucket will be (assume the string to be massless)
- (A) $(1/4) mg d$ (B) $(-3/4) mgd$ (C) $(-4/3) mgd$ (D) $(4/3) mgd$
5. PQ is a smooth inclined plane whose angle θ can be varied in such a way that point Q remains fixed and P can move on a vertical line PR . A particle slides from rest from point P at different value of θ time for descent from P and Q is noted. The following statement (s) is /are correct about the time of descent :
- (A) the minimum time of descent is $2\sqrt{\ell/g}$
 (B) the time descent is minimum at $\theta=90^\circ$
 (C) the time of descent decreases continuously as θ is increased
 (D) the time of descent first decreases then increases.

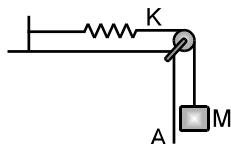


COMPREHENSION

Rain is falling with a velocity $(-4\hat{i} + 8\hat{j} - 10\hat{k})$. A person is moving with a velocity of $(6\hat{i} + 8\hat{j})$ on the ground.

6. Find the velocity of rain with respect to man and the direction from which the rain appears to be coming.
7. The speed with which the rain drops hit the person is :
- (A) 10 m/s (B) $10\sqrt{2}$ m/s (C) $\sqrt{180}$ m/s (D) $\sqrt{360}$ m/s
8. The velocity of man w.r.t. rain is :
- (A) $-6\hat{i} - 8\hat{j}$ (B) $4\hat{i} - 8\hat{j} + 10\hat{k}$ (C) $-10\hat{i} - 10\hat{k}$ (D) $10\hat{i} + 10\hat{k}$

4. Block A in the figure is released from rest when the extension in the spring is x_0 ($x_0 < mg/k$). The maximum downward displacement of the block is (ther is no friction) :

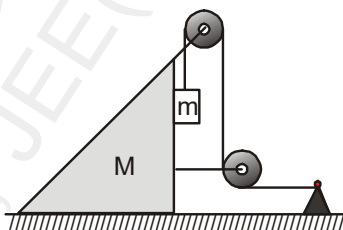


- (A) $\frac{2Mg}{K} - 2x_0$ (B) $\frac{Mg}{2K} + x_0$
 (C) $\frac{2Mg}{K} - x_0$ (D) $\frac{2Mg}{K} + x_0$
5. The minimum work done required to accelerate a truck on a horizontal road from rest to speed v
 (A) is less than that required to accelerate it from v to $2v$.
 (B) is equal than that required to accelerate it from v to $2v$.
 (C) is more than that required to accelerate it from v to $2v$.
 (D) may be any one of the above since it depends on the force acting on the truck and the distance over which it acts.
6. Which of the following relations are always true?

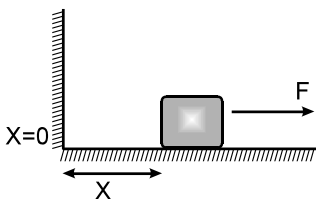
\vec{v} = velocity, \vec{a} = acceleration, $K = \frac{1}{2}mv^2$ = Kinetic energy

(A) $\frac{dK}{dt} = m\vec{v} \cdot \vec{a}$ (B) $\frac{d|\vec{v}|}{dt} = \frac{\vec{a} \cdot \vec{v}}{|\vec{v}|}$ (C) $\frac{d|\vec{v}|}{dt} = \left| \frac{d\vec{a}}{dt} \right|$ (D) $|\Delta \vec{v}| = \left| \int_{t_1}^{t_2} \vec{a} dt \right|$

7. In the arrangement shown in Fig. the masses of the wedge M and the body m are known. The appreciable friction exists only between the wedge and the body m , the friction coefficient being equal to μ . The masses of the pulley and the thread are negligible. Find the acceleration of the body m relative to the horizontal surface on which the wedge slides.



8. The block of mass m initially at $x = 0$ is acted upon by a horizontal force at any position x is given as $F = a - bx^2$ (where $a > \mu mg$), as shown in the figure. The co-efficient of friction between the surfaces of contact is μ . The net work done on the block is zero, if the block travels a distance of _____.

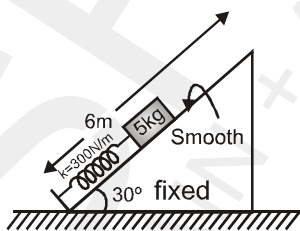


Topics : Relative Motion, Work, Power and Energy, Friction

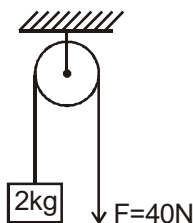
Type of Questions

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]

- Two bikes A and B start from a point. A moves with uniform speed 40 m/s and B starts from rest with uniform acceleration 2 m/s². If B starts at t = 0 and A starts from the same point at t = 10 s, then the time interval during the journey in which A was ahead of B is :
 (A) 20 s (B) 8 s
 (C) 10 s (D) A is never ahead of B
- A block of mass 5 kg is released from rest when compression in spring is 2m. Block is not attached with the spring and natural length of the spring is 4m. Maximum height of block from ground is : (g = 10 m/s²)

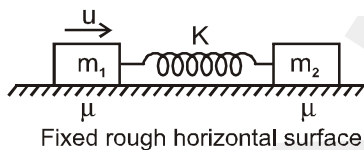


- (A) 5.5 m (B) 4.5 m
 (C) 6 m (D) 7.5 m
- A block of mass 2 kg is hanging over a smooth and light pulley through a light string. The other end of the string is pulled by a constant force F = 40 N. At t = 0 the system is at rest as shown. Then in the time interval from t = 0 to t = $\frac{2}{\sqrt{10}}$ seconds, pick up the correct statement (s) : (g = 10 m/s²)

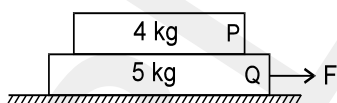


- (A) tension in the string is 40 N (B) work done by gravity is - 20 J
 (C) work done by tension on block is 80 J (D) None of these

4. The blocks of mass $m_1 = 1 \text{ kg}$ and $m_2 = 2 \text{ kg}$ are connected by an ideal spring, rest on a rough horizontal surface. The spring is unstressed. The spring constant of spring is $K = 2 \text{ N/m}$. The coefficient of friction between blocks and horizontal surface is $\mu = \frac{1}{2}$. Now the left block is imparted a velocity u towards right as shown. The largest value of u (in m/s) such that the block of mass m_2 never moves is (Take $g = 10 \text{ m/s}^2$)

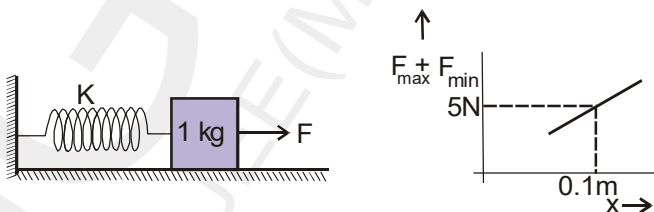


5. If the lower block is held fixed & force is applied to P, minimum force required to slide P on Q is 12 N . Now if Q is free to move on frictionless surface and force is applied to Q then the minimum force F required to slide P on Q is _____.



COMPREHENSION

A block of mass 1 kg is placed on a rough horizontal surface. A spring is attached to the block whose other end is joined to a rigid wall, as shown in the figure. A horizontal force is applied on the block so that it remains at rest while the spring is elongated by x ($x \geq \frac{\mu mg}{k}$). Let F_{max} and F_{min} be the maximum and minimum values of force F for which the block remains in equilibrium. For a particular x , $F_{\text{max}} - F_{\text{min}} = 2 \text{ N}$. Also shown is the variation of $F_{\text{max}} + F_{\text{min}}$ versus x , the elongation of the spring.



6. The coefficient of friction between the block and the horizontal surface is :
 (A) 0.1 (B) 0.2 (C) 0.3 (D) 0.4
7. The spring constant of the spring is:
 (A) 25 N/m (B) 20 N/m (C) 2.5 N/m (D) 50 N/m
8. The value of F_{min} , if $x = 3 \text{ cm}$ is :
 (A) 0 (B) 0.2N (C) 5N (D) 1N

Topics : Relative Motion, Work, Power and Energy

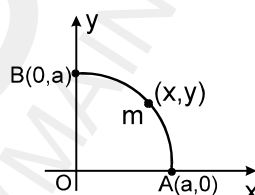
Type of Questions

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 to Q.3	(4 marks, 5 min.) [8, 10]
Comprehension ('-1' negative marking) Q.4 to Q.6	(3 marks, 3 min.) [9, 9]
Match the Following (no negative marking) (2 × 4) Q.7	(8 marks, 10 min.) [8, 10]

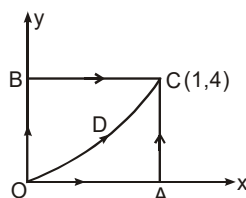
1. Two objects moving along the same straight line are leaving point A with an acceleration a , $2a$ & velocity $2u$, u respectively at time $t = 0$. The distance moved by the object with respect to point A when one object overtakes the other is :

(A) $\frac{6u^2}{a}$ (B) $\frac{2u^2}{a}$ (C) $\frac{4u^2}{a}$ (D) none of these

2. A particle of mass 'm' moves along the quarter section of the circular path whose centre is at the origin. The radius of the circular path is 'a'. A force $\vec{F} = y\hat{i} - x\hat{j}$ newton acts on the particle, where x , y denote the coordinates of position of the particle. Calculate the work done by this force in taking the particle from point A ($a, 0$) to point B ($0, a$) along the circular path.

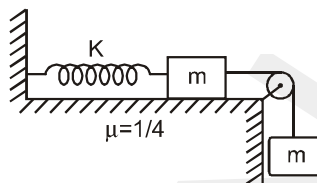


3. A particle is moved along the different paths OAC, OBC & ODC as shown in the fig. Path ODC is a parabola, $y = 4x^2$. Find the work done by a force $\vec{F} = xy\hat{i} + x^2y\hat{j}$ on the particle along these paths. Is this force a conservative force ?

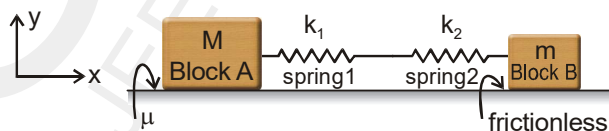


COMPREHENSION

Consider the system shown below, with two equal masses m and a spring with spring constant K . The coefficient of friction between the left mass and horizontal table is $\mu = 1/4$, and the pulley is frictionless. The string connecting both the blocks is massless and inelastic. The system is held with the spring at its unstretched length and then released.



4. The extension in spring when the masses come to momentary rest for the first time is
 (A) $\frac{3mg}{2K}$ (B) $\frac{mg}{2K}$ (C) $\frac{mg}{K}$ (D) $\frac{2mg}{K}$
5. The minimum value of μ for which the system remains at rest once it has stopped for the first time is
 (A) $\frac{1}{\sqrt{3}}$ (B) $\frac{1}{3}$ (C) $\frac{1}{2}$ (D) $\frac{1}{\sqrt{2}}$
6. If the string connecting both the masses is cut just at the instant both masses came to momentary rest for the first time in question 5, then maximum compression of spring during resulting motion is (Take $\mu = 1/4$)
 (A) $\frac{2mg}{3K}$ (B) $\frac{mg}{2K}$ (C) $\frac{mg}{K}$ (D) $\frac{1mg}{3K}$
7. Two blocks A and B of masses m and M are placed on a horizontal surface, both being interconnected with a horizontal series combination of two massless springs 1 and 2, of force constants k_1 and k_2 respectively as shown. Friction coefficient between block A and the surface is μ and the springs are initially non-deformed. Now the block B is displaced slowly to the right by a distance x , and it is observed that block A does not slip on the surface. Block B is kept in equilibrium by applying an external force at that position. Match the required information in the left column with the options given in the right column.



Left column

- (A) Friction force on block A by the surface
- (B) Force by spring 1 on block A
- (C) Force exerted by spring 2 on spring 1.
- (D) External force on block B.

Right column

- (p) $k_1 x (-\hat{i})$
- (q) $\mu Mg (-\hat{i})$
- (r) $\frac{k_1 k_2 x}{k_1 + k_2} (\hat{i})$
- (s) $\frac{k_1 k_2 x}{k_1 + k_2} (-\hat{i})$

Topics : Relative Motion, Work, Power and Energy, Projectile Motion

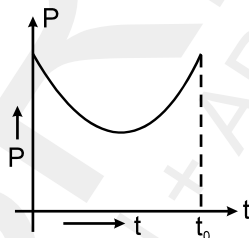
Type of Questions

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. For a particle undergoing rectilinear motion with uniform acceleration, the magnitude of displacement is one third the distance covered in some time interval. The magnitude of final velocity is less than magnitude of initial velocity for this time interval. Then the ratio of initial speed velocity to the final speed for this time interval is :

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

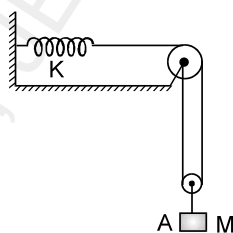
2. Power versus time graph for a given force is given below. Work done



by the force upto time $t(\leq t_0)$.

- (A) First decreases then increases
 (B) First increases then decreases
 (C) Always increases
 (D) Always decreases

3. Block A in the figure is released from the rest when the extension in the spring is x_0 . The maximum downward displacement of the block will be :



- (A) $Mg/2k - x_0$ (B) $Mg/2k + x_0$ (C) $2 Mg/k - x_0$ (D) $2 Mg/k + x_0$

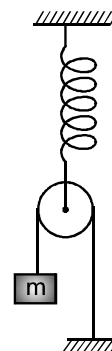
4. Block m is released from rest when spring is in its natural length (assume pulley is ideal and block does not strike on ground during its motion in vertical plane)

than :

- (A) maximum elongation in spring is $4 mg/k$
 (B) maximum elongation in spring is $2 mg/k$

(C) maximum speed of block is $2g\sqrt{\frac{m}{k}}$

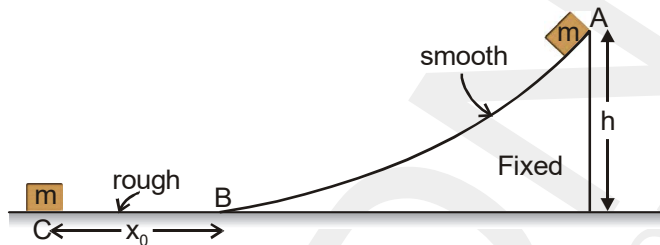
(D) maximum speed of block is $g\sqrt{\frac{m}{k}}$



5. A particle is projected at an angle of 30° w.r.t. horizontal with speed 20 m/s : (use $g = 10 \text{ m/s}^2$)
 (i) Find the position vector of the particle after 1 s .
 (ii) Find the angle between velocity vector and position vector at $t = 1 \text{ s}$.

COMPREHENSION

A small block of mass m is released from a fixed smooth wedge as shown in figure. Initial point is marked as A. Bottom of wedge is marked as B and at a point C the block stops moving because the straight part of floor is rough.



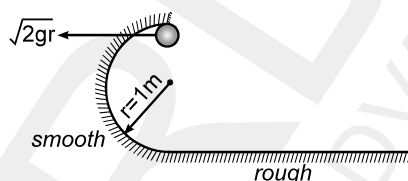
6. Work done by normal reaction is zero during the motion of the block
 (A) from point A to B only
 (B) from point B to C only
 (C) from A to C
 (D) None of these
7. The friction coefficient of the block with the floor is :
 (A) $\frac{h}{x_0}$ (B) $\frac{x_0}{h}$ (C) zero (D) 1
8. The velocity of the block at the midpoint between B to C will be :
 (A) $\frac{\sqrt{2gh}}{2}$ (B) $\sqrt{2gh}$ (C) \sqrt{gh} (D) $\frac{\sqrt{gh}}{2}$

Topics : Work, Power and Energy, Circular Motion

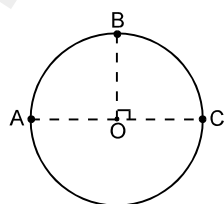
Type of Questions

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]
Comprehension ('-1' negative marking) Q.8 to Q.10	(3 marks, 3 min.) [9, 9]

1. A body is given a velocity $\sqrt{2gr}$ at the highest point of a half circular smooth track which is joined by a rough horizontal track whose co-efficient of friction is $\mu = 0.5$. Then the distance travelled by particle before it stops on horizontal track is: ($r = 1$ m)



- (A) 1 m (B) 4 m (C) 6 m (D) none of these
2. A particle moves along a circle of radius R with a constant angular speed ω . Its displacement (only magnitude) in time t will be
- (A) ωt (B) $2R \cos \omega t$ (C) $2R \sin \omega t$ (D) $2R \sin \frac{\omega t}{2}$
3. Three particle A, B & C move in a circle of radius $r = \frac{1}{\pi}$ m, in anticlockwise direction with speeds 1 m/s, 2.5 m/s and 2 m/s respectively. The initial positions of A, B and C are as shown in figure. The ratio of distance travelled by B and C by the instant A, B and C meet for the first time is



- (A) 3 : 2 (B) 5 : 4 (C) 3 : 5 (D) 3 : 7
4. Two bodies having masses 10 kg and 5 kg are moving in concentric orbits of radii 4 and 8 such that their time periods are the same. Then the ratio of their centripetal accelerations is
- (A) $\frac{1}{2}$ (B) 2 (C) 8 (D) $\frac{1}{8}$
5. A stone is thrown horizontally under gravity with a speed of 10m/sec. Find the radius of curvature of it's trajectory at the end of 3 sec after motion began.
- (A) $10\sqrt{10}$ m (B) $100\sqrt{10}$ m (C) $\sqrt{10}$ m (D) 100 m

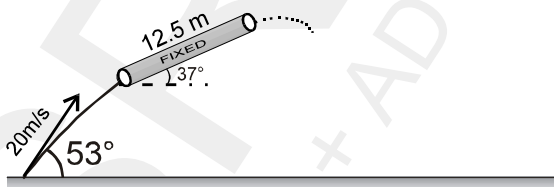
6. A particle begins to move with a tangential acceleration of constant magnitude 0.6 m/s^2 in a circular path. If it slips when its total acceleration becomes 1 m/s^2 , then the angle through which it would have turned before it starts to slip is :
 (A) $1/3 \text{ rad}$ (B) $2/3 \text{ rad}$ (C) $4/3 \text{ rad}$ (D) 2 rad
7. One of the forces acting on a particle is conservative then which of the following statement(s) are true about this conservative force
 (A) Its work is zero when the particle moves exactly once around any closed path.
 (B) Its work equals the change in the kinetic energy of the particle
 (C) Then that particular force must be constant.
 (D) Its work depends on the end points of the motion, not on the path between.

