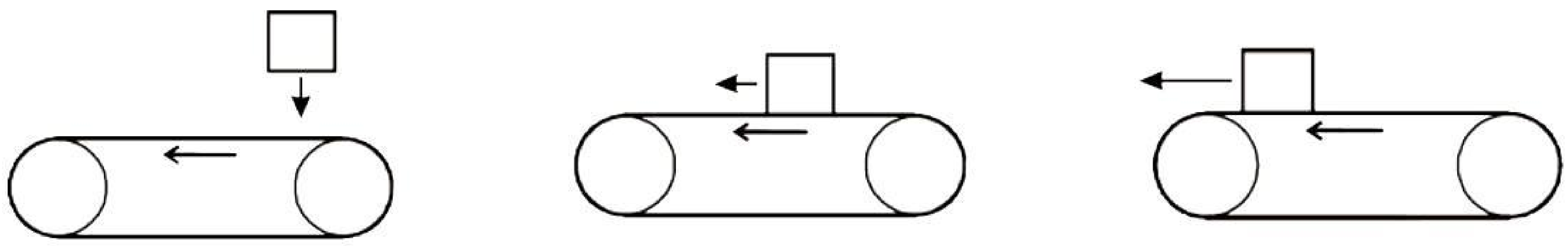
[SINGLE CORRECT CHOICE TYPE]

Q.1 A crate of mass m is dropped vertically onto a conveyor belt that is moving at v m/s. A motor maintains the belt's constant speed. The belt initially slides under the crate. After a short time, the crate is moving at the speed of the belt. During the period in which the crate is being accelerated, find the work done by the motor which drives the belt. **[3]**



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

Q.2 A uniform chain of mass 'm' and length ℓ is held on a horizontal frictionless table with $\frac{1}{n}$ th of its length hanging over the edge of the table. The wok done in pulling the chain up on the table is **[3]**

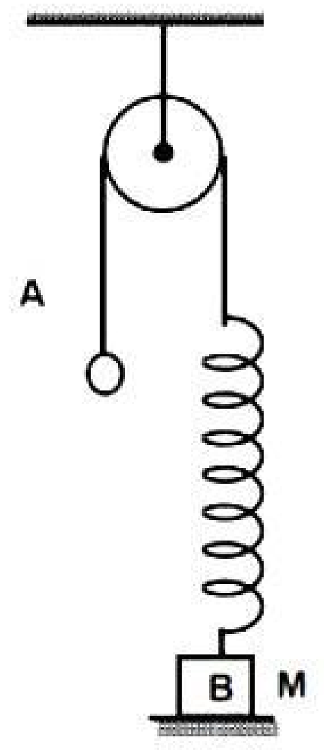
(A) $\frac{mg\ell}{n}$ (B) $\frac{mg\ell}{2n}$ (C) $\frac{mg\ell}{n^2}$ (D) $\frac{mg\ell}{2n^2}$

Q.3 A bullet is fired normally on a immovable wooden plank. It loses 25 % of its kinetic energy in penetrating a thickness x of the plank. What is the total thickness penetrated by the bullet ? **[3]**

(A) 2x (B) 4x (C) 6 x (D) 5x

Q.4 In the figure 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 **[3]**

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



Q.5 A uniform chain of mass M and length L lies on a frictionless table with length ℓ_0 hanging over the edge. The chain begins to slide down. Then the speed with which the end slides away from the edge is given by

(A) $v = \sqrt{\frac{g}{L}(L+\ell_0)}$ (B) $v = \sqrt{\frac{g}{L}(L-\ell_0)}$ (C) $v = \sqrt{\frac{g}{L}(L^2-\ell_0^2)}$ (D) $v = \sqrt{\frac{g}{L}(L^2+\ell_0^2)}$ **[3]**

Q.6 How much work is done in raising a stone of mass 5 Kg and relative density 3 lying at the bed of a lake through height of 3 metre? (Take $g = 10\ ms^{-2}$): **[3]**

(A) 25 J (B) 100 J (C) 75 J (D) None of the above

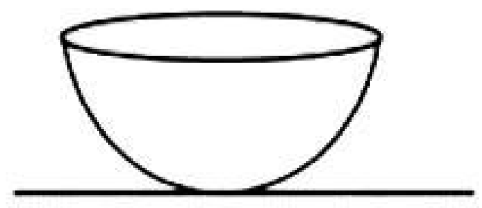
Q.7 A particle of mass m is moving in a horizontal circle of radius r under a centripetal force equal to $-\frac{K}{r^2}$, where K is a constant. Then KE of the particle will be **[3]**