COMPREHENSION

A particle of mass 0.1 kg is launched at an angle of 53° with the horizontal. The particle enters a fixed rough hollow tube whose length is slightly less than 12.5 m and which is inclined at an angle of 37° with the horizontal as shown in figure. It is known that the velocity of ball when it enters the tube is parallel

to the axis of the tube. The coefficient of friction between the particle and tube inside the tube is $\mu = \frac{3}{8}$.

[Take $g = 10 \text{ m/s}^2$]



8. The velocity of the particle as it enters the tube is :
 (A) 12 m/s (B) 16 m/s (C) 9 m/s (D) 15 m/s
9. The kinetic energy of the particle when it comes out of the tube is approximately equal to :
 (A) Zero (B) 4 J (C) 7.2 J (D) 11.2 J
10. The distance from the point of projection where the particle will land on the horizontal plane after coming out from the tube is approximately equal to :
 (A) 8.4 m (B) 10 m (C) 18.4 m (D) 36.8 m

Topics : Work, Power and Energy, Circular Motion

Type of Questions

Single choice Objective ('-1' negative marking) Q.1 to Q.6

(3 marks, 3 min.)

M.M., Min.

[18, 18]

Subjective Questions ('-1' negative marking) Q.7

(4 marks, 5 min.)

[4, 5]

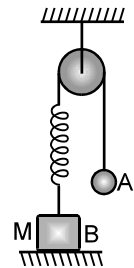
1. A block of mass m starts at rest at height h on a frictionless inclined plane. The block slides down the plane, travels across a rough horizontal surface with coefficient of kinetic friction μ , and compresses a spring with force constant k a distance x before momentarily coming to rest. Then the spring extends and the block travels back across the rough surface, sliding up the plane. The block travels a total distance d on rough horizontal surface. The correct expression for the maximum height h' that the block reaches on its return is:



- (A) $mgh' = mgh - \mu mgd$ (B) $mgh' = mgh + \mu mgd$
(C) $mgh' = mgh + \mu mgd + kx^2$ (D) $mgh' = mgh - \mu mgd - kx^2$

2. In the Figure, the ball A is released from rest when the spring is at its natural length. For the block B, of mass M to leave contact with the ground at some stage, the minimum mass of A must be:

- (A) $2M$ (B) M (C) $M/2$
(D) A function of M and the force constant of the spring.



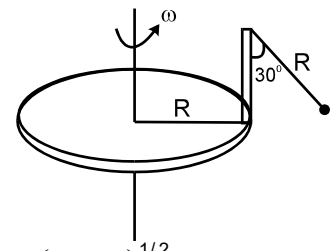
3. A particle is moving in a circle

- (A) The resultant force on the particle must be towards the centre.
(B) The resultant force may be towards the centre.
(C) The direction of the angular acceleration and the angular velocity must be the same.
(D) The cross product of the tangential acceleration and the angular velocity will be zero.

4. The potential energy function associated with the force $\vec{F} = 4xy\hat{i} + 2x^2\hat{j}$ is :

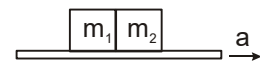
- (A) $U = -2x^2y$ (B) $U = -2x^2y + \text{constant}$
(C) $U = 2x^2y + \text{constant}$ (D) not defined

5. A disc of radius R has a light pole fixed perpendicular to the disc at the circumference which in turn has a pendulum of length R attached to its other end as shown in figure. The disc is rotated with a constant angular speed ω . The string is making an angle 30° with the rod. Then the angular speed ω of disc is:



- (A) $\left(\frac{\sqrt{3}g}{R}\right)^{1/2}$ (B) $\left(\frac{\sqrt{3}g}{2R}\right)^{1/2}$ (C) $\left(\frac{g}{\sqrt{3}R}\right)^{1/2}$ (D) $\left(\frac{2g}{3\sqrt{3}R}\right)^{1/2}$

6. Two blocks of masses m_1 and m_2 are placed in contact with each other on a horizontal platform. The coefficient of friction between the platform and the two blocks is the same. The platform moves with an acceleration. The force of interaction between the blocks is:

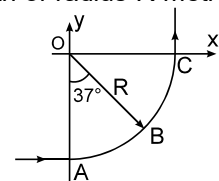


- (A) zero only if $m_1 = m_2$ (B) zero in all cases
(C) non-zero only if $m_1 > m_2$ (D) non-zero only if $m_1 < m_2$.

7. A car initially traveling eastwards turns north by traveling in a quarter circular path of radius R metres at uniform speed as shown in figure. The car completes the turn in T second.

(a) What is the acceleration of the car when it is at B located at an angle of 37° . Express your answers in terms of unit vectors \hat{i} and \hat{j}

(b) The magnitude of car's average acceleration during T second period.

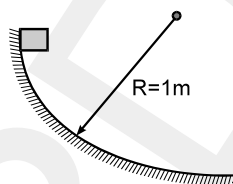


Topic : Work, Power and Energy

Type of Questions

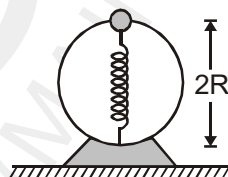
		M.M., Min.
Single choice Objective ('-1' negative marking) Q.1 to Q.4	(3 marks, 3 min.)	[12, 12]
Subjective Questions ('-1' negative marking) Q.5 to Q.6	(4 marks, 5 min.)	[8, 10]
Comprehension ('-1' negative marking) Q.7 to Q.11	(3 marks, 3 min.)	[15, 15]

1. A block of mass 1 kg slides down a vertical curved track that is one quadrant of a circle of radius 1m. Its speed at the bottom is 2 m/s. The work done by frictional force is :



- (A) 8 J (B) - 8 J (C) 4 J (D) - 4 J

2. A bead of mass m slides without friction on a vertical hoop of radius R . The bead moves under the combined influence of gravity and a spring of spring constant k attached to the bottom of the hoop. For simplicity assume, the equilibrium length of the spring to be zero. The bead is released at the top of the hoop with negligible speed as shown. The bead, on passing the bottom point will have a velocity of :

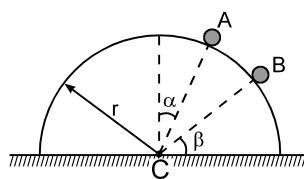


- (A) $2\sqrt{gR}$ (B) $2\sqrt{gR + \frac{2kR^2}{m}}$ (C) $2\sqrt{gR + \frac{kR^2}{m}}$ (D) $\sqrt{2gR + \frac{kR^2}{m}}$

3. In a simple pendulum, the breaking strength of the string is double the weight of the bob. The bob is released from rest when the string is horizontal. The string breaks when it makes an angle θ with the vertical.

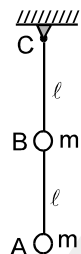
- (A) $\theta = \cos^{-1} \frac{1}{3}$ (B) $\theta = 60^\circ$ (C) $\theta = \cos^{-1} \frac{2}{3}$ (D) $\theta = 0$

4. A particle initially at rest starts moving from point A on the surface of a fixed smooth hemisphere of radius r as shown. The particle loses its contact with hemisphere at point B. C is centre of the hemisphere. The equation relating α and β is



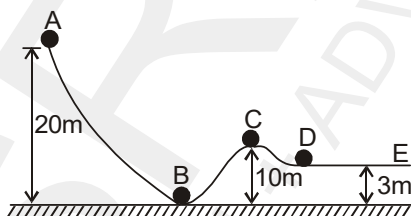
- (A) $3 \sin \alpha = 2 \cos \beta$ (B) $2 \sin \alpha = 3 \cos \beta$
 (C) $3 \sin \beta = 2 \cos \alpha$ (D) $2 \sin \beta = 3 \cos \alpha$

5. A heavy particle is projected from a point on the horizontal at an angle 60° with the horizontal with a speed of 10m/s . Then the radius of the curvature of its path at the instant of crossing the same horizontal is _____.
6. A weightless rod of length 2ℓ carries two equal masses ' m ', one secured at lower end A and the other at the middle of the rod at B. The rod can rotate in vertical plane about a fixed horizontal axis passing through C. What horizontal velocity must be imparted to the mass at A so that it just completes the vertical circle.



COMPREHENSION

A smooth sphere (mass 10 kg , negligible radius) rolls on a smooth curved surface from the point A with a speed of 10 m/s as shown in figure . The sphere reaches the point D passing through point B . If the ground is taken as reference, Then [Take $g = 10\text{ m/s}^2$]



7. The total energy of the sphere at the point A ,
 (A) 2500 J (B) zero (C) 1500 J (D) 2000 J
8. The kinetic energy & the potential energy at point B ,
 (A) 2500 J , 0 J (B) 0 J , 2500 J (C) 2500 J , 1500 J (D) 1500 J , 2500 J
9. The kinetic energy at C
 (A) 2500 J (B) zero (C) 1500 J (D) 2000 J
10. The kinetic energy at D ,
 (A) 2200 J (B) zero (C) 1500 J (D) 2000 J
11. Will the sphere go beyond D ?
 (A) Yes (B) No
 (C) More information is required (D) None of these

PHYSICS
DPP
 DAILY PRACTICE PROBLEMS

DPP No. 44

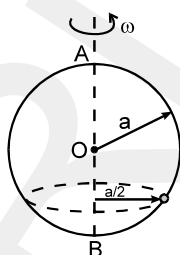
Total Marks : 36
 Max. Time : 38 min.

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

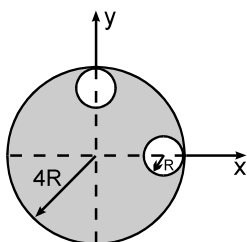
Type of Questions

Type of Questions	M.M., Min.
Single choice Objective ('-1' negative marking) Q.1 to Q.4	(3 marks, 3 min.) [15, 15]
Multiple choice objective ('-1' negative marking) Q.5	(4 marks, 4 min.) [4, 4]
Comprehension ('-1' negative marking) Q.6 to Q.8	(3 marks, 3 min.) [9, 9]
Match the Following (no negative marking) (2 × 4) Q. 9	(8 marks, 10 min.) [8, 10]

1. A smooth wire is bent into a vertical circle of radius a . A bead P can slide smoothly on the wire. The circle is rotated about vertical diameter AB as axis with a constant speed ω as shown in figure. The bead P is at rest w.r.t. the wire in the position shown. Then ω^2 is equal to :

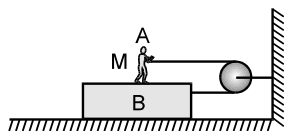


- (A) $\frac{2g}{a}$ (B) $\frac{2g}{a\sqrt{3}}$ (C) $\frac{g\sqrt{3}}{a}$ (D) $\frac{2a}{g\sqrt{3}}$
2. A ball suspended by a thread swings in a vertical plane so that its acceleration in the extreme position and lowest position are equal in magnitude. Angle θ of thread deflection in the extreme position will be:
- (A) $2 \tan^{-1} \frac{1}{2}$ (B) $\tan^{-1} \frac{1}{2}$ (C) $\tan^{-1} \sqrt{2}$ (D) $\tan^{-1} 2$
3. An automobile enters a turn of radius R . If the road is banked at an angle of 45° and the coefficient of friction is 1, the minimum and maximum speed with which the automobile can negotiate the turn without skidding is:
- (A) $\sqrt{\frac{rg}{2}}$ and \sqrt{rg} (B) $\frac{\sqrt{rg}}{2}$ and \sqrt{rg} (C) $\frac{\sqrt{rg}}{2}$ and $2\sqrt{rg}$ (D) 0 and infinite
4. From the uniform disc of radius $4R$ two small disc of radius R are cut off. The centre of mass of the new structure will be : (Centre of lower circular cavity lies on x-axis and centre of upper circular cavity lies on y-axis)



- (A) $\hat{i}\frac{R}{5} + \hat{j}\frac{R}{5}$ (B) $-\hat{i}\frac{R}{5} + \hat{j}\frac{R}{5}$
 (C) $-\hat{i}\frac{R}{5} - \hat{j}\frac{R}{5}$ (D) $-\frac{3R}{14}(\hat{i} + \hat{j})$

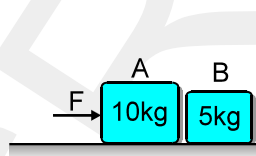
5. As shown in the figure, M is a man of mass 60 kg standing on a block of mass 40 kg kept on ground. The co-efficient of friction between the feet of the man and the block is 0.3 and that between B and the ground is 0.1. If the person pulls the string with 100 N force, then :



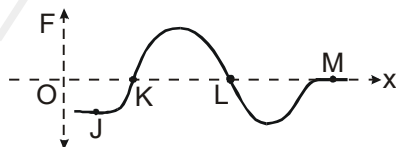
- (A) B will slide on ground
 (B) A and B will move together with acceleration 1 m/s^2
 (C) the friction force acting between A & B will be 40 N
 (D) the friction force acting between A & B will be 180 N

COMPREHENSION

Two bodies A and B of masses 10 kg and 5 kg are placed very slightly separated as shown in figure. The coefficient of friction between the floor and the blocks is $\mu = 0.4$. Block A is pushed by an external force F. The value of F can be changed. When the welding between block A and ground breaks, block A will start pressing block B and when welding of B also breaks, block B will start pressing the vertical wall –



6. If $F = 20 \text{ N}$, with how much force does block A presses the block B
 (A) 10 N (B) 20 N (C) 30 N (D) Zero
7. What should be the minimum value of F, so that block B can press the vertical wall
 (A) 20 N (B) 40 N (C) 60 N (D) 80 N
8. If $F = 50 \text{ N}$, the friction force (shear force) acting between block B and ground will be :
 (A) 10 N (B) 20 N (C) 30 N (D) None
9. A particle moving along x-axis is being acted upon by one dimensional conservative force F. In the F–x curve shown, four points J, K, L, M are marked on the curve. Column II gives different type of equilibrium for the particle at different positions. Column I gives certain positions on the force position graphs. Match the positions in Column-I with the corresponding nature of equilibrium at these positions.



Column I

- (A) Point J is position of
 (B) Point K is position of
 (C) Point L is position of
 (D) Point M is position of

Column II

- (p) Neutral equilibrium
 (q) Unstable equilibrium
 (r) Stable equilibrium
 (s) No equilibrium

PHYSICS
DPP
 DAILY PRACTICE PROBLEMS

DPP No. 45

Total Marks : 31
 Max. Time : 32 min.

Topics : Circular Motion, Center of Mass, Newton's Law of Motion, Work , Power and Energy

Type of Questions

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]
Comprehension ('-1' negative marking) Q.8 to Q.10	(3 marks, 3 min.) [9, 9]

1. A circular curve of a highway is designed for traffic moving at 72 km/h. If the radius of the curved path is 100 m, the correct angle of banking of the road should be given by :

- (A) $\tan^{-1} \frac{2}{3}$ (B) $\tan^{-1} \frac{3}{5}$ (C) $\tan^{-1} \frac{2}{5}$ (D) $\tan^{-1} \frac{1}{4}$

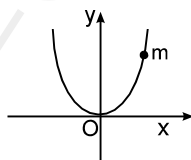
2. Two semicircular rings of linear mass densities λ and 2λ and of radius 'R' each are joined to form a complete ring. The distance of the center of the mass of complete ring from its geometrical centre is :

- (A) $\frac{3R}{8\pi}$ (B) $\frac{2R}{3\pi}$ (C) $\frac{3R}{4\pi}$ (D) none of these

3. The centre of mass of a non uniform rod of length L whose mass per unit length λ varies as $\lambda = \frac{kx^2}{L}$ where k is a constant & x is the distance of any point on rod from its one end, is (from the same end)

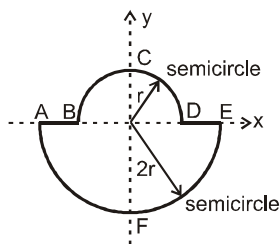
- (A) $\frac{3}{4} L$ (B) $\frac{1}{4} L$ (C) $\frac{k}{L}$ (D) $\frac{3k}{L}$

4. A bead of mass m is located on a parabolic wire with its axis vertical and vertex at the origin as shown in figure and whose equation is $x^2 = 4ay$. The wire frame is fixed in vertical plane and the bead can slide on it without friction. The bead is released from the point $y = 4a$ on the wire frame from rest. The tangential acceleration of the bead when it reaches the position given by $y = a$ is :



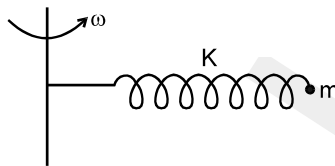
- (A) $\frac{g}{2}$ (B) $\frac{\sqrt{3}g}{2}$ (C) $\frac{g}{\sqrt{2}}$ (D) $\frac{g}{\sqrt{5}}$

5. A uniform thin rod is bent in the form of closed loop ABCDEFA as shown in the figure. The y-coordinate of the centre of mass of the system is

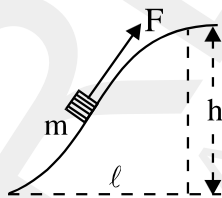


- (A) $\frac{2r}{\pi}$ (B) $-\frac{6r}{3\pi + 2}$ (C) $-\frac{2r}{\pi}$ (D) Zero

6. A particle of mass m is fixed to one end of a light spring of force constant k and unstretched length ℓ . The system is rotated about the other end of the spring with an angular speed ω ($\omega < \sqrt{\frac{k}{m}}$) in gravity free space. The increase in length of the spring is :



- (A) $\frac{m\omega^2\ell}{k}$ (B) $\frac{m\omega^2\ell}{k - m\omega^2}$ (C) $\frac{m\omega^2\ell}{k + m\omega^2}$ (D) none of these
7. A body of mass m was slowly hauled up the hill as shown in figure by a force F which at each point was directed along a tangent to the trajectory. Find the work performed by this force, if the height of the hill is h , the length of its base ℓ , and the coefficient of friction k .



COMPREHENSION

One end of massless inextensible string of length ℓ is fixed and other end is tied to a small ball of mass m . The ball is performing a circular motion in vertical plane. At the lowest position, speed of ball is $\sqrt{20g\ell}$. Neglect any other forces on the ball except tension and gravitational force. Acceleration due to gravity is g .

8. Motion of ball is in nature of
 (A) circular motion with constant speed
 (B) circular motion with variable speed
 (C) circular motion with constant angular acceleration about centre of the circle.
 (D) none of these
9. At the highest position of ball, tangential acceleration of ball is -
 (A) 0 (B) g (C) $5g$ (D) $16g$
10. During circular motion, minimum value of tension in the string -
 (A) zero (B) mg (C) $10mg$ (D) $15mg$

PHYSICS
DPP
 DAILY PRACTICE PROBLEMS

DPP No. 46

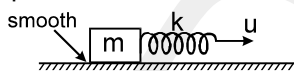
Total Marks : 28
Max. Time : 32 min.