(A) $\frac{K}{r^2}$ (B) kr (C) 2k/r (D) k/2r

Q.8 The kinetic energy K of a particle moving along a circle of radius R depends on the distance covered 's' as $K = as^2$ where 'a' is a constant. The force acting on the particle is **[3]**

(A) $\frac{2as^2}{R}$ (B) $2as\left(1+\frac{s^2}{R^2}\right)^{1/2}$ (C) 2as (D) 2a

Q.9 Work done in turning the thin hemispherical bowl of mass M and radius R upside down is **[3]**



(A) MgR/2 (B) $\frac{2}{3}$MgR (C) $\frac{4}{3}$MgR (D) Zero

Q.10 A particle rests on the top of a hemisphere of radius R. Find the smallest horizontal velocity that must be imparted to the particle if it is to leave the hemisphere without sliding down it. **[3]**

(A) $\sqrt{gR}$ (B) $\sqrt{2gR}$ (C) $\sqrt{3gR}$ (D) $\sqrt{5gR}$

Q.11 A particle of mass m moves on the x-axis under the influence of a force of attraction towards the origin O given by $F = -k/x^2\,\hat{i}$. If the particle starts from rest at a distance a from the origin the speed it will attain to reach the position x will be: **[3]**

(A) $\sqrt{\frac{2k}{m}}\left[\frac{a-x}{ax}\right]^{1/2}$ (B) $\sqrt{\frac{2k}{m}}\left[\frac{a+x}{ax}\right]^{1/2}$ (C) $\sqrt{\frac{k}{m}}\left[\frac{ax}{a-x}\right]$ (D) $\sqrt{\frac{m}{2k}}\left[\frac{a-x}{ax}\right]^{1/2}$

Q.12 The potential energy of a particle oscillating along x-axis is given as $U = 20 + (x-2)^2$ where U is in joules and x in meters. Total mechanical energy of the particle is 36 J. Maximum kinetic energy of the particle is **[3]**

(A) 24 J (B) 36 J (C) 16 J (D) 20 J

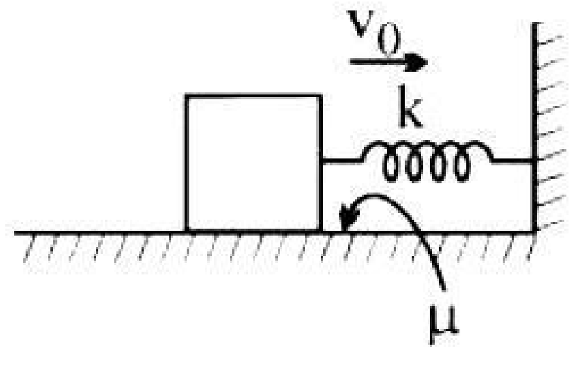
Q.13 A water pump is used to deliver the water at constant rate. By what factor power of pump should be increased to increase the rates n times ? **[3]**

(A) n (B) n^2 (C) n^3 (D) $n^{3/2}$

Q.14 A block of mass m is suspended by a light thread from an elevator. The elevator is accelerating upward with uniform acceleration 'a'. Work done during t sec by the tension in the thread is **[3]**

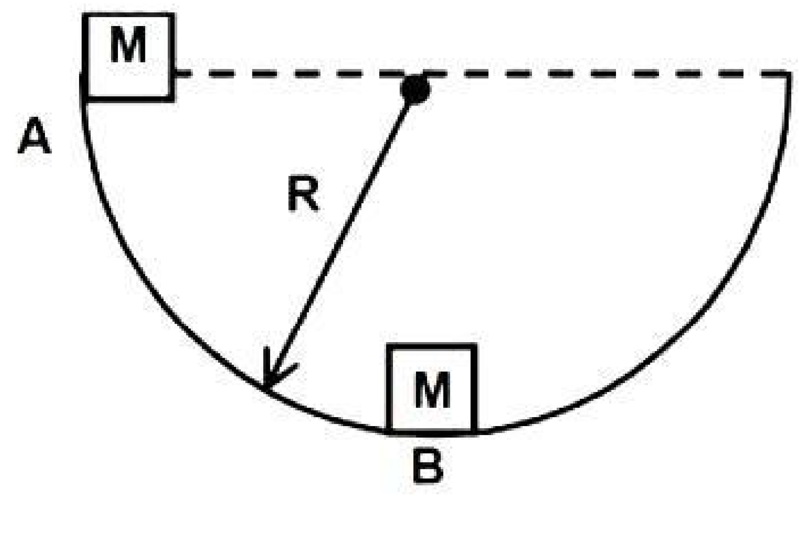
(A) $\frac{m}{2}(g+a)at^2$ (B) $\frac{m}{2}(g-a)at^2$ (C) $\frac{m}{2}gat^2$ (D) zero

Q.15 In the position shown, the spring is at its natural length. The block of mass m is given a velocity v_0 towards the vertical support at t = 0. The coefficient of friction between the block and the surface is given by $\mu = \alpha x$, where α is a positive constant and x is the position of the block from its starting position. The block comes to rest for the first time at x = **[3]**



(A) $v_0\sqrt{\frac{m}{k+\alpha mg}}$ (B) $v_0\sqrt{\frac{m}{k}}$ (C) $v_0\sqrt{\frac{m}{\alpha mg}}$ (D) None of these

Q.16 When a block of mass 'm' is released from point 'A' on the surface of a smooth bowl, the normal reaction force on it at B would be equal to **[3]**



(A) mg (B) 2mg

(C) 3mg (D) zero

Q.17 A person brings a mass of 1kg from infinity to a point 'A'. Initially the mass was at rest but it moves at a speed of 2m/s as it reached A. The work done by the person on the mass is –3J. The potential at 'A' is
(A) –3 J/kg (B) –2 J/kg (C) –5 J/kg (D) None of these **[3]**

Q.18 A block is attached to a horizontal spring of stiffness k. The other end of the spring is attached to a fixed wall. The entire system lie on a horizontal surface and the spring is in natural state. The natural length of the spring is ℓ_0. If the block is slowly lifted up vertically to a height $\frac{5}{12}\ell_0$ from its initial position, which of the following is correct? **[4]**

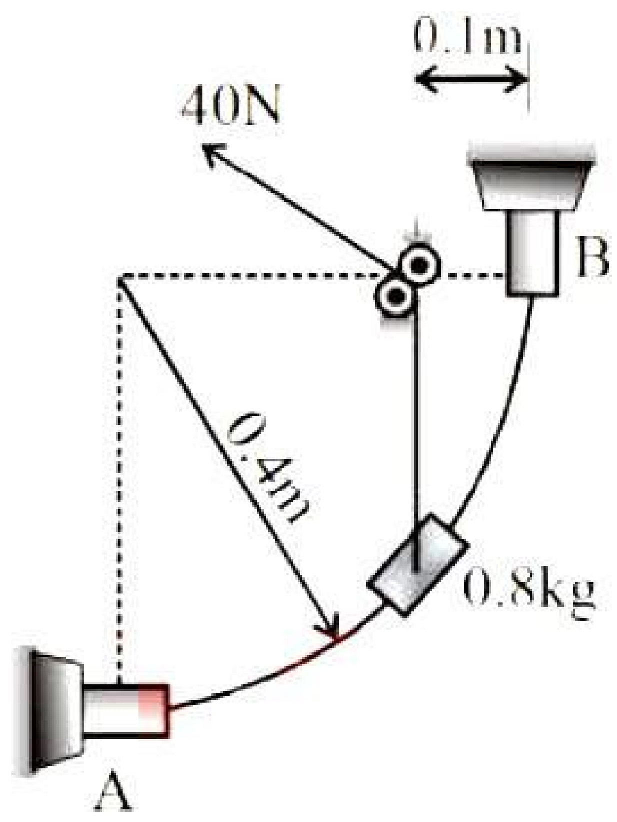
(A) The work done by the gravity = $\frac{5}{12}$ mg ℓ_0

(B) The work done by the spring force = + $\frac{k\ell_0^2}{288}$

(C) The work done by the lifting force = $\frac{5}{12}mg\ell_0 + \frac{k\ell_0^2}{288}$

(D) The sum of works done by all the forces on the block is non zero.