Topics : Center of Mass, Work, Power and Energy, Friction

Type of Questions

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]
Match the Following (no negative marking) (2 × 4)Q.7	[8 marks, 10 min.] [8, 10]

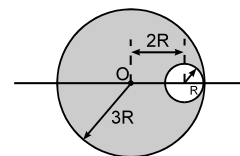
1. A block attached with an ideal spring is kept on a smooth horizontal surface. Now the free end of the spring is pulled with a constant velocity u horizontally. Then the maximum energy stored in the spring and block system during subsequent motion is :



- (A) $\frac{1}{2} mu^2$ (B) mu^2 (C) $2mu^2$ (D) $4 mu^2$
2. A block of mass 1kg is pushed on a movable wedge of mass 2kg and height $h = 30$ cm with a velocity $u = 6$ m/sec. Before striking the wedge it travels 2 m on a rough horizontal portion. Velocity is just sufficient for the block to reach the top of the wedge. Assuming all surfaces are smooth except the given horizontal part and collision of block and wedge is jerkless, the friction coefficient of the rough horizontal part is :

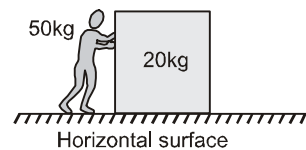


- (A) 0.125 (B) 0.377 (C) 0.675 (D) 0.45
3. In the figure shown find out the distance of centre of mass of a system of a uniform circular plate of radius $3R$ from O in which a hole of radius R is cut whose centre is at $2R$ distance from centre of large circular plate.



- (A) $R/4$ (B) $R/5$ (C) $R/2$ (D) none of these
4. Which of the following statement is not true?
- (A) Work done by conservative force on an object depends only on the initial and final states and not on the path taken.
- (B) The change in the potential energy of a system corresponding to conservative internal forces is equal to negative of the work done by these forces.
- (C) If some of the internal forces within a system are non-conservative, then the mechanical energy of the system is not constant.
- (D) If the internal forces are conservative, the work done by the internal forces is equal to the change in mechanical energy.

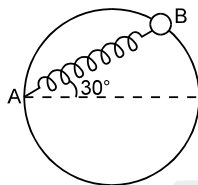
5. A boy of mass 50 kg produces an acceleration of $2m/s^2$ in a block of mass 20kg by pushing it in horizontal direction. The boy moves with the block such that boy and the block have same acceleration. There is no friction between the block and fixed horizontal surface but there is friction between foot of the boy and horizontal surface. Find friction force (in Newton) exerted by the horizontal surface on the boy.



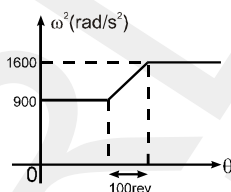
6. Four particles of mass 5, 3, 2, 4 kg are at the points (1, 6), (-1, 5), (2, -3), (-1, -4). Find the coordinates of their centre of mass.
7. Motion of particle is described in column-I. In column-II, some statements about work done by forces on the particle from ground frame is given. Match the particle's motion given in column-I with corresponding possible work done on the particle in certain time interval given in column-II.

Column-I	Column-II
(A) A particle is moving in horizontal circle	(p) work done by all the forces may be positive
(B) A particle is moving in vertical circle with uniform speed	(q) work done by all the forces may be negative
(C) A particle is moving in air (projectile motion without any air resistance) under gravity	(r) work done by all the forces must be zero
(D) A particle is attached to roof of moving train on inclined surface.	(s) work done by gravity may be positive.

4. A bead of mass m is attached to one end of a spring of natural length R and spring constant $K = \frac{(\sqrt{3} + 1)mg}{R}$. The other end of the spring is fixed at point A on a smooth vertical ring of radius R as shown in figure. The normal reaction at B just after it is released is :



- (A) $\frac{mg}{2}$ (B) $\sqrt{3} mg$ (C) $3\sqrt{3} mg$ (D) $\frac{3\sqrt{3}mg}{2}$
5. The square of the angular velocity ω of a certain wheel increases linearly with the angular displacement during 100 rev of the wheel's motion as shown. Compute the time t required for the increase.



6. A particle of mass 2kg starts to move at position $x = 0$ and time $t = 0$ under the action of force $F = (10 + 4x)$ N along the x -axis on a frictionless horizontal track. Find the power delivered by the force in watts at the instant the particle has moved by the distance 5m.
7. In column-I condition on velocity, force and acceleration of a particle is given. Resultant motion is described in column-II. \vec{u} = initial velocity, \vec{F} = resultant force and \vec{v} = instantaneous velocity.

Column-I

- (A) $\vec{u} \times \vec{F} = 0$ and $\vec{F} = \text{constant}$
 (B) $\vec{u} \cdot \vec{F} = 0$ and $\vec{F} = \text{constant}$
 (C) $\vec{v} \cdot \vec{F} = 0$ all the time and $|\vec{F}| = \text{constant}$ and the particle always remains in one plane.
 (D) $\vec{u} = 2\hat{i} - 3\hat{j}$ and acceleration at all time $\vec{a} = 6\hat{i} - 9\hat{j}$

Column-II

- (p) path will be circular path
 (q) speed will increase
 (r) path will be straight line
 (s) path will be parabolic

8. **STATEMENT-1** : The work done by all forces on a system equals to the change in kinetic energy of that system. This statement is true even if nonconservative forces act on the system.

STATEMENT-2 : The total work done by internal forces may be positive.

- (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. 48

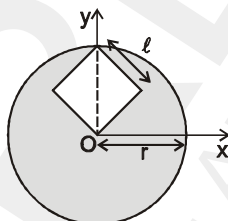
Total Marks : 25
 Max. Time : 26 min.

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

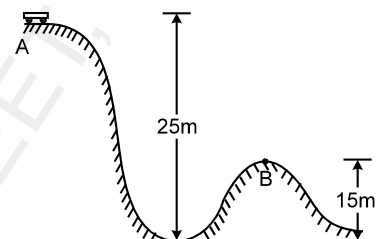
Type of Questions

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]
Assertion and Reason (no negative marking) Q. 8	(3 marks, 3 min.) [3, 3]

1. A disc (of radius r cm) of uniform thickness and uniform density ρ has a square hole with sides of length $l = \frac{r}{\sqrt{2}}$ cm. One corner of the hole is located at the center of the disc and centre of the hole lies on y -axis as shown. Then the y -coordinate of position of center of mass of disc with hole (in cm) is



- (A) $-\frac{r}{2(\pi - \frac{1}{4})}$ (B) $-\frac{r}{4(\pi - \frac{1}{4})}$ (C) $-\frac{r}{4(\pi - \frac{1}{2})}$ (D) $-\frac{3r}{4(\pi - \frac{1}{4})}$
2. A flywheel rotates with a uniform angular acceleration. Its angular velocity increases from 20π rad/s to 40π rad/s in 10 seconds. How many rotations did it make in this period?
 (A) 80 (B) 100 (C) 120 (D) 150
3. Figure shows the roller coaster track. Each car will start from rest at point A and will roll with negligible friction. It is important that there should be at least some small positive normal force exerted by the track on the car at all points, otherwise the car would leave the track. With the above fact, the minimum safe value for the radius of curvature at point B is ($g = 10 \text{ m/s}^2$):



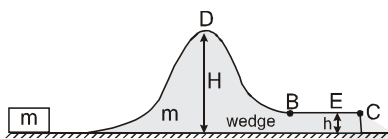
- (A) 20 m (B) 10 m (C) 40 m (D) 25 m
4. A crate of mass m is pulled with a force F along a fixed right angled horizontal trough as in figure. The coefficient of kinetic friction between the crate and the trough is μ . Find the value of force F required to pull it along the trough with constant velocity.



COMPREHENSION

Figure shows an irregular wedge of mass m placed on a smooth horizontal surface. Part BC is rough.

5. What minimum velocity should be imparted to a small block of same mass m so that it may reach point B :



- (A) $2\sqrt{gH}$ (B) $\sqrt{2gH}$ (C) $2\sqrt{g(H-h)}$ (D) \sqrt{gh}

6. The magnitude of velocity of wedge when the block comes to rest (w.r.t. wedge) on part BC is :

- (A) \sqrt{gH} (B) $\sqrt{g(H-h)}$ (C) $2\sqrt{gH}$ (D) none of these

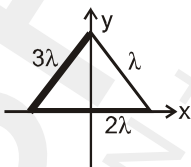
7. If the coefficient of friction between the block and wedge is μ , and the block comes to rest with respect to wedge at a point E on the rough surface then BE will be

- (A) $\frac{H}{\mu}$ (B) $\frac{H-h}{\mu}$ (C) $\frac{h}{\mu}$ (D) none of these

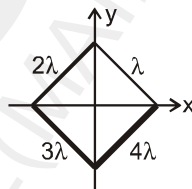
8. In each situation of column-I a mass distribution is given and information regarding x and y-coordinate of centre of mass is given in column-II. Match the figures in column-I with corresponding information of centre of mass in column-II.

Column-I

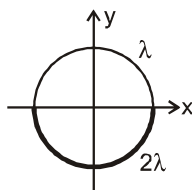
(A) An equilateral triangular wire frame is made using three thin uniform rods of mass per unit lengths λ , 2λ and 3λ as shown



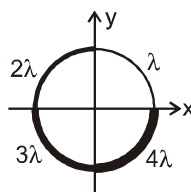
(B) A square frame is made using four thin uniform rods of mass per unit length lengths λ , 2λ , 3λ and 4λ as shown



(C) A circular wire frame is made of two uniform semicircular wires of same radius and of mass per unit length λ and 2λ as shown



(D) A circular wire frame is made of four uniform quarter circular wires of same radius and mass per unit length λ , 2λ , 3λ and 4λ as shown



Column-II

(p) $x_{cm} \geq 0$

(q) $y_{cm} \geq 0$

(r) $x_{cm} < 0$

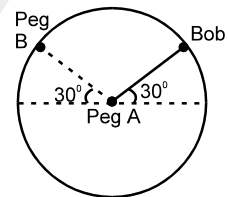
(s) $y_{cm} < 0$

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

Type of Questions

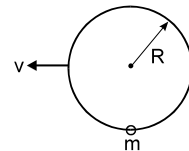
Type of Questions	M.M., Min.
Single choice Objective ('-1' negative marking) Q.1 to Q.3	(3 marks, 3 min.) [9, 9]
Multiple choice objective ('-1' negative marking) Q.4 to Q.5	(4 marks, 4 min.) [8, 8]
Subjective Questions ('-1' negative marking) Q.6	(4 marks, 5 min.) [4, 5]
Comprehension ('-1' negative marking) Q.7 to Q.9	(3 marks, 3 min.) [9, 9]

1. A bob is attached to one end of a string other end of which is fixed at peg A. The bob is taken to a position where string makes an angle of 30° with the horizontal. On the circular path of the bob in vertical plane there is a peg 'B' at a symmetrical position with respect to the position of release as shown in the figure. If V_c and V_a be the minimum speeds in clockwise and anticlockwise directions respectively, given to the bob in order to hit the peg 'B' then ratio $V_c : V_a$ is equal to :



- (A) 1 : 1 (B) 1 : $\sqrt{2}$ (C) 1 : 2 (D) 1 : 4

2. A ring of radius R lies in vertical plane. A bead of mass 'm' can move along the ring without friction. Initially the bead is at rest at the bottom most point on ring. The minimum horizontal speed v with which the ring must be pulled such that the bead completes the vertical circle

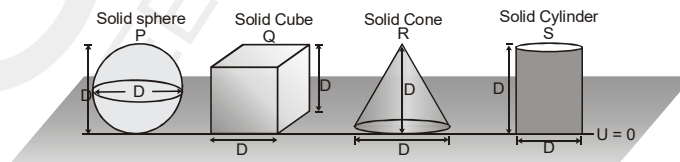


- (A) $\sqrt{3gR}$ (B) $\sqrt{4gR}$ (C) $\sqrt{5gR}$ (D) $\sqrt{5.5gR}$

3. An object is moving in a circle at constant speed v. The magnitude of rate of change of momentum of the object

- (A) is zero (B) is proportional to v (C) is proportional to v^2 (D) is proportional to v^3

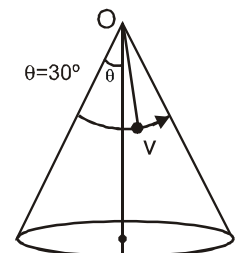
4. Assuming potential energy 'U' at ground level to be zero.



All objects are made up of same material.

- U_p = Potential energy of solid sphere U_q = Potential energy of solid cube
 U_r = Potential energy of solid cone U_s = Potential energy of solid cylinder
 (A) $U_s > U_p$ (B) $U_q > U_s$ (C) $U_p > U_q$ (D) $U_p > U_s$

5. A bob of mass 2 kg is suspended from point O of a cone with an inextensible string of length $\sqrt{3}$ m. It is moving in horizontal circle over the surface of cone as shown in the figure. Then : ($g = 10 \text{ m/s}^2$)



- (A) bob loses contact with cone if $v > \sqrt{5}$ m/s
 (B) normal force on bob is 19 N when $v = 2$ m/s
 (C) tension in string is $\frac{38}{\sqrt{3}}$ N when $v = 2$ m/s
 (D) normal force on bob is $\frac{17}{\sqrt{3}}$ N when $v = 2$ m/s

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

Type of Questions

Single choice Objective ('-1' negative marking) Q.1 to Q.5

(3 marks, 3 min.)

M.M., Min.

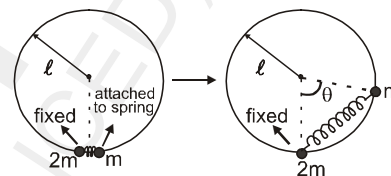
[15, 15]

Comprehension ('-1' negative marking) Q.6 to Q.9

(3 marks, 3 min.)

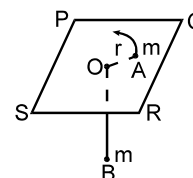
[12, 12]

1. The string is now replaced by a spring of spring constant k and natural length ℓ . Mass $2m$ is fixed at the bottom of the frame. The mass m which has the other end of the spring attached to it is brought near the mass $2m$ and released as shown in figure. The maximum angle θ that the spring will subtend at the centre will be : (Take $k = 10 \text{ N/m}$, $\ell = 1 \text{ m}$, $m = 1 \text{ kg}$ and $\ell = r$)



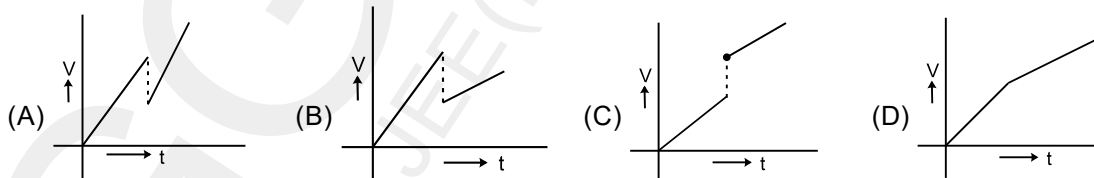
- (A) 60° (B) 30° (C) 90° (D) None of these

2. In the figure PQRS is a frictionless horizontal plane on which a particle A of mass m moves in a circle of radius r with an angular velocity ω such that $\omega^2 r = g/3$. Another particle of mass m is tied to A through an inextensible massless string. O is the hole through which string passes down to B. B can move only vertically. The tension in the string at this instant will be:

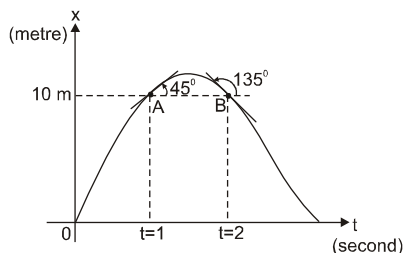


- (A) $mg/3$ (B) $2mg/3$ (C) $mg/6$ (D) none

3. Two balls of same mass are released simultaneously from heights h & $2h$ from the ground level. The balls collide with the floor & sticks to it. Then the velocity-time graph of centre of mass of the two balls is best represented by :



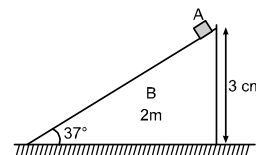
4. Displacement-time curve of a particle moving along a straight line is shown. Tangents at A and B make angles 45° and 135° with positive x-axis respectively. The average acceleration of the particle during $t = 1$, $t = 2$ second is :



- (A) -2 m/s^2 (B) 1 m/s^2
 (C) -1 m/s^2 (D) zero

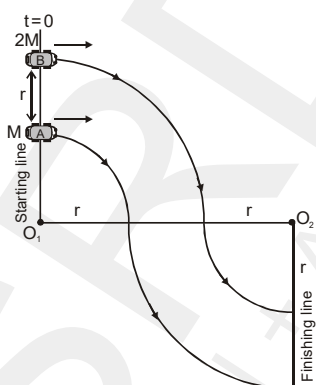
5. A particle A of mass m is situated at highest point of wedge B of mass $2m$ is released from rest. Then distance travelled by wedge B (with respect to ground) when particle A reaches at lowest position. Assume all surfaces are smooth.

- (A) $4/3$ cm (B) $8/3$ cm
 (C) $2/3$ cm (D) none of these

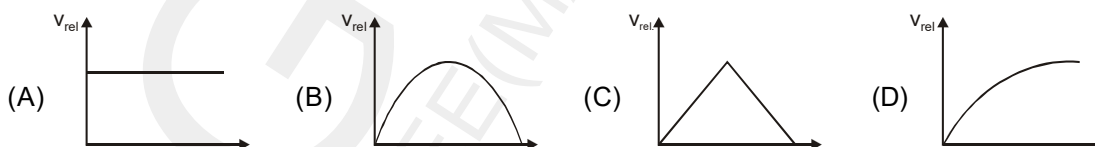


COMPREHENSION

Two racing cars 'A' and 'B' having masses ' M ' and ' $2M$ ' respectively start running from the starting line on a horizontal plane. Both cars 'A' and 'B' have same speed ' V ' which is constant through out the journey. The track of the two cars are the arcs of concentric circle having centres O_1 and O_2 as shown in figure with data. The friction coefficient of the two cars with the road is same. There is a finishing line at the end of the arc. Using these informations solve the following questions.



6. Graph between the magnitude of relative velocity of the two car and time is :



7. The magnitude of relative acceleration of two cars when car 'A' just reaches the end of circular arc of radius ' r '.

- (A) 0 (B) $(\sqrt{5-2\sqrt{2}}) \frac{V^2}{2r}$ (C) $\sqrt{2} \frac{V^2}{r}$ (D) $\frac{V^2}{r}$

8. The time interval during which the two cars have same angular speed :

- (A) Always along the motion (B) Never
 (C) $\frac{\pi r}{2V}$ (D) $\frac{\pi r}{4V}$

9. Which of the following statements is **incorrect**.

- (A) Both car reaches the finishing line at same time.
 (B) Frictional force acting on the cars is directed towards centre whenever it acts
 (C) Frictional force have same magnitude for two car 'A' and 'B' during the trip.
 (D) None of these

DPP 31 TO 50 (ANSWER KEY)

DPP NO. - 31

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

DPP NO. - 32

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

DPP NO. - 33

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

5. (B)(D) 6. (B)(D) 7. (a) $t = 4\sqrt{\frac{\ell}{3g}}$

(b) $S_A = 4V\sqrt{\frac{\ell}{3g}} - \frac{2}{3}\ell$, $S_B = 4V\sqrt{\frac{\ell}{3g}} - \frac{5}{3}\ell$,

8. (a) $T_1 = 0$; $T_2 = 0$; $T_3 = 0$; $a = g$
(b) $T_1 = 0$; $T_2 = 0$; $T_3 = 0$; $a = g$
(c) $T_1 = 0$; $T_2 = 0$; $T_3 = 0$; $a = g$

DPP NO. - 34

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

DPP NO. - 35

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

DPP NO. - 36

1. (D) 2. (C) 3. (B) 4. (B)
5. (A)(D)
6. $(-10\hat{i} - 10\hat{k})$ rain appears to come 45° with \hat{i}
7. (B) 8. (D)

DPP NO. - 37

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

6. (A), (B), (D) 7. $w = \left(a = \frac{g\sqrt{2}}{\mu + 2 + (M/m)} \right)$

8. $x = [3(a - \mu mg)/b]^{1/2}$

DPP NO. - 38

1. (D) 2. (A) 3. (A), (C) 4. 10m/s.
5. 27 N 6. (A) 7. (A) 8. (A)

DPP NO. - 39

1. (A) 2. $-\frac{\pi a^2}{2}$
3. $w_{OAC} = 8 \text{ J}$, $w_{OBC} = 2 \text{ J}$; $w_{ODC} = 19/3 \text{ J}$, No
4. (A) 5. (B) 6. (C)
7. (A) s (B) r (C) r (D) r

DPP NO. - 40

1. (A) 2. (C) 3. (A)
4. (A)(C) 5. (i) $10\sqrt{3}\hat{i} + 5\hat{j}$,
(ii) $\cos^{-1}\left(2\sqrt{\frac{3}{13}}\right)$
6. (C) 7. (A) 8. (C)

DPP NO. - 41

1. (C) 2. (D) 3. (B)
4. (A) 5. (B) 6. (B)
7. (A), (D) 8. (D) 9. (A)
10. (C)

DPP NO. - 42

1. (A) 2. (C) 3. (B)
4. (B) 5. (D) 6. (B)
7. (a) $\frac{\pi^2 R}{20T^2} (-3\hat{i} + 4\hat{j}) \text{ m/s}^2$

(b) $\frac{\pi R}{\sqrt{2}T^2} \text{ m/s}^2$

DPP NO. - 43

1. (B) 2. (C) 3. (C)
4. (C) 5. 20 m 6. $u = \sqrt{\frac{48}{5}g\ell}$
7. (A) 8. (A) 9. (C)
10. (A) 11. (A)

DPP NO. - 44

1. (B) 2. (A) 3. (D)
4. (D) 5. (A)(B)(C)
6. (D) 7. (C) 8. (A)
9. (A) s (B) q (C) r (D) p

DPP NO. - 45

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

4. (C) 5. (B) 6. (B)
 7. $A = mg(h + k\ell)$ 8. (B)
 9. (A) 10. (D)

DPP NO. - 46

1. (C) 2. (C) 3. (A)
 4. (D) 5. 140 N. 6. (1/7, 23/14)
 7. (A) p,q (B) r, s (C) p,q,s (D) p,q,s

DPP NO. - 47

1. (D) 2. (C) 3. (B)
 4. (D) 5. $\frac{40\pi}{7}$ sec. 6. 300
 7. (A) r (B) q,s (C) p (D) q,r 8. (B)

DPP NO. - 48

1. (C) 2. (D) 3. (A)
 4. $F = \sqrt{2}\mu mg$ 5. (A) 6. (A)
 7. (B) 8. (A) q,r (B) p,s (C) p,s (D) p,s

DPP NO. - 49

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

6. (a) $5\mu_k > 4\mu_s$, (b) $x = \left(\frac{\mu_k mg}{K}\right)^{1/3}$

7. (A), (D) 8. (B) 9. (C), (D)

DPP NO. - 50

1. (A) 2. (B) 3. (B)
 4. (A) 5. (A) 6. (B)
 7. (B) 8. (C) 9. (C)



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CLASS : XI (PHYSICS)

D P P

DAILY PRACTICE PROBLEM

Solutions

DPP-31 TO 50

DPP NO. - 31

1. $u = \frac{0+v_1}{2}, \frac{v_1+v_2}{2} = v, \frac{-v_2+u}{2} = v$

Hence $v = \text{velocity of } M = \frac{3u}{4}$

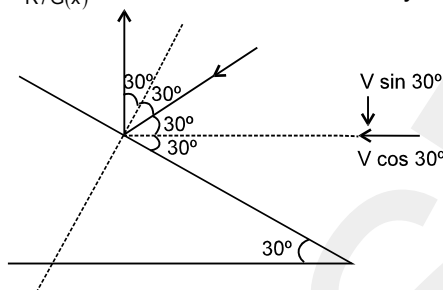
2. For the driver to observe the rain move vertically upward after the elastic collision, rain should come at an angle 30° with the horizontal (as clear from figure).

Let, velocity of rain w.r.t. car be $V_{m/c}$

$\vec{V}_{R/G} = \vec{V}_{R/C} + \vec{V}_{C/G}$

$\vec{V}_{R/G(x)} = \vec{V}_{R/C(x)} + \vec{V}_{C/G(x)}$

But $\vec{V}_{R/G(x)} = 0$, since rain fall vertically down.



$\Rightarrow \vec{V}_{C/G(x)} = -\vec{V}_{R/C(x)} = -(V \cos 30^\circ)$

$\Rightarrow |\vec{V}_{C/G(x)}| = V \cos 30^\circ \dots\dots(i)$

Now, $\vec{V}_{R/G(y)} = \vec{V}_{R/C(y)}$

$\Rightarrow -10 = -V \sin 30^\circ + 0$

[Since ; $V_{R/G(y)} = -10 \text{ m/s}$; $V_{C/G(y)} = 0$]

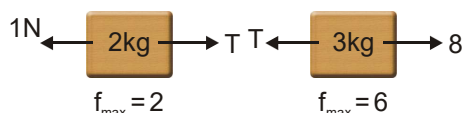
$\Rightarrow V \sin 30^\circ = 10 \Rightarrow V = 20 \text{ m/s}$.

Substituting $V = 20 \text{ m/s}$ in equation (i)

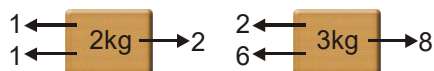
$\vec{V}_{C/G(x)} = V \cos 30^\circ = 20 \times \frac{\sqrt{3}}{2} = 10\sqrt{3} \text{ m/s}$.

$\therefore \vec{V}_{C/G} = 10\sqrt{3} \hat{i} \text{ m/s}$.

3. (C) FBD



Net force without friction on system is '7N' in right side so first maximum friction will come on 3 kg block.



So $f_1 = 1 \text{ N}$, $f_2 = 6 \text{ N}$, $T = 2 \text{ N}$

$f_1 = 1 \text{ N}$, $f_2 = 6 \text{ N}$, $T = 2 \text{ N}$

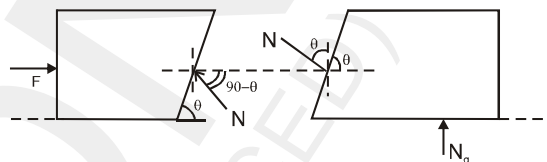
4. $F = N \sin \theta$ $N = \frac{F}{\sin \theta}$

$N \sin \theta = \mu (N \cos \theta + mg)$

$F = \mu (F \cot \theta + mg)$

$F (1 - \mu \cot \theta) = \mu mg$

$F = \frac{\mu mg}{1 - \mu \cot \theta}$



On putting $\mu = \frac{1}{\sqrt{3}}$ and $\theta = 30^\circ$

$\mu = \frac{1}{\sqrt{3}}$ $\theta = 30^\circ$

$F = \infty$

Therefore motion will not start for any value of F.

5. The magnitude of deceleration from graph is

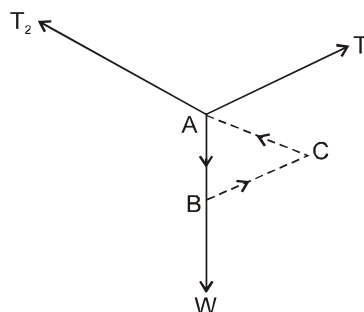
$a = \frac{8-0}{4-0} = 2 \text{ m/s}^2$

The deceleration of block is

$a = \mu g$ $\therefore \mu = \frac{a}{g} = 0.2$

6. $\vec{AB} = \vec{W}$, $\vec{BC} = \vec{T}_1$, $\vec{CA} = \vec{T}_2$

$\vec{AB} + \vec{BC} + \vec{CA} = 0$



Ans. (E)

7. Suppose blocks A and B move together. Applying NLM on C, A + B, and D

$$60 - T = 6a$$

$$T - 18 - T' = 9a$$

$$T' - 10 = 1a$$

Solving $a = 2 \text{ m/s}^2$

To check slipping between A and B, we have to find friction force in this case. If it is less than limiting static friction, then there will be no slipping between A and B.

Applying NLM on A.

$$T - f = 6(2)$$

as $T = 48 \text{ N}$

$$f = 36 \text{ N}$$

and $f_s = 42 \text{ N}$ hence A and B move together.

and $f < f_s$ $T' = 12 \text{ N}$.

DPP NO. - 32

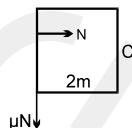
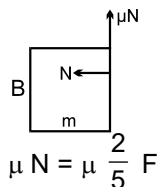
1. The acceleration of system is

$$a = \frac{F}{5m}$$

Hence the normal reaction B exerts on C is

$$N = 2ma = \frac{2}{5} F$$

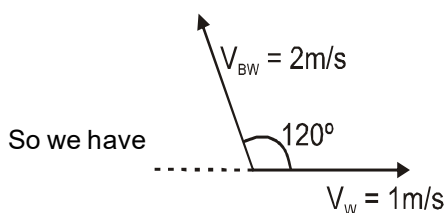
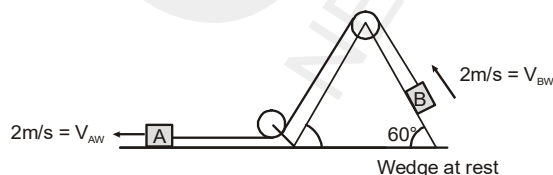
Thus frictional force on 'B' is



For B not to fall down.

$$\mu \frac{2}{5} F = mg \quad \text{or} \quad F = \frac{5mg}{2\mu}$$

2. Velocity of block A w.r.t. wedge is 2 m/s



$$\vec{V}_{BW} = \vec{V}_B - \vec{V}_W \Rightarrow \vec{V}_B = \vec{V}_{BW} + \vec{V}_W$$

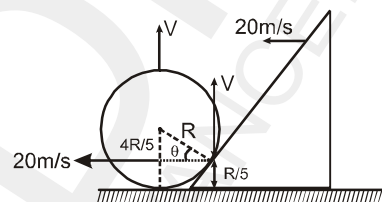
So

$$V_B = \sqrt{(V_W)^2 + (V_{BW})^2 + 2V_W \times V_{BW} (\cos 125^\circ)}$$

$$= \sqrt{1^2 + 2^2 + 2 \times 1 \times 2 \times (-1/2)} = \sqrt{3} \text{ m/s}$$

3. Let v be velocity of sphere

$$\sin \theta = \frac{4}{5}, \quad \cos \theta = \frac{3}{5}$$



From wedge constraint ;

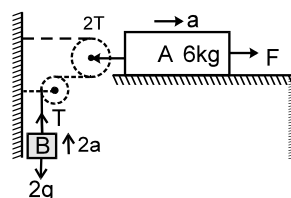
$$V \sin \theta = 20 \cos \theta$$

$$V = 20 \cot \theta$$

$$V = 20 \times \frac{3}{4} = 15 \text{ m/s}$$

4. (B)

$$a = \frac{v^2}{2s} = \frac{25}{10} = 2.5 \text{ m/s}^2$$

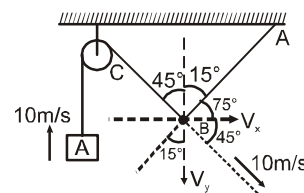


For 6 kg : - $F - 2T = 6a$

For 2 kg : - $T - 2g = 2(2a)$

From (1) & (2) $F = 75 \text{ N}$

5. Let V_x & V_y be rectangular components of velocity of mass B



Net velocity along string BC is

$$V_x \sin 45^\circ + V_y \cos 45^\circ = 10$$

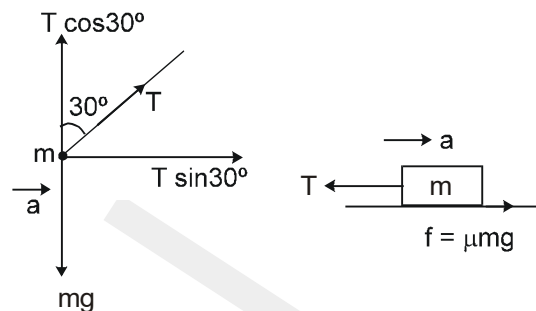
$$V_x + V_y = 10\sqrt{2} \quad \dots\dots\dots(i)$$

Net velocity along string BA is

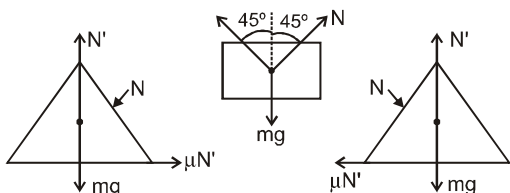
$$V_x \cos 75^\circ - V_y \cos 15^\circ = 0 \quad \dots\dots\dots(ii)$$

Solving equations (ii) & (i)

$$V = \sqrt{V_x^2 + V_y^2} = \frac{20}{\sqrt{3}} \text{ m/s.}$$



6. The free body diagrams of all bodies are as shown.



From FBD of block

$$2N \cos 45^\circ = Mg \quad \dots (1)$$

For wedge to remain at rest

$$N \sin 45^\circ < \mu N' \quad \dots (2)$$

$$\text{and } N' = mg + N \cos 45^\circ \quad \dots (3)$$

From 1, 2 and 3 we get

$$M \leq \frac{2\mu m}{1-\mu}$$

7. If we consider blocks 2 & 1 independently then there accelerations would be for block (1)

$$a_1 = g \sin \theta - \mu_1 g \cos \theta = g \left[\frac{\sqrt{3}}{2} - \frac{1}{2} \times \frac{1}{2} \right]$$

$$= \frac{g [2\sqrt{3} - 1]}{4}$$

for block (2)

$$a_2 = g \sin \theta - \mu_2 g \cos \theta = g \left[\frac{\sqrt{3}}{2} - \frac{2}{5} \times \frac{1}{2} \right]$$

$$= \frac{g}{10} [5\sqrt{3} - 2]$$

since $a_2 > a_1$ so both blocks will move separately.

$$8. T \sin 30^\circ = ma \quad \dots\dots\dots(1)$$

$$T \cos 30^\circ = mg \quad \dots\dots\dots(2)$$

dividing equation (1) by equation (2)

$$\tan 30^\circ = \frac{a}{g}$$

$$\Rightarrow a = g \tan 30^\circ$$

$$\Rightarrow a = \frac{g}{\sqrt{3}} \quad \text{Ans.}$$

$$\text{From (2) } T = \frac{mg}{\cos 30^\circ} = \frac{2mg}{\sqrt{3}} \quad \text{Ans.}$$

$$\text{and } \mu mg - T = ma$$

$$\Rightarrow \mu mg = T + ma = \frac{2mg}{\sqrt{3}} + ma$$

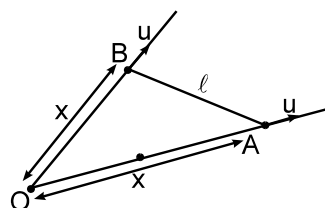
$$= \frac{2mg}{\sqrt{3}} + \frac{mg}{\sqrt{3}}$$

$$\Rightarrow \mu mg = \frac{3mg}{\sqrt{3}} = \sqrt{3} mg$$

$$\Rightarrow \mu = \sqrt{3} \quad \text{Ans.}$$

DPP NO. - 33

1. To an observer who starts falling freely under gravity from rest at the instant stones are projected, the motion of stone A and B is seen as



$$\frac{dx}{dt} = u \quad \dots\dots(1)$$

$$\frac{d\ell}{dt} = u \quad \dots\dots(2)$$

$\therefore x = \ell$ and $\angle BOA = 60^\circ$

2. Block slides down itself if inclination of plane is greater than angle of repose else it has to be pushed down. sw

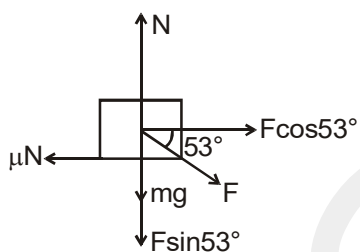
3. Max. frictional force

$$f_{\max} = \mu N$$

$$= \mu(mg + F \sin 53^\circ)$$

$$= 0.2 (20 \times 10 + 30 \times \frac{4}{5})$$

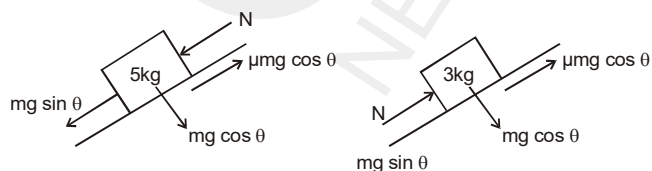
$$= 44.8 \text{ N}$$



As applied horizontal force is $F \cos 53^\circ = 18 \text{ N} < f_{\max}$, friction force will also be 18 N.

4. **Case-I** : $\mu_1 = 0.5, \mu_2 = 0.3$

Along the incline, acceleration of 5 kg block will be less than acceleration of 3 kg block provided they move alone on the incline. The reason is greater friction coefficient of 5 kg block, as acceleration along the incline is $g \sin \theta - \mu g \cos \theta$. One to the contain, both blocks will move together. In this case FBDs of both are shown.