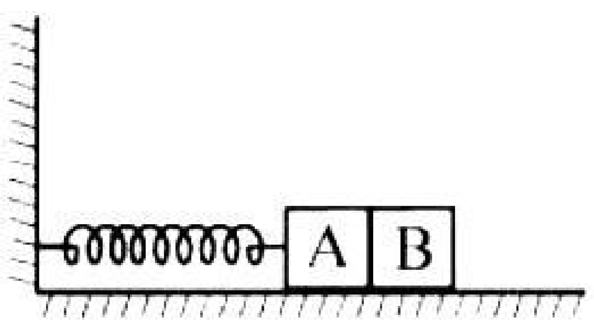
Q.19 The 0.8 kg collar slides freely on the fixed vertical circular rod. Calculate the velocity v of the collar as it hits the stop at B if it elevated from rest at A by the action of the constant 40N force in the cord. The cord is guided by the small fixed pulleys. **[3]**



(A) 4 m/s (B) $4\sqrt{2}$ m/s
(C) 32 m/s (D) 8 m/s

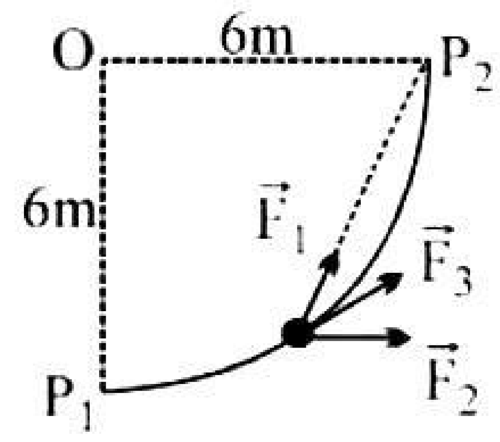
[MULTIPLE CORRECT CHOICE TYPE]

Q.20 A block A of mass 1 kg is in contact with another block of same mass. A is attached to a spring of natural length 1 m and spring constant 100 N/m. The coefficient of friction for both of them is same (μ = 0.2). The spring is initially compressed by 10 cm and released. What is a possible length of the spring when both blocks are in contact? **[4]**



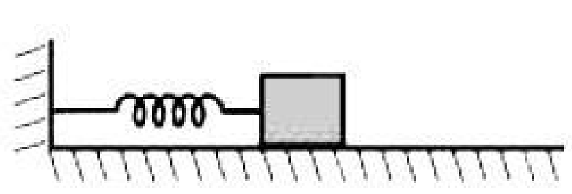
(A) 90 cm (B) 95 cm (C) 105 cm (D) 103 cm

Q.21 A smooth track in the form of a quarter circle of radius 6 m lies in the vertical plane. A particle moves from P_1 to P_2 under the action of forces $\vec{F}_1$, $\vec{F}_2$ and $\vec{F}_3$. Force $\vec{F}_1$ is always toward P_2 and is always 20 N in magnitude. Force $\vec{F}_2$ always acts horizontally and is always 30 N in magnitude. Force $\vec{F}_3$ always acts tangentially to the track and is of magnitude 15 N. Select the correct alternative(s) **[4]**



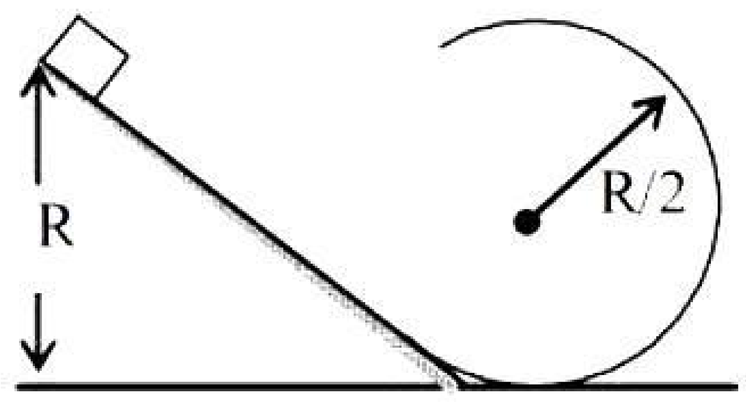
(A) work done by $\vec{F}_1$ is 120 J (B) work done by $\vec{F}_2$ is 180 J
(C) work done by $\vec{F}_3$ is 45 π (D) $\vec{F}_1$ is conservative in nature

Q.22 A spring block system is placed on a rough horizontal floor. The block is pulled towards right to give spring some elongation and released. Then **[4]**



(A) the block may stop before the spring attains its natural length.
(B) the block must stop with spring having some compression.
(C) the block may stop with spring having some compression.
(D) it is not possible that the block stops at mean position.