For 5 kg block
 $m_1 g \sin \theta + N - \mu_1 m_1 g \cos \theta = m_1 a$
 For 3 kg block
 $m_2 g \sin \theta - N - \mu_2 m_2 g \cos \theta = m_2 a$

5. **(B,D) Case I** :

Since, no relative motion :

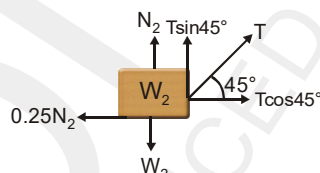
$$a = \frac{F_1 - F_f}{5} = \frac{F_f}{3} \Rightarrow F_{1(\max)} = \frac{8}{3} F_f$$

Case II :

$$a = \frac{F_f}{5} = \frac{F_2 - F_f}{3} \Rightarrow F_{2(\max)} = \frac{8}{5} F_f$$

Clearly ; $F_{1(\max)} > F_{2(\max)}$ and $\frac{F_{1(\max)}}{F_{2(\max)}} = \frac{5}{3}$

6. **B, D**

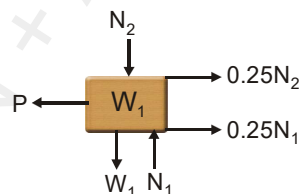


For W_2 :

$$N_2 + T \sin 45^\circ = W_2 = 100 \quad \dots (1)$$

$$T \cos 45^\circ = 0.25 N_2 \quad \dots (2)$$

$$\Rightarrow T = 20\sqrt{2} \text{ N}, N_2 = 80 \text{ N}$$



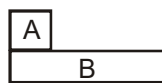
For W_1 :

$$P = 0.25 (N_1 + N_2) \quad \dots (3)$$

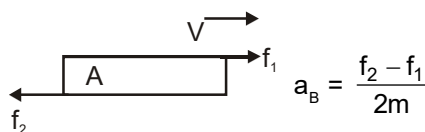
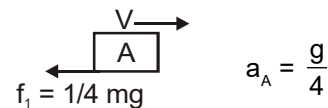
$$N_2 + W_1 = N_1 \quad \dots (4)$$

$$\Rightarrow N_1 = 280 \text{ N}$$

7.



System start moving towards right with velocity v.



$$= \frac{\frac{1}{2}(3m)g - \frac{1}{4}mg}{2m} = \frac{5g}{8}$$

$$U_{rel} = 0$$

$$a_{rel} = \frac{5g}{8} - \frac{g}{4} = \frac{3g}{8}$$

$$\therefore l = \frac{13}{28}gt^2$$

$$t = 4\sqrt{\frac{l}{3g}}$$

$$S_1 = vt - \frac{1}{2}gt^2 = 4v\sqrt{\frac{l}{3g}} - \frac{2l}{3}$$

$$S_2 = vt - \frac{15}{28}gt^2 = 4v\sqrt{\frac{l}{3g}} - \frac{5}{3}l$$

8. **Ans.** (a) $T_1 = 0; T_2 = 0; T_3 = 0; a = g$
 (b) $T_1 = 0; T_2 = 0; T_3 = 0; a = g$
 (c) $T_1 = 0; T_2 = 0; T_3 = 0; a = g$

DPP NO. - 34

1. If $F = 0$

Then assuming no relative motion acceleration of A +

$$B = \frac{300}{15} = 20 \text{ m/s}^2$$

$$\therefore 20 \text{ m/s}^2 > \mu g$$

where $\mu = 0.5$ and $g = 10 \text{ m/s}^2$

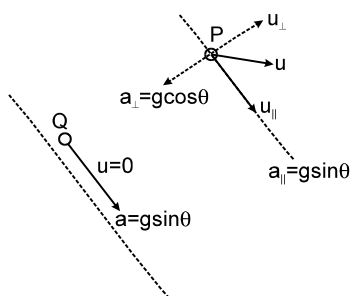
\therefore relative motion shall exist. Hence $F = 0 \text{ N}$.

$$; f_n F = 0$$

2. Acceleration as shown in the graph can be converted into force by multiplying with $m = 3 \text{ kg}$. Therefore area under the curve ($F - x$ curve) is

$$\left[\frac{1}{2} \times 2 \times 12\right] + [4 \times 12] = 60 \text{ J.}$$

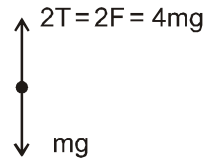
3. It can be observed from figure that P and Q shall collide if the initial component of velocity of P along incline. $u_{\parallel} = 0$ that is particle is projected perpendicular to incline.



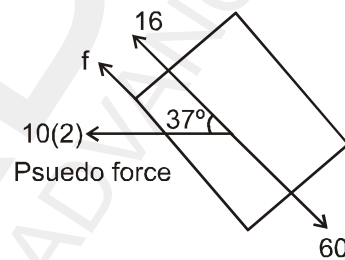
$$\therefore \text{Time of flight } T = \frac{2u_{\perp}}{g \cos \theta} = \frac{2u}{g \cos \theta}$$

$$\therefore u = \frac{gT \cos \theta}{2} = 10 \text{ m/s.}$$

4. F.B.D. of block
 $\Rightarrow 2T - mg = ma$
 $a = 3g$



5. (A, B) If moving with constant velocity then $a = 0$
 so friction available $= \mu mg \cos \theta$
 $= (0.8)(10)(10)(4/5) = 64 \text{ N}$.



but $mg \sin \theta = 60 \text{ N}$

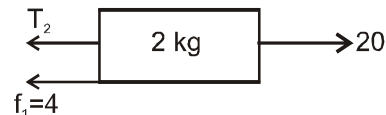
so required friction is 60 N .

So net force is zero.

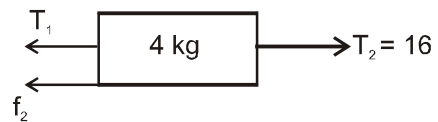
$$(C) a = 2 \hat{i} \quad f = mg \sin 37^\circ - m a \cos 37^\circ = 44 \text{ N}$$

$$(D) f = mg \sin 37^\circ - m a \cos 37^\circ = -20 \text{ N}$$

- 6 to 8.

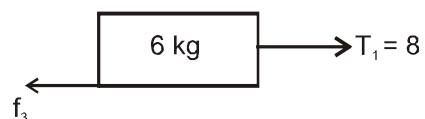


$$T_2 + 4 = 20, T_2 = 16 \text{ Nt}$$



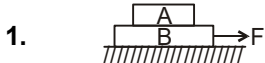
$$f_2 = 8, T_2 = T_1 + f_2, T_2 = T_1 + 8$$

$$T_1 = 8$$

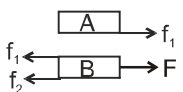


$$f_3 = 8.$$

DPP NO. - 35



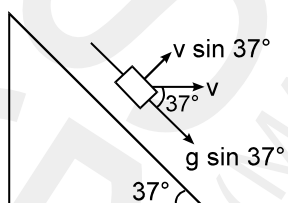
1. Consider the blocks shown in the figure to be moving together due to friction between them. The free body diagrams of both the blocks is shown below.



Work done by static friction on A is positive and on B is negative.

2. From graph ; Let m be mass of block
 when $a = 0$, $F = 4 = f_{\max}$
 when $a = 1$, $F = 6$
 $\Rightarrow F - f_{\max} = ma$
 $\Rightarrow 6 - 4 = m(1)$
 $\Rightarrow m = 2\text{kg}$

3. Because the acceleration of wedge is zero, the normal reaction exerted by wedge on block is $N = mg \cos 37^\circ$. The acceleration of the block is $g \sin 37^\circ$ along the incline and initial velocity of the block is $v = 10 \text{ m/s}$ horizontally towards right as shown in figure.



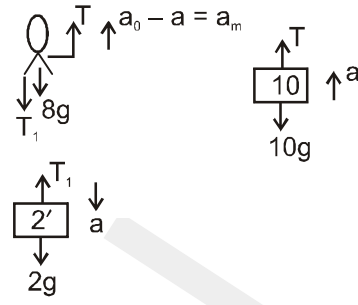
The component of velocity of the block normal to the incline is $v \sin 37^\circ$. Hence the displacement of the block normal to the incline in $t = 2$ second is

$$S = v \sin 37^\circ \times 2 = 10 \times \frac{3}{5} \times 2 = 12 \text{ m.}$$

\therefore The work done by normal reaction

$$W = mg \cos 37^\circ \times S = 100 \times \frac{4}{5} \times 12 = 960 \text{ J}$$

4. $a_{(\text{cm}) \text{ left}} = a_{\text{cm right}}$
- $$\frac{8(a_0 - a) - 2a}{8 + 2} = \frac{10a}{10}$$
- $$a = \frac{2}{5} a_0$$



$$a_m = a_0 - a = \frac{3}{5} a_0 = 1.2 \text{ m/s}^2$$

$$t = \sqrt{\frac{2 \times S}{a_m}} = 2 \text{ Sec.}$$

5. $W = \int_1^0 -5dz = 5\text{J}$

6. to 8 Angle (θ') of repose ;
 $m(g + a) \sin \theta' = F$
 $m(g + a) \cos \theta' = R$
 $\therefore \frac{F}{R} = \tan \theta'$

$$\theta' = \tan^{-1} \left(\frac{F}{R} \right) = \alpha$$

Hence angle of repose does not change.

7. To slide $mg \sin \theta > \mu mg \cos \theta$
 $\sin \theta > \mu \cos \theta$
 $\tan \theta > \mu$
 $\theta > \tan^{-1} \mu$

8. Shear force $= \mu mg \cos \theta$

$$= \frac{3}{4} \times mg \times \frac{\sqrt{3}}{2} = \frac{3\sqrt{3}}{8} mg = 0.6 mg$$

But, pulling force $= mg \sin \theta = mg \sin 30^\circ = 0.5 mg < f_{\text{smax}}$. \therefore block does not slide.

Hence frictional force (shear force) between the block of the plane at this situation will be

$$= mg \sin 30^\circ = \frac{mg}{2} \text{ (not } \frac{3\sqrt{3}}{8} mg)$$

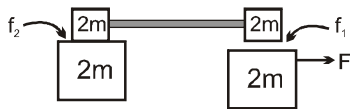
Alternate Sol.

$$\tan \theta = \frac{1}{\sqrt{3}} = \frac{\sqrt{3}}{3} = \frac{1.73}{3} = 0.58 < \mu$$

\therefore block does not slide. $\therefore f_s = mg \sin 30^\circ$

DPP NO. - 36

1. Given system can accelerate in rightward direction



$f_2 < f_1$, so all three blocks A, B, C will move with same acceleration for all value of F.

2. $W_{ext} = -W_g$

$$= -\left(\frac{M}{4}\right)g\left(-\frac{L}{8}\right) = \frac{MgL}{32}$$

3. $P\vec{Q} = (2-3)\hat{i} + (-1-2)\hat{j} (4 - (-1))\hat{k}$

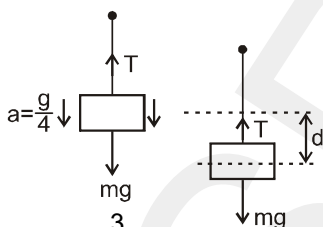
$$\vec{F} \cdot \vec{PQ} = -4 + 9 + 10 = 15 \text{ J}$$

4. Let tension in string be T, then work done by tension T = -Td

Applying newton's second law on the bucket

$$mg - T = m\left(\frac{g}{a}\right)$$

$$\text{or } T = \frac{3}{4} mg$$



$$\therefore \text{required work done} = -\frac{3}{4} mg d$$

5. $\frac{l}{\cos\theta} = 0 + \frac{1}{2}(g\sin\theta) \cdot t^2$

$$t = \sqrt{\frac{2l}{g\sin\theta \cdot \cos\theta}} = \sqrt{\frac{4l}{g\sin 2\theta}}$$

t will be minimum if $\sin 2\theta = \text{maximum}$.

$$\theta = 45^\circ$$

$$t_{\min} = 2\sqrt{\frac{l}{g}}$$

Since as θ increases from 0 to 45° t decreases and as θ increases 45° to 90° t increases

6. to 8. $\vec{V}_{rm} = \vec{V}_r - \vec{V}_m = (-10\hat{i} - 10\hat{k})$

Ans. $(-10\hat{i} - 10\hat{k})$ rain appears to come 45° with \hat{i} .

7. $V_m = \sqrt{10^2 + 10^2} = 10\sqrt{2} \text{ m/sec.}$

8. $\vec{V}_{mr} = -\vec{V}_{rm} = 10\hat{i} + 10\hat{k}$

6. (A) $W_{CL} + W_f = \Delta KE \therefore W_{CL} = \Delta KE - W_f$
 (a) During accelerated motion negative work is done against friction and there is also change is kinetic energy. Hence net work needed is +ve.

(b) During uniform motion work is done against friction only and that is +ve.

(c) During retarded motion, the load has to be stopped in exactly 50 metres. If only friction is considered then the load stops in 12.5 metres] which is less than where it has to stop. Hence the camel has to apply some force so that the load stops in 50m ($>12.5 \text{ m}$).

Therefore the work done in this case is also +ve.

7. $W_{CL} |_{\text{accelerated motion}} = \Delta KE - W_{\text{friction}}$ where W_{CL} is work done by camel on load.

$$= \left[\frac{1}{2}mv^2 - 0\right] - [-\mu_k mg \cdot 50] = 1000 \left[\frac{125}{2}\right]$$

similarly, $W_{CL} |_{\text{retardation}} = \Delta KE - W_{\text{friction}}$

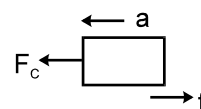
$$\left[0 - \frac{1}{2}mv^2\right] - [-\mu_k mg \cdot 50] = 1000 \left[\frac{75}{2}\right]$$

$$\therefore \frac{W_{CL} |_{\text{accelerated motion}}}{W_{CL} |_{\text{retarded motion}}}$$

$$= \frac{125}{75} = \frac{5}{3}$$

$$\Rightarrow 5 : 3$$

8. Maximum power = $F_{\max} \times V$
 Maximum force applied by camel is during the accelerated motion.



We have $V^2 - U^2 = 2as$

$$25 = 0^2 + 2 \cdot a \cdot 50$$

$a = 0.25 \text{ m/s}^2$; for accelerated motion

$$\therefore F_c - f = ma$$

$$\therefore F_c = \mu mg + ma = 0.1 \times 1000 \times 10 + 1000 \times 2.5 = 1000 + 250 = 1250 \text{ N}$$

This is the critical point just before the point where it attains maximum velocity of almost 5 m/s.

Hence maximum power at this point is = $1250 \times 5 = 6250 \text{ J/s}$.

DPP NO. - 37

1. $mg \times 1 = \frac{1}{2} mu^2 \Rightarrow u^2 = 2g \dots\dots\dots (1)$

$$v^2 = u^2 + 2as \Rightarrow 0 = 2g - 2a(3)$$

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

$$\therefore \mu_k g = \frac{g}{3} \therefore \mu_k = \frac{1}{3}$$

2. As long as the block of mass m remains stationary, the block of mass M released from rest comes down by

$$\frac{2Mg}{K} \text{ (before coming it rest momentarily again).}$$

Thus the maximum extension in spring is

$$x = \frac{2Mg}{K} \dots\dots\dots (1)$$

for block of mass m to just move up the incline

$$kx = mg \sin \theta + \mu mg \cos \theta \dots\dots\dots (2)$$

$$2Mg = mg \times \frac{3}{5} + \frac{3}{4} mg \times \frac{4}{5}$$

or $M = \frac{3}{5} m$ **Ans.**

3. Change in velocity = $\frac{\text{area under F-T graph}}{\text{mass}} =$

$$\frac{60 + (-10)}{10} = 5 \text{ m/s}$$

$$W_F = \Delta K.E. = \frac{1}{2} (10) 5^2 = 125 \text{ J}$$

4. $\frac{1}{2} k x_0^2 + Mgh = \frac{1}{2} k(x_0+h)^2 + 0$

$$\Rightarrow h = \frac{2Mg}{k} - 2x_0$$

Maximum downward displacement

$$= \left[\frac{2Mg}{k} - 2x_0 \right]$$

5. Minimum work done to accelerate the truck from speed 0 to v and from v to $2v$ are

$$\Delta W_1 = \frac{1}{2} mv^2 - \frac{1}{2} m(0)^2 = \frac{1}{2} mv^2$$

$$\text{and } \Delta W_2 = \frac{1}{2} m(2v)^2 - \frac{1}{2} m(v)^2 = \frac{3}{2} mv^2$$

$$\therefore \Delta W_1 < \Delta W_2$$

Sol. For W to be maximum ; $\frac{dW}{dx} = 0$;

i.e. $F(x) = 0 \Rightarrow x = \ell, x = 0$

Clearly for $d = 1$, the work done is maximum.

Alternate Solution :

External force and displacement are in the same direction

\therefore Work will be positive

continuously so it will be maximum when displacement is maximum.

6. $\bar{a} = \frac{d\bar{v}}{dt} \Rightarrow d\bar{v} = \bar{a} dt$

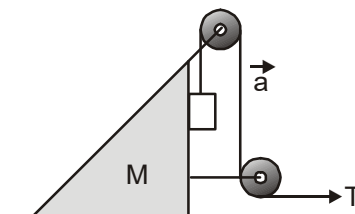
$$\Rightarrow \Delta\bar{v} = \int_{t_1}^{t_2} \bar{a} dt$$

Rate of change of speed = component of acceleration along velocity

$$\Rightarrow \frac{d|\bar{v}|}{dt} = \bar{a} \cdot \frac{\bar{v}}{v}$$

$$K = \frac{1}{2} m \bar{v} \cdot \bar{v} \Rightarrow \frac{dK}{dt} = m \bar{v} \cdot \bar{a}$$

7.



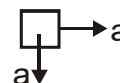
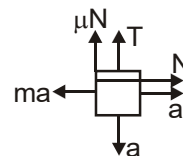
$$N = ma \quad T = (M + m)a$$

$$mg - T - \mu ma = ma$$

$$mg - (M + m)a - \mu ma = ma$$

$$a = \frac{g}{\mu + 2 + (M/m)}$$

$$a_m = \sqrt{2} a = \frac{\sqrt{2}g}{\mu + 2 + (M/m)}$$



8. $W_f + W_F = -\mu mgx + \int_0^x (a - bx^2) dx$

$$0 = (-\mu mg + a)x - \frac{bx^3}{3}$$

$$\Rightarrow x = \sqrt{\frac{3(a - \mu mg)}{b}}$$

DPP NO. - 38

1. A will be ahead of B when $x_A > x_B$

$$40(t - 10) > (0)t + \frac{1}{2}(2)t^2$$

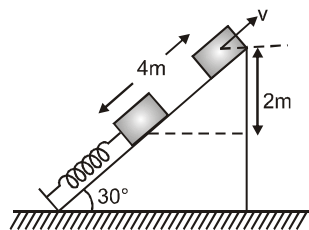
as A is 10 sec. late than B.

$$\Rightarrow t^2 - 40t + 400 < 0$$

$$\Rightarrow (t - 20)^2 < 0$$

Which is not possible. So A will never be ahead at B.