Q.23 A block of mass m is released on the frictionless incline as shown from a height R. The incline turns in to a circle of radius R/2. The maximum height attained by the block is **[4]**



(A) less than R/2
(B) greater than R/2
(C) equal to R
(D) less than R

Q.24 The potential energy of a particle of mass 1kg in a conservative field is given as $U = (3x^2y^2 + 6x)$ J, where x and y are measured in meter. Initially particle is at (1, 1) & at rest, then incorrect statement is: **[4]**

(A) $\vec{F} = -\left[(6xy^2 + 6)\hat{i} + 6x^2y\hat{j}\right]$

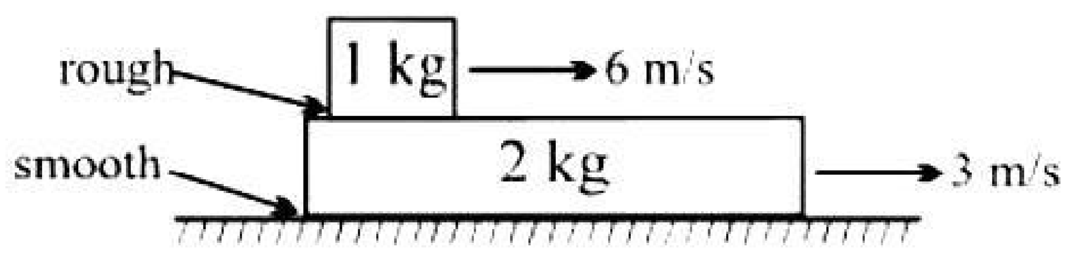
(B) Magnitude of initial acceleration of particle is $6\sqrt{5}$ ms^2.

(C) Work done to slowly bring the particle to origin is – 9 J.

(D) If particle is left free it moves in straight line.

[MATRIX TYPE]

Q.25 In the figure shown, upper block is given a velocity 6 m/s and very long plank, velocity 3m/s. The following quantities are to be matched when both attain same velocity. **[6]**



	Column I		**Column II**
(A)	Work done by friction on 1 kg block in Joule	(P)	Positive
(B)	Work done by friction on 2 kg plank in Joule	(Q)	Negative
(C)	Magnitude of change in momentum in N-s of 2kg plank	(R)	3
(D)	Change in K.E. of system consisting of block and plank in joule	(S)	7
		(T)	2

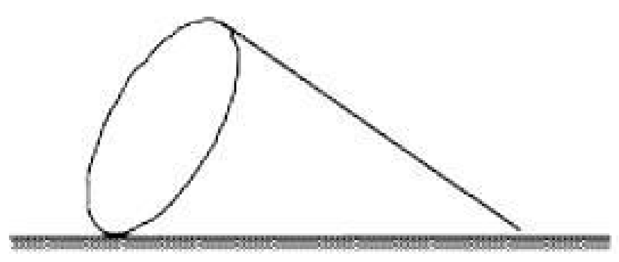
Q.26 Match the column **[6]**

Column-I | **Column-II**

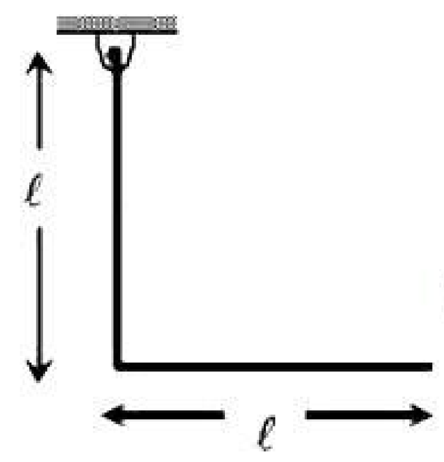
(A) 

mass m

(P) In stable equilibrium

(B)  solid cone

(Q) In unstable equilibrium

(C) 

uniform L shaped rod.

(R) In neutral equilibrium

(S) Not in equilibrium

ANSWER KEY

Q.1	B	Q.2	D	Q.3	B	Q.4	C	Q.5	C	Q.6	B	Q.7	D
Q.8	B	Q.9	D	Q.10	A	Q.11	A	Q.12	C	Q.13	C	Q.14	A
Q.15	A	Q.16	C	Q.17	C	Q.18	C	Q.19	B	Q.20	A,B		
Q.21	B,C,D	Q.22	A,C	Q.23	B, D	Q.24	D	Q.25	(A) Q; (B) P,S; (C) P,T; (D) R, Q				
Q.26	(A) P (B) P,R (C) S												

HINTS & SOLUTIONS

Q.1 (B)

$$W_{motor} + W_{fr} = \Delta