2. By energy conservation,



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

$$= \frac{1}{2} \times 300 \times (2)^2 = 5 \times 10 \times 2 + \frac{1}{2} \times 5v^2$$

$$\Rightarrow v^2 = 200$$

$$\text{Also, } H = \frac{v^2 \sin^2 30^\circ}{2g} = 2.5 \text{ m}$$

So, total height from ground = 3 + 2.5 = 5.5m.

3. Acceleration of block is = 10 m/s²

$$\therefore \text{displacement } s = \frac{1}{2}at^2 = \frac{1}{2} \times 10 \times \frac{4}{10}$$

$$= 2\text{m}$$

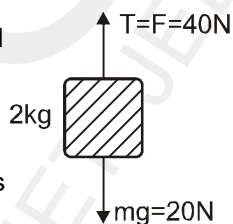
Tension in the string is 40 N

Work done by gravity is

$$- 20 \times 2 = - 40 \text{ J}$$

and work done by tension is

$$40 \times 2 = 80 \text{ J}$$



4. For the block of mass m_2 , not to move, the maximum compression in the spring x_0 should be such that

$$kx_0 = \mu m_2 g \quad \dots (1)$$

Applying work energy theorem to block of mass m_1 , we get

$$\frac{1}{2}m_1u^2 = \frac{1}{2}kx_0^2 + \mu m_1gx_0 \quad \dots (2)$$

From equation (1) and (2) we get

$$\frac{1}{2}m_1u^2 = \frac{1}{2} \frac{\mu^2 m_2^2 g^2}{K} + \frac{\mu^2 m_1 m_2 g^2}{K} \quad \text{putting the}$$

appropriate value we get $u=10\text{m/s}$.

5. Case (i): $f_{\max} \leftarrow \text{4 kg P} \rightarrow F_{\min}$
 $f_{\max} = F_{\min} = 12 \text{ N}$

Case (ii): $\text{4 kg P} \rightarrow F_{\max} = 12\text{N}$
 $a \rightarrow$

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

$$f_{\max} = 12$$

$$\Rightarrow 4a = 12$$

$$\Rightarrow 4 \left(\frac{F}{m} \right) = 12 \Rightarrow F = 12 \text{ N}$$

6. $F_{\max} = kx + \mu mg$

$$F_{\min} = kx - \mu mg$$

$$\therefore F_{\max} - F_{\min} = 2 \mu mg$$

$$\text{or } 2 = 2 \mu \times 10$$

$$\therefore \mu = 0.1$$

7. $F_{\max} + F_{\min} = 2kx \quad \dots (1)$

from graph $F_{\max} + F_{\min} = 5$

and $x = 0.1$

Putting in equation (1)

$$t = 2k(0.1)$$

$$k = 25 \text{ N/m}$$

8. When $x = 0.03$

$$kx = 25 \times 0.03$$

$$= 0.75 \text{ N, which is less than } \mu mg = 0.1 \times 10$$

$$= 1 \text{ N}$$

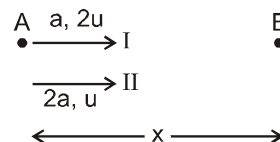
\therefore The block will be at rest, without applying force F.

DPP NO. - 39

1. Let both will meet at point B

$$x = 2ut + \frac{1}{2}at^2$$

$$x = ut + \frac{1}{2}(2a)t^2$$



$$\text{So } 2ut + \frac{1}{2}at^2 = ut + at^2$$

$$ut = \frac{1}{2}at^2 \Rightarrow t = \frac{2u}{a}$$

$$\text{So } x = 2u\left(\frac{2u}{a}\right) + \frac{1}{2}a\left(\frac{2u}{a}\right)^2 = \frac{6u^2}{a}$$

2. Work done by force F ;

$$w = \int \vec{F} \cdot d\vec{r} = \int (y\hat{i} - x\hat{j}) \cdot (dx\hat{i} + dy\hat{j})$$

$$= \int (ydx - xdy) \dots\dots\dots(1)$$

$$\therefore x^2 + y^2 = a^2 \quad \therefore xdx + ydy = 0$$

$$\Rightarrow W = \int \left(y \left(\frac{-ydy}{x} \right) - xdy \right)$$

$$= - \int \frac{(x^2 + y^2)}{x} dy$$

$$= - \int_0^a \frac{a^2}{\sqrt{a^2 - y^2}} dy = - \frac{\pi a^2}{2}$$

Alternate Method

It can be observed that the force is tangent to the curve at each point and the magnitude is constant. The direction of force is opposite to the direction of motion of the particle.

\therefore work done = (force) \times (distance)

$$= - \sqrt{x^2 + y^2} \frac{\pi a}{2} = - a \times \frac{\pi a}{2} = - \frac{\pi a^2}{2} \text{ J}$$

Ans. $w = - \frac{\pi a^2}{2} \text{ J}$

3. $(W_F)_{OAC} = \int (xydx + x^2ydy)$

$$= \int_0^A (xydx + x^2ydy) + \int_A^C (xydx + x^2ydy)$$

ON OA path ;
 $y = 0$, $dy = 0$ and on AC path
 $x = 1$, $dx = 0$

$$(W_F)_{OAC} = \int_0^A (0 \cdot dx + 0 \cdot dy) + \int_{y=0}^{y=4} (0 + 1y dy) = 8 \text{ J}$$

$$(W_F)_{OBC} = 0 + \int_B^C (xydx + x^2ydy)$$

$$= \int_{x=0}^1 \{x \cdot 4 dx + x^2 \cdot 4(0)\} = 2 \text{ J}$$

$$(W_F)_{ODC} = \int_{y=4x^2} (xydx + x^2ydy)$$

$$= \int_0^1 (x \cdot 4x^2 dx + x^2 \cdot 4x^2 \cdot 8x dx) = 1 + \frac{32}{6}$$

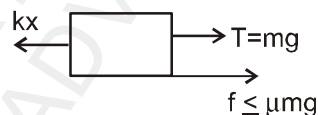
$$= \frac{19}{3} \text{ J}$$

4. From work energy theorem, the masses stop when total work done on them is zero.

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

$$\therefore \frac{2mg}{k} (1 - \mu) = \frac{3mg}{2k}$$

5. When the masses are stopped at this value of x, the forces on left mass for it to remain at rest is zero



$$\Rightarrow kx = mg + f$$

$$\Rightarrow k \frac{2mg}{k} (1 - \mu) \leq mg + \mu mg$$

$$\therefore \mu \geq 1/3 \quad \therefore \text{least value of } \mu \text{ is } 1/3.$$

6. At the instant string is cut, let the extension in spring be x_0 . The maximum compression x will occur for spring when left block comes to rest first time after the string is cut

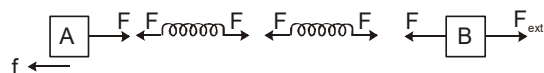
\therefore From work energy Theorem $\Delta W = 0$

$$\frac{1}{2} kx_0^2 - \frac{1}{2} kx^2 - \mu mg (x + x_0) = 0$$

$$x_0 = \frac{3mg}{2k} \text{ and } \mu = \frac{1}{4}$$

solving we get $x = \frac{mg}{k}$

7. The free body diagram (FBD) is :



Tension in both springs will be same

(\therefore they are massless)

$$F = K_2 X_2 = K_1 X_1 \text{ and } X_1 + X_2 = X$$

$$\therefore X_1 = \frac{K_2}{K_1 + K_2} X, \quad X_2 = \frac{K_1}{K_1 + K_2} X$$

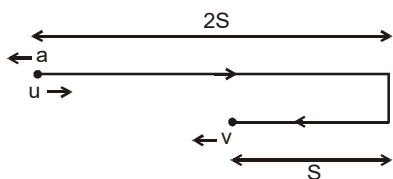
$$\therefore F = \frac{K_1 K_2}{K_1 + K_2} X$$

$$f = F = \frac{K_1 K_2}{K_1 + K_2} X(-\hat{i})$$

$$\therefore a \rightarrow S, b \rightarrow R, c \rightarrow R, d \rightarrow R$$

DPP NO. - 40

1. Let u and v denote initial and final velocity, then the nature of motion is indicated in diagram

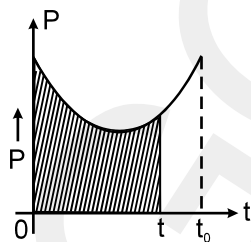


Hence initial and final speed are given by equation

$$0^2 = u^2 - 2a \times 2S \quad \text{and} \quad v^2 = 0^2 + 2as$$

$$\therefore v = \frac{u}{\sqrt{2}} \quad \text{or} \quad \frac{u}{v} = \sqrt{2} \quad \text{Ans.}$$

2. The work done by force from time $t = 0$ to $t = t$ sec. is given by shaded area in graph below. Hence as t increases, this area increases.



\therefore Work done by force keeps on increasing.

3. From work, energy theorem :

$$W_g + U_i - U_f = \Delta K$$

$$Mgh + \frac{1}{2} Kx_0^2 - \frac{1}{2} K(x_0 + 2h)^2 = 0$$

$$\Rightarrow \frac{1}{2} K(x_0^2 - (x_0 + 2h)^2) = -Mgh$$

$$\Rightarrow \frac{1}{2} K(x_0 + x_0 + 2h)(x_0 - x_0 - 2h) = -Mgh$$

$$\Rightarrow \frac{1}{2} K 2(x_0 + h)(-2h) = -Mgh$$

$$h = \frac{Mg}{2K} - x_0.$$

4. By energy conservation $\frac{1}{2} kx^2 = mg(2x)$

$$\Rightarrow x = \frac{4mg}{k} \quad (\text{maximum elongation})$$

at equilibrium $kx = 2mg$

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

$$\text{So } (K.E.)_{\max} = mg(2x) - \frac{1}{2} kx^2$$

$$= 2mg\left(\frac{2mg}{k}\right) - \frac{1}{2} k\left(\frac{2mg}{k}\right)^2$$

$$\frac{1}{2} mv_{\max}^2 = \frac{2m^2 g^2}{k}$$

$$\Rightarrow v_{\max} = 2g\sqrt{\frac{m}{k}}$$

5. (i) $x = u \cos \theta t$

$$= 20 \times \frac{\sqrt{3}}{2} \times t = 10\sqrt{3} \text{ m}$$

$$y = u \sin \theta t - \frac{1}{2} \times 10 \times t^2$$

$$= 20 \times \frac{1}{2} \times (1) - 5(1)^2 = 5 \text{ m}$$

$$\text{Position vector, } \vec{r} = 10\sqrt{3} \hat{i} + 5 \hat{j}, \quad |\vec{r}| = \sqrt{(10\sqrt{3})^2 + 5^2}$$

(ii) $v_x = 10\sqrt{3} \hat{i}$

$$v_y = u_y + a_y t = 10 - g t = 0$$

$$\therefore \vec{v} = 10\sqrt{3} \hat{i}, \quad |\vec{v}| = 10\sqrt{3}$$

$$\vec{v} \cdot \vec{r} = (10\sqrt{3} \hat{i}) \cdot (10\sqrt{3} \hat{i} + 5 \hat{j}) = 300$$

$$\vec{v} \cdot \vec{r} = |\vec{v}| |\vec{r}| \cos \theta$$

$$\Rightarrow \cos \theta = \frac{\vec{v} \cdot \vec{r}}{|\vec{v}| |\vec{r}|} = \frac{300}{10\sqrt{3} \sqrt{325}}$$

$$\Rightarrow \theta = \cos^{-1}\left(2\sqrt{\frac{3}{13}}\right)$$

6. The normal reaction is always \perp to surface and the

displacement is always along the surface.

∴ force and displacement are ⊥ to each other. From A to C it is zero.

7. Total work done by gravity = work done against friction

$$mgh = \mu mg \cdot x_0$$

$$\Rightarrow \mu = \frac{h}{x_0}$$

8. (work done by gravity – work done by friction) = change in K.E.

$$\therefore mgh - \mu mg \frac{x_0}{2} = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$$

$$= mgh - \frac{h}{x_0}mg \frac{x_0}{2} = \frac{1}{2}mv_f^2 - 0 \quad \therefore \mu = \frac{h}{x_0}$$

$$\therefore \frac{mgh}{2} = \frac{1}{2}mv_f^2 \Rightarrow v_f = \sqrt{gh}$$

duration of time t is $v_B : v_C = 5 : 4$

$$4. \frac{2\pi r_1}{v_1} = \frac{2\pi r_2}{v_2} \Rightarrow \frac{v_1}{v_2} = \frac{r_1}{r_2} = \frac{1}{2}$$

$$\frac{v_1^2/r_1}{v_2^2/r_2} = \left(\frac{v_1}{v_2}\right)^2 \cdot \left(\frac{r_2}{r_1}\right) = \frac{1}{4} \cdot 2 = \frac{1}{2}$$

$$\text{Alternate method } \frac{a_1}{a_2} = \frac{\omega^2 r_1}{\omega^2 r_2} = \frac{r_1}{r_2} = \frac{4}{8} = \frac{1}{2}$$

5. Method (I)

After 3 sec.

$$V_y = u_y + gt = -30 \text{ m/s}$$

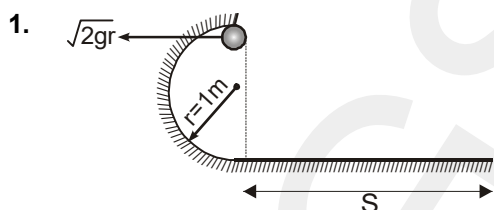
$$\text{and } V_x = 10 \text{ m/s} \quad \therefore V^2 = V_x^2 + V_y^2$$

$$\Rightarrow V = 10\sqrt{10} \text{ m/s}$$

$$\text{Now, } \tan \alpha = \frac{V_x}{V_y} = \frac{1}{3}$$

$$\Rightarrow \sin \alpha = \frac{1}{\sqrt{10}}$$

DPP NO. - 41



By work energy theorem

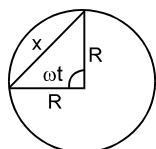
$$W_g + W_f = K_f - K_i$$

$$\Rightarrow mg \cdot 2r - \mu mgS = 0 - \frac{1}{2}m(2gr)$$

$$\Rightarrow 3mgr = \mu mgS$$

$$\Rightarrow S = \frac{3r}{\mu} = \frac{3 \times 1}{0.5} = 6\text{m}$$

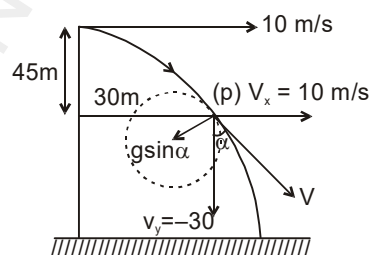
2.



$$\cos \omega t = \frac{R^2 + R^2 - x^2}{2R^2}$$

$$\therefore x = 2R \sin \frac{\omega t}{2}$$

3. The ratio of distance travelled by B and C in same



$$\text{Radius of curvature } r = \frac{V_1^2}{g \sin \alpha}$$

$$r = 100\sqrt{10} \text{ m}$$

Method (II)

Let horizontal and vertical position of point p be x & y respectively

$$\therefore x = Vt \text{ and } y = \frac{1}{2}gt^2$$

$$\therefore \text{equation of trajectory } y = \frac{gx^2}{2V^2}$$

$$\therefore \frac{dy}{dx} = \frac{gx}{V^2} \text{ and } \frac{d^2y}{dx^2} = \frac{g}{V^2}$$

$$\text{Radius of curvature } r = \frac{\left\{1 + \left(\frac{dy}{dx}\right)^2\right\}^{3/2}}{\frac{d^2y}{dx^2}}$$

$$= \frac{\left(1 + \frac{g^2 x^2}{V^4}\right)^{3/2}}{g/v^2}$$

Now after 3 s $x = Vt = 30$ m

and $V = 10$ m/s

$$\therefore r = 100\sqrt{10} \text{ m.}$$

6. $a_{\text{Net}} = \sqrt{a_t^2 + a_c^2}$

$$\omega^2 = \omega_0^2 + 2\alpha\theta$$

$$\therefore \omega_0 = 0$$

$$\text{so } \omega^2 = 2\alpha\theta$$

$$\omega^2 R = 2(\alpha R\theta)$$

$$a_c = \omega^2 R = 2a_t\theta$$

$$1 = \sqrt{0.36 + (1.2 \times \theta)^2}$$

$$\Rightarrow 1 - 0.36 = (1.2 \theta)^2$$

$$\Rightarrow \frac{0.8}{1.2} = \theta$$

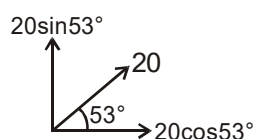
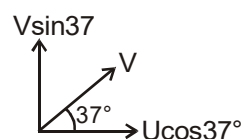
$$\Rightarrow \theta = \frac{2}{3} \text{ radian}$$

7. Only the following statements are true from definition of a conservative force.

"Its work is zero when the particle moves exactly once around any closed path".

"Its work depends on the end points of the motion, not on the path between".

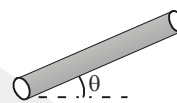
8. The particle while entering has inclination of 37° . Let its velocity here be V .



Now $V \cos 37^\circ = 20 \cos 53^\circ$ as horizontal component does not change.

$$\therefore V = 20 \times \frac{3}{5} \times \frac{5}{4} = 15 \text{ m/s.}$$

9. The initial velocity is 15 m/s acceleration of particle is $(g \sin\theta + \mu g \cos\theta)$ downwards along the tube.



$$\therefore a = 10 \sin 37 + \frac{3}{8} \times 10 \times \cos 37 = 10 \times \frac{3}{5}$$

$$+ \frac{3}{8} \times 10 \times \frac{4}{5} = 9 \text{ m/s}^2$$

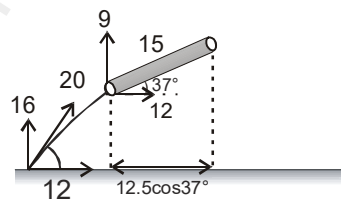
$$\therefore V^2 = u^2 + 2as$$

$$V^2 = 15^2 - 2 \times 9 \times 12.5 = 0$$

$$\therefore V^2 = 0$$

Given that the tube is slightly less than 12.5 m. It means the particle will just drop from tube. Hence K.E. at the tube end = 0.

10. Time taken by projectile to reach the bottom of tube from point of projection is



$$9 = 16 - gt \therefore t = \frac{7}{10} = 0.7 \text{ sec.}$$

During this time particle travels 12×0.7 m = 8.4 m horizontally.

$$\therefore \text{Total distance} = 8.4 \text{ m} + 12.5 \cos 37^\circ = 8.4 + 10 = 18.4 \text{ m.}$$

DPP NO. - 42

1. Final P.E. of block = Initial P.E. of block + work done by friction

$$\therefore mgh' = mgh - \mu mgd$$

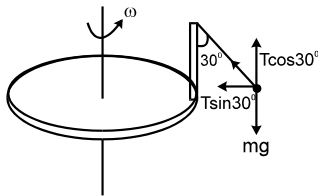
3. In uniform circular motion force is towards center but in nonuniform circular motion net force is not towards centre.

In retardation angular acceleration and angular velocity are opposite to each other.

Tangential acceleration and angular velocity are perpendicular to each other so cross product will not be zero.

4. $F_x = -\frac{\partial U}{\partial x}$ or $F_y = -\frac{\partial U}{\partial y}$, only (B) option satisfies the criteria.
5. (D) The bob of the pendulum moves in a circle of radius

$$(R + R\sin 30^\circ) = \frac{3R}{2}$$



Force equations : $T\sin 30^\circ = m\left(\frac{3R}{2}\right)\omega^2$

$$T\cos 30^\circ = mg$$

$$\Rightarrow \tan 30^\circ = \frac{3\omega^2 R}{2g} = \frac{1}{\sqrt{3}}$$

$$\Rightarrow \omega = \sqrt{\frac{2g}{3\sqrt{3}R}}$$

Ans.

6. For $a < \mu g$
 $N = 0$
 For $a > \mu g$

$$a_{m_1+m_2} = \frac{(m_1 + m_2)a - \mu(m_1 + m_2)g}{(m_1 + m_2)}$$

$$= a - \mu g \quad \text{w.r.t platform}$$

For m_1

$$m_1 a - \mu m_1 g + N = m_1 \times a_{m_1+m_2}$$

$$m_1 a - \mu m_1 g + N = m_1 (a - \mu g)$$

$$N = 0.$$

7. Speed of car is $v = \frac{\pi R}{2T}$ m/s

(a) The acceleration of car is $\frac{v^2}{R} = \frac{\pi^2 R}{4T^2}$ at B and is

directed from B to O.

\therefore Acceleration vector of car at B is

$$\vec{a} = \frac{v^2}{R} (-\sin 37^\circ \hat{i} + \cos 37^\circ \hat{j}) = \frac{\pi^2 R}{20T^2}$$

$$(-3\hat{i} + 4\hat{j}) \text{ m/s}^2$$

(b) The magnitude of average acceleration of car is in time T is

$$\frac{|\vec{v}_C - \vec{v}_B|}{T} = \frac{\sqrt{2}v}{T} = \frac{\pi R}{\sqrt{2}T^2} \text{ m/s}^2$$

DPP NO. - 43

1. $mg + w_{fk} = \frac{1}{2}(1)^2 - 0$

$$w_{fk} = 2 - 10$$

2. From mechanical energy conservation :

$$mg(2R) + \frac{1}{2}k(2R)^2 = \frac{1}{2}mv^2$$

$$v = 2\sqrt{gR + \frac{kR^2}{m}}$$

3. $T = mg\cos\theta + \frac{mv^2}{r}$ (i)

$$T = 2mg$$
(ii)

M.E. conservation

$$mgr = mgr(1 - \cos\theta) + \frac{1}{2}mv^2$$
(iii)

From (i), (ii) & (iii) $\theta = \cos^{-1} \frac{2}{3}$ **Ans.**

4. (C) Let v be the speed of particle at B, just when it is about to lose contact.

From application of Newton's second law to the particle normal to the spherical surface.

$$\frac{mv^2}{r} = mg \sin \beta$$
 (1)

Applying conservation of energy as the block moves from A to B..

$$\frac{1}{2}mv^2 = mg(r \cos \alpha - r \sin \beta)$$
 (2)

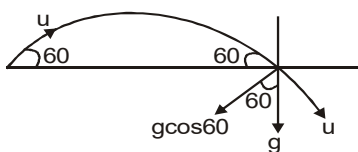
Solving 1 and 2 we get

$$3 \sin \beta = 2 \cos \alpha$$

5. radial acceleration at the point of landing

$$a_n = g \cos 60 = \frac{u^2}{r}$$

$$\Rightarrow r = \frac{u^2}{g \cos 60} = \frac{(10)^2}{10 \times 1/2} = 20 \text{ m}$$

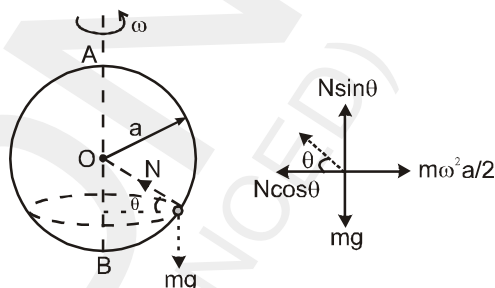


1. As ; $\cos \theta = \frac{a}{2a}$

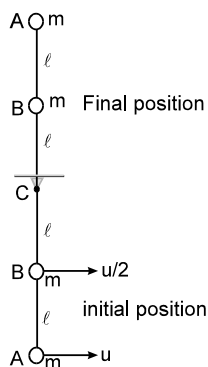
$$\theta = 60^\circ$$

$$\therefore N \sin 60^\circ = mg$$

$$N \cos 60^\circ = m \frac{\omega^2 a}{2}$$



6.



Let the initial velocity given to the mass at A be u . Then the velocity of mass at B is $u/2$

As the system moves from initial the final position
 Increase in potential energy is $= 4 mg\ell + 2mg\ell$
 Decrease in kinetic energy

$$= \frac{1}{2}mu^2 + \frac{1}{2}m\left(\frac{u}{2}\right)^2 = \frac{5}{8}mu^2$$

From conservation of energy

$$\frac{5}{8}mu^2 = 6mg\ell \quad \text{or} \quad u = \sqrt{\frac{48}{5}g\ell}$$

7. ME_A

$$= \frac{1}{2}Mv^2 + Mg \times 20 = \frac{1}{2} \times 10^2 \times 10 + 10 \times 20 \times 10 = 2500 \text{ J.}$$

8. $ME_B = KE_B + PE_B = ME_A$
 $PE_B = 0 \quad KE_B = ME_A = 2500 \text{ J.}$

9. $KE_C = (ME)_A - (PE)_C = 2500 - 10 \times 10 \times 10 = 1500 \text{ J.}$

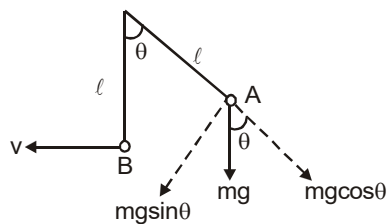
10. $KE_D = (ME)_A - (PE)_D = 2500 - 10 \times 10 \times 3 = 2200 \text{ J.}$

w.r.t. wire

$$\therefore \tan 60^\circ = \frac{2g}{\omega^2 a} \quad \omega^2 = \frac{2g}{a\sqrt{3}}$$

2. $a_A = g \sin \theta$ (only tangential)

$$a_B = \frac{v^2}{\ell} \text{ (only radial)}$$



$$K.E. + P.E. = K.E. + P.E.$$

$$= \frac{1}{2}m0^2 + mg\ell(1 - \cos \theta) = \frac{1}{2}mv^2$$

$$v^2 = 2g\ell(1 - \cos \theta) \quad \dots\dots\dots(i)$$

$$\therefore a_B = \frac{v^2}{\ell} = 2g(1 - \cos \theta)$$

Since, $a_A = a_B$
 $\therefore g \sin \theta = 2g(1 - \cos \theta)$

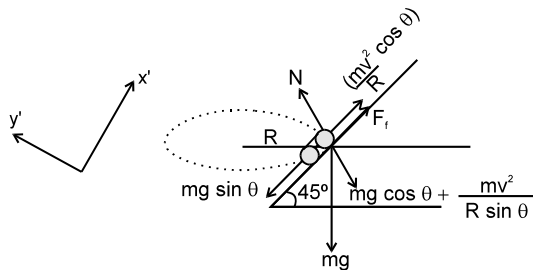
$$\Rightarrow 2 \sin \frac{\theta}{2} \cos \frac{\theta}{2} = 2 \times 2 \sin^2 \frac{\theta}{2}$$

DPP NO. - 44

$$\Rightarrow \tan \frac{\theta}{2} = \frac{1}{2}$$

$$\Rightarrow \theta = 2 \tan^{-1} \left(\frac{1}{2} \right) \quad \text{Ans.(A)}$$

3. F.B.D. for minimum speed (w.r.t. automobile):



$$\Sigma f_y = N - mg \cos \theta - \frac{mv^2}{R} \sin \theta = 0.$$

$$\Sigma f_x = \frac{mv^2}{R} \cos \theta + \mu N - mg \sin \theta = 0$$

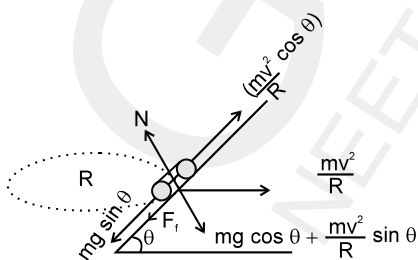
$$\Rightarrow \frac{mv^2}{R} \cos \theta + \mu(mg \cos \theta + \frac{mv^2}{R} \sin \theta) - mg \sin \theta = 0$$

$$\Rightarrow v^2 = \frac{(\mu R g \cos \theta - R g \sin \theta)}{(\cos \theta + \mu \sin \theta)}$$

$$\text{for } \theta = 45^\circ \text{ and } \mu = 1 :$$

$$v_{\min} = \frac{Rg - Rg}{1+1} = 0$$

F.B.D for maximum speed (w.r.t. automobile)



$$\Sigma f_x = \frac{mv^2}{R} \cos \theta - mg \sin \theta - \mu(mg \cos \theta + \frac{mv^2}{R} \sin \theta) = 0$$

$$\text{for } \theta = 45^\circ \text{ and } \mu = 1$$

$$v_{\max} = \infty \text{ (infinite)}$$

4. Centre of mass of circular disc of radius

$$4R = (0, 0)$$

Centre of mass of upper disc = (0, 3R)

Centre of mass of lower disc = (3R, 0)

Let M be mass of complete disc and then the mass

of cut out disc are $\frac{M}{16}$

Hence, centre of mass of new structure is given by

$$\bar{x} = \frac{m_1 x_1 - m_2 x_2 - m_3 x_3}{m_1 - m_2 - m_3}$$

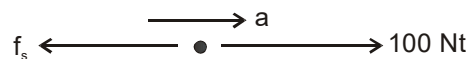
$$= \frac{M(0) - \frac{M}{16}(0) - \frac{M}{16}(3R)}{M - \frac{M}{16} - \frac{M}{16}} = \frac{-3R}{14}$$

$$\bar{y} = \frac{m_1 y_1 - m_2 y_2 - m_3 y_3}{m_1 - m_2 - m_3}$$

$$= \frac{M(0) - \frac{M}{16}(3R) - \frac{M}{16}(0)}{M - \frac{M}{16} - \frac{M}{16}} = \frac{-3R}{14}$$

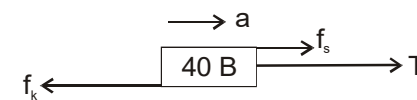
$$\text{Position vector of C.M.} = -\frac{3R}{14}(\hat{i} + \hat{j})$$

5. F BD of M



$$100 - f_s = 60 a \quad \rightarrow \quad (1)$$

F BD of B



$$T + f_s - f_k = 40 a \quad \rightarrow \quad (2)$$

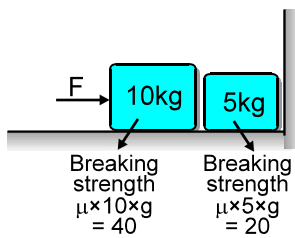
$$f_k = (0.1)(60 + 40) g$$

From (1) and (2)

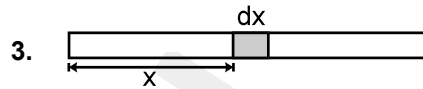
$$100 - f_s = 60 a$$

$$f_s = 40 \text{ Nt}$$

6. If $F = 20 \text{ N}$, 10 kg block will not move and it would not press 5 kg block So $N = 0$.

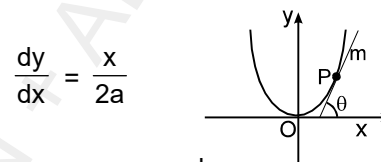


$$\frac{m\left(-\frac{2R}{\pi}\right) + 2m\left(\frac{2R}{\pi}\right)}{3m} = \frac{2R}{3\pi}$$



$$\therefore x_{cm} = \frac{\int_0^L Kx^2 dx \cdot x}{\int_0^L Kx^2 dx} = \frac{\frac{x^4}{4} \Big|_0^L}{\frac{x^3}{3} \Big|_0^L} = \frac{3}{4} L$$

4. $x^2 = 4ay$ Differentiating w.r.t. y, we get



\therefore At $(2a, a)$, $\frac{dy}{dx} = 1$

\Rightarrow hence $\theta = 45^\circ$

the component of weight along tangential direction is $mg \sin \theta$.

hence tangential acceleration is $g \sin \theta = \frac{g}{\sqrt{2}}$

5. The centre of mass of semicircular ring is at a distance

$\frac{2r}{\pi}$ from its centre. (Let $\lambda = \text{mass/length}$)

$$\therefore Y_{cm} = \frac{\lambda\pi r \times \frac{2r}{\pi} - \lambda \times 2\pi r \times \frac{4r}{\pi}}{\lambda\pi r + \lambda r + \lambda r + \lambda \times 2\pi r} = -\frac{6r}{3\pi + 2}$$

6.

$$kx = m\omega^2 l + m\omega^2 x$$

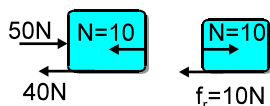
$$(k - m\omega^2) x = m\omega^2 l$$

$$x = \frac{m\omega^2 l}{k - m\omega^2} \quad \text{Ans. (B)}$$

7. For slowly havled $\Delta K = 0$

7. $F_{min} = f_A + f_B = 60 \text{ N}$.

8. If $F = 50 \text{ N}$, force on 5 kg block = 10 N



So friction force = 10 N

9. Point J \longrightarrow No equilibrium
 K \longrightarrow Unstable equilibrium
 L \longrightarrow Stable equilibrium
 M \longrightarrow Neutral equilibrium

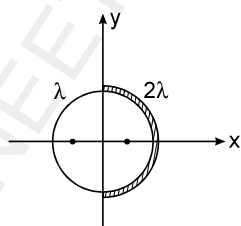
DPP NO. - 45

1. $V = \sqrt{gR \tan \theta} \Rightarrow (20)^2 = 10 \times 100 \times \tan \theta$

$$\Rightarrow \tan \theta = \frac{4}{10} = \frac{2}{5}$$

$$\Rightarrow \theta = \tan^{-1}(2/5) \quad \text{Ans: None}$$

2. Let the two half rings be placed in left and right of y-axis with centre as shown in figure.



Then the coordinate of centre of mass of left and right

half rings are $\left(-\frac{2R}{\pi}, 0\right)$ and $\left(\frac{2R}{\pi}, 0\right)$.

\therefore x-coordinates of centre of mass of complete ring is

$$W_F + W_g + W_f = \Delta K$$

$$W_g = -mgh$$

$$W_f = -mgk\ell$$

$$W_F = mgh + mgk\ell = mg\ell (h + k\ell).$$

8. As speed of ball is variable, so motion is non uniform circular motion.
9. At the highest position of ball, tangential acceleration of ball is zero,
10. Tension in the string is minimum when ball is at the

highest position. By conservation of energy $\frac{1}{2}mv^2 + mg(2\ell) = \frac{1}{2}m(20g\ell)$

$$v^2 = 16g\ell$$

where v is the velocity of ball at the highest point.

So $T + mg = \frac{mv^2}{\ell}$

$$T = \frac{m16g\ell}{\ell} - mg = 15mg$$

DPP NO. - 46

1. As ; $W_{ext} = \Delta(ME)$; ME = Mechanical energy. Mechanical energy will keep on increasing upto the instant the W_{ext} is positive, which will happen till there is no compression in the spring. First the spring gets extended to a maximum and after which the extension decreases upto the natural length. After that there is a compression in the spring, results in a -ve external work (so as to move the end of spring at constant speed u).

Hence maximum energy stored is at the natural length.

$$\& ME_{max} = \frac{1}{2}mv^2$$

At the natural length $v = 2u$, since the block is moving at this instant at a speed u with respect to the other end of the spring.

Hence $ME_{max} = \frac{1}{2}m(2u)^2 = 2mu^2.$

2. Apply work energy theorem $\mu mg(2) + mgh = KE_f - KE_i \dots\dots\dots(1)$

at the highest point $V_{block} = V_{wedge}$
 velocity of the block after passing through the rough surface is $v = \sqrt{36 - 2\mu g(2)}$

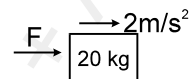
so applying momentum conservation $1(v) = (1 + 2)v_f$
 $\Rightarrow v_f = v/3$
 $\Rightarrow \mu = 0.675$

3. $\bar{x} = \frac{m_1x_1 + (-m_2)x_2}{m_1 + (-m_2)}$

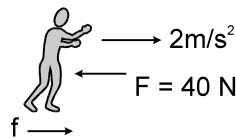
$$= \frac{A_1x_1 + (-A_2)x_2}{A_1 + (-A_2)}$$

$A_1 = \pi(3R)^2, A_2 = \pi R^2$
 $x_1 = 0, x_2 = 2R$
 $\therefore \bar{x} = -R/4$

5. For Block $F = 20.2 = 40 N$



As boy exerts 40 N force on block, block exerts 40 N force on the boy, in opposite direction. As boy is also moving with same acceleration $f - 40 = 50.2$



$f = 140 N.$

Aliter : Consider the boy + block system. The only external force is friction acting on boy 'f'

$\therefore f = (M_{boy} + M_{block})a = 140 N.$
 $\therefore f = (M_{man} + M_{block})a = 140 N.$

6. $X_{cm} = \frac{m_1x_1 + m_2x_2 + m_3x_3 + m_4x_4}{m_1 + m_2 + m_3 + m_4}$

$$= \frac{5 \times 1 + 3 \times (-1) + 2 \times (2) + 4 \times (-1)}{5 + 3 + 2 + 4} = \frac{2}{14} = \frac{1}{7}$$

$Y_{cm} = \frac{m_1y_1 + m_2y_2 + m_3y_3 + m_4y_4}{m_1 + m_2 + m_3 + m_4}$

$$= \frac{5 \times (6) + 3 \times 5 + 2 \times (-3) + 4 \times (-4)}{5 + 3 + 2 + 4}$$

$$= \frac{23}{14}$$

7. (A) If motion is uniform circular motion (constant speed), change in kinetic energy of particle is zero

$$W_{\text{all}} = KE_2 - KE_1$$

$$W_{\text{all}} = 0$$

If motion is non uniform circular motion then kinetic energy of particle may decrease or increase. So work done by all the forces may be positive or negative.

(B) The particle's speed is constant, so work done by all the force is zero. For vertical downward displacement, work done by gravity is positive.

(C) In projectile motion, for upward vertical displacement, speed particle decreases, so work done by all the forces will be negative. For vertical downward displacement, speed of particle increases, so work done by all the force will be positive.

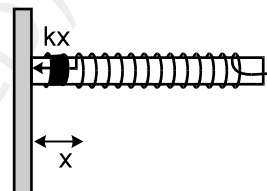
(D) If the speed of train is increasing, then work done by all the forces is positive and vice versa. If train is moving downward the incline, work done by gravity on the particle is positive.

$$k_i + u_i = k_f + v_f$$

$$\frac{1}{2} m \times 5 g \ell + 0 = \frac{1}{2} m v^2 + m g \ell$$

$$\Rightarrow V = \sqrt{3g\ell}$$

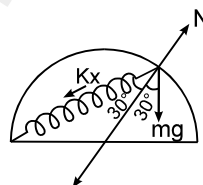
3. For the ring to move in a circle at constant speed the net force on it should be zero. Here spring force will provide the necessary centripetal force.



$$\therefore kx = m\omega^2$$

$$\Rightarrow \omega = \sqrt{\frac{k}{m}} = \sqrt{\frac{300}{3}} = 10 \text{ rad/sec. Ans.}$$

4. The extension is spring is $x = 2R \cos 30^\circ - R = (\sqrt{3} - 1)R$



$$kx \cos 30^\circ + mg \cos 30^\circ$$

Applying Newton's second law to the bead normal to circular ring at point B

$$N = K (\sqrt{3} - 1)R \cos 30^\circ + mg \cos 30^\circ$$

$$= \frac{(\sqrt{3} + 1)}{R} mg (\sqrt{3} - 1) R \cos 30^\circ + mg \cos 30^\circ$$

$$N = \frac{3\sqrt{3} mg}{2}$$

5. We have $\Delta\theta = 2\pi \times (100 \text{ rev}) = 200\pi \text{ rad}$

$$\text{So } \omega^2 = \omega_0^2 + 2\alpha\Delta\theta$$

$$\Rightarrow 1600 = 900 + 2\alpha \times 200\pi$$

$$\Rightarrow \alpha = \frac{700}{400\pi} = \frac{7}{4\pi}$$

$$\text{Also } \omega = \omega_0 + \alpha t$$

$$\Rightarrow 40 = 30 + \frac{7}{4\pi} t$$

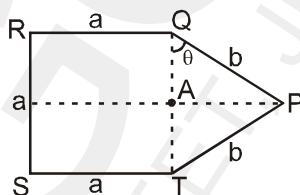
$$\Rightarrow t = \frac{40\pi}{7}$$

DPP NO. - 47

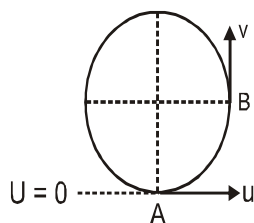
1. If centre of mass is at A

$$a^2 \sigma \frac{a}{2} = \sigma \frac{1}{2} ab \sin\theta \frac{1}{3} b \sin\theta$$

$$\text{or } \frac{b}{a} = \sqrt{\frac{13}{4}}$$



2.



Minimum velocity at lowest point to complete the circle

$$\text{is } u = \sqrt{5g\ell}$$

so by energy conservation between point A and B

6. According to W.E. theorem

$$\frac{1}{2} mV^2 - 0 = \int_0^5 (10 + 4x) dx$$

$$V = 10\text{m/s}$$

$$\text{Force at that moment} = (10 + 20) = 30 \text{ N}$$

$$\begin{aligned} \text{Instantaneous power} &= \vec{F} \cdot \vec{V} \\ &= 30 \times 10 = 300\text{W} \end{aligned}$$

7. (A) $\vec{F} = \text{constant}$ and $\vec{u} \times \vec{F} = 0$

Therefore initial velocity is either in direction of constant force or opposite to it. Hence the particle will move in straight line and speed may increase or decrease.

(B) $\vec{u} \cdot \vec{F} = 0$ and $\vec{F} = \text{constant}$

initial velocity is perpendicular to constant force, hence the path will be parabolic with speed of particle increasing.

(C) $\vec{v} \cdot \vec{F} = 0$ means instantaneous velocity is always perpendicular to force. Hence the speed will remain constant. And also $|\vec{F}| = \text{constant}$. Since the particle moves in one plane, the resulting motion has to be circular.

(D) $\vec{u} = 2\hat{i} - 3\hat{j}$ and $\vec{a} = 6\hat{i} - 9\hat{j}$. Hence initial velocity is in same direction of constant acceleration, therefore particle moves in straight line with increasing speed.

8. Both the statements are true. The work done by all forces on a system is equal to change in its kinetic energy, irrespective of fact whether work done by internal forces is positive, is zero or is negative.

DPP NO. - 48

1. This disc can be assumed to be made of a complete uniform disc and a square plate with same negative mass density.

$$\begin{aligned} Y_{\text{cm}} &= \frac{m_1 y_1 + m_2 y_2}{m_1 + m_2} \\ &= \frac{(\pi r^2)\sigma(0) + \ell^2(-\sigma)(r/2)}{\pi r^2\sigma + \ell^2(-\sigma)} \\ &= \frac{-\ell^2 r}{2(\pi r^2 - \ell^2)} = \frac{-\frac{r^3}{2}}{2(\pi r^2 - \frac{r^2}{2})} = \frac{-r}{4\left(\pi - \frac{1}{2}\right)} \end{aligned}$$

2. $\alpha = \frac{40\pi - 20\pi}{10} \text{ rad/sec}^2$

$$= 2\pi \text{ rad/sec}^2$$

$$\omega_2^2 = \omega_1^2 + 2\alpha\theta$$

$$(40\pi)^2 = (20\pi)^2 + 2(2\pi)\theta$$

$$\theta = \frac{(40\pi)^2 - (20\pi)^2}{4\pi} = \frac{60\pi \times 20\pi}{4\pi} = 300\pi$$

$$2\pi n = 300\pi$$

$$n = 150.$$

3. $V_B = \sqrt{2 \times 10 \times 10}$; $\frac{m v_B^2}{R} \leq mg$; $R \geq \frac{v_B^2}{g}$

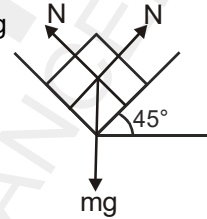
$$\Rightarrow R \geq 20 \text{ m}$$

4. $2N \sin 45^\circ = mg$

$$N = \frac{mg}{\sqrt{2}}$$

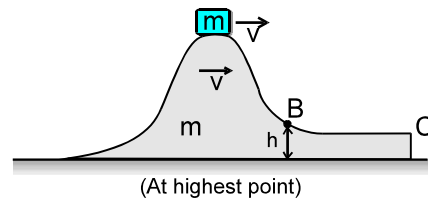
$$F = 2\mu N$$

$$= 2\mu \frac{mg}{\sqrt{2}} = \sqrt{2} \mu mg.$$



5. Let 'u' be the required minimum velocity. By momentum conservation :

$$mu = (m + m)v \Rightarrow v = u/2.$$



Energy equation :

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

Substituting $v = u/2$:

$$u = 2\sqrt{gH}$$

6. When the block comes to rest, the wedge continues to move at $V = \frac{u}{2} = \sqrt{gH}$ on the smooth surface. (since, momentum of wedge-block system remains conserved).

7. By work-energy theorem on the system :

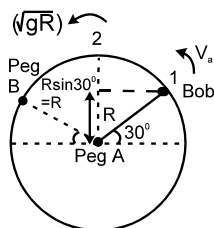
$$-(\mu mg)(BE) - mgh = -\frac{1}{4} mu^2$$

$$= -\frac{1}{4} m (4gH) \Rightarrow BE = \frac{H-h}{\mu}$$

8. (A) Centre of mass lies in second quadrant.
 (B), (C) and (D) Centre of mass lies on y-axis and below x-axis.

DPP NO. - 49

1. (C) For anti-clockwise motion, speed at the highest point should be \sqrt{gR} . Conserving energy at (1) & (2):



$$\frac{1}{2}mv_a^2 = mg\frac{R}{2} + \frac{1}{2}m(gR)$$

$$\Rightarrow v_a^2 = gR + gR = 2gR$$

$$\Rightarrow v_a = \sqrt{2gR}$$

For clock-wise motion, the bob must have atleast that much speed initially, so that the string must not become loose any where until it reaches the peg B.

At the initial position :

$$T + mg\cos 60^\circ = \frac{mv_c^2}{R} ; \quad V_c \text{ being the initial speed}$$

in clockwise direction.

For $V_{c \text{ min}}$: Put $T = 0$;

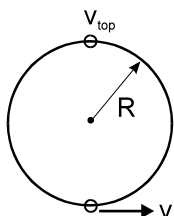
$$V_{c \text{ min}} : \quad T = 0$$

$$\Rightarrow V_c = \sqrt{\frac{gR}{2}}$$

$$\Rightarrow V_c/V_a = \frac{\sqrt{\frac{gR}{2}}}{\sqrt{2gR}} = \frac{1}{2}$$

$$\Rightarrow V_c : V_a = 1 : 2 \quad \text{Ans.}$$

2. In the frame of ring (inertial w.r.t. earth), the initial velocity of the bead is v at the lowest position.



The condition for bead to complete the vertical circle is, its speed at top position

$$v_{\text{top}} \geq 0$$

From conservation of energy

$$\frac{1}{2} m v_{\text{top}}^2 + mg (2R) = \frac{1}{2} mv^2$$

$$\text{or } v = \sqrt{4gR}$$

3. As the speed is constant, so there is only $a_n \propto v^2$.

Hence the net force is equal to $\frac{mv^2}{R}$. Hence the

magnitude of rate of change of momentum (i.e. force) is proportional to v^2 .

5. $T \cos 30^\circ + N \sin 30^\circ = mg$

$$\Rightarrow \sqrt{3} T + N = 2 mg \quad \dots\dots\dots(i)$$

$$T \sin 30^\circ - N \cos 30^\circ = \frac{mv^2}{(\sqrt{3}/2)} \quad \Rightarrow T \sin 30^\circ$$

$$- 3N = 4mv^2$$

$$\sqrt{3}T - 3N = 4mv^2 \quad \dots\dots\dots(ii)$$

$$\text{by (i),(ii)} \Rightarrow N = \frac{2mg - 4mv^2}{4} ; \quad T =$$

$$\frac{6mg - 4mv^2}{4\sqrt{3}}$$

$$\text{for } N > 0 \Rightarrow v < \sqrt{5} \text{ m/s}$$

$$\text{at } v = 2 \quad T = \frac{38}{\sqrt{3}} N ; \quad N = 2N.$$

Solution :

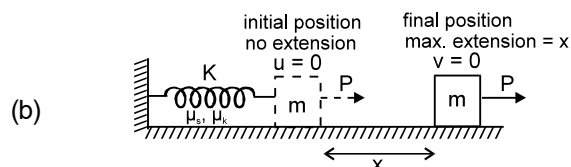
In P, Q and S; the centre of masses lie at $D/2$ height from the base level. Where as in R (cons) the com lies at $D/4$ height from the base.

Hence $U_p > U_q$.

Ans. (C).

6. (a) For motion to start

$$\frac{5\mu_k mg}{4} > \mu_s mg \quad \text{or } 5\mu_k > 4\mu_s$$



At the final position of the block extension in spring is

maximum and the speed of the block is $v = 0$. Hence the net work done in taking the block from initial to final position

$\Delta W =$ work done by P + work done by spring force F + work done by friction = 0

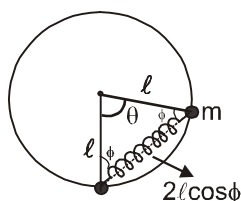
$$= P x - \int_0^x Kx^3 \cdot dx - \mu_k mgx = \frac{5\mu_k mg}{4} x - \frac{Kx^4}{4}$$

$$- \mu_k mgx = 0$$

solving we get $x = \left(\frac{\mu_k mg}{K} \right)^{1/3}$ **Ans.**

DPP NO. - 50

1. Length of spring at maximum = $2\ell \cos\phi$
 \therefore Extension is $x = (2\ell \cos\phi - \ell)$
 Now initial potential energy of the spring is converted into final PE of spring and gravitational PE.



$$\therefore \frac{1}{2} k \ell^2 = \frac{1}{2} k (2\ell \cos\phi - \ell)^2 + mg (\ell - \ell \cos\phi)$$

Putting values

$$\frac{1}{2} \times 10 \times 1^2 = \frac{1}{2} \times 10 (2 \cos\phi - 1)^2 + 10$$

$$- \cos\theta)$$

$$\therefore \theta = \pi - 2\phi$$

$$5 = 5 (2 \cos\phi - 1)^2 + 10 (1 + \cos 2\phi)$$

$$1 = (4 \cos^2\phi + 1 - 4\cos\phi) + 2(1 + 2\cos^2\phi - 1)$$

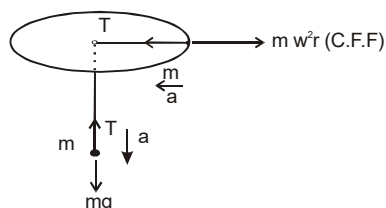
$$8 \cos^2\phi = 4 \cos\phi$$

$$\therefore \cos\phi = \frac{1}{2}$$

$$\therefore \phi = 60^\circ$$

$$\theta = 60^\circ$$

2. $T - m \omega^2 r = ma$



$$T - m \left(\frac{g}{3} \right) = ma \quad \longrightarrow \quad (1)$$

$$mg - T = ma \quad \longrightarrow \quad (2) \quad T - \frac{mg}{3} = mg - T$$

$$\Rightarrow 2T = 4 mg/3$$

$$\Rightarrow T = 2 mg/3 \quad \text{Ans. (B)}$$

3. **(B)** As both the balls are released simultaneously, at any instant before the lower balls reaches the ground both have the same velocity ; $v = gt$ i.e. 'v' vs. 't' is a straight line graph.

$$V_{CM} = \frac{mv(t) + mv(t)}{2m} = v(t) ; v(t) \text{ being the instantaneous velocity.}$$

Just after the lower ball strikes ground and comes to rest :

$$V_{CM} = \frac{mv(t)}{2m} = \frac{v(t)}{2}$$

i.e. the velocity suddenly drops to half its value.

Hence graphs (A) & (B) are chosen.

After collision :

$$a_{CM} = \frac{m(g) + m(0)}{m + m} = \frac{g}{2}$$

i.e. the slope (of v-t curve) should decrease to half.

Hence (B) is the best option.

4. $a_{av} = \frac{V_f - V_i}{\Delta t} = \frac{(\text{Slope at B}) - (\text{Slope at A})}{1s}$

$$= \frac{-1-1}{1} = -2 \text{ m/s}^2$$

5. $\Sigma m \Delta r_{cm} = m_1 \Delta r_1 + m_2 \Delta r_2$
 $= (m + 2m) (0) = m(x - 4) + 2m(x)$

$$\Rightarrow x = \frac{4}{3} \text{ cm.}$$

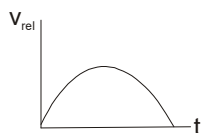
6. At any moment relative velocity $v_{rel} = v_A - v_B$
 It has same magnitude but different direction so

$$v_{rel} = \sqrt{v^2 + v^2 + 2v^2 \cos(180 - \theta)}$$

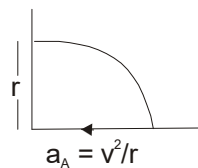
$$= \sqrt{2v^2(1 - \cos\theta)}$$

$$v_{rel} = \sqrt{2}v \sin \frac{\theta}{2}$$

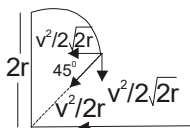
θ change with time t



7. For A



For B



$$= a_{rel} = \left\{ \left(\frac{v^2}{r} - \frac{v^2}{2\sqrt{2}r} \right) \hat{i} - \frac{v^2}{2\sqrt{2}r} \hat{j} \right\}$$

$$= |a_{rel}| = \frac{v^2}{2\sqrt{2}r} \left[(2\sqrt{2} - 1)^2 + 1^2 \right]$$

$$= \frac{v^2}{2\sqrt{2}r} \left[\sqrt{(2\sqrt{2} - 1)^2 + 1^2} \right]$$

$$= \frac{v^2}{2r} \sqrt{\frac{8 + 1 - 4\sqrt{2} + 1}{2}}$$

$$= \frac{v^2}{2r} \sqrt{\frac{10 - 4\sqrt{2}}{2}} = \frac{v^2}{2r} \sqrt{5 - 2\sqrt{2}}$$

$$= \frac{v^2}{2r} \sqrt{2.172} \quad (B)$$

8. For same angular speed ω

$$w = \frac{2\pi n}{t_1}$$

n : fractional revolution number of revolution

For 'A' $n = 1/4$

$$w = \frac{2\pi(1/4)}{t_1} \quad w = \left(\frac{v}{r} \right)$$

$$\frac{v}{r} = \frac{\pi}{2t_1} \quad \dots\dots (i)$$

For B car $t_1 = \left(\frac{\pi r}{2v} \right)$

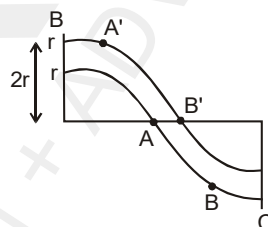
$$w = \frac{2\pi r}{t_2} = \left(\frac{\pi}{4t_2} \right) = \left(\frac{v}{2r} \right)$$

$$\frac{v}{r} = \left(\frac{\pi}{2t_2} \right)$$

So time interval for equal angular velocity

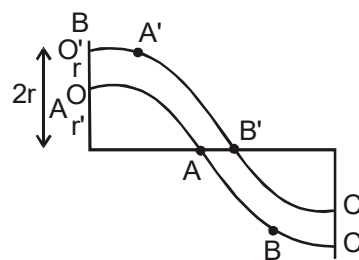
$$\Rightarrow \Delta t = \left(\frac{\pi r}{2v} \right) = t_1 = t_2$$

9. (A) Both have same linear speed at mean
 When A at A' than B at A'
 When A at B than B at B' When A at C then B at C'



(B) Friction for always towards centre to provide sufficient centripetal force $\frac{mv^2}{r}$

(C) From above diagram



For car A $\rightarrow O'$ to A $fs = \frac{mv^2}{r}$

For car B $\rightarrow O''$ to B' $fs' = \frac{mv^2}{2r}$

For A $\rightarrow A$ to C $= \frac{mv^2}{2r} = fs$

For B $\rightarrow B'$ to C' $= \frac{mv^2}{r} = fs'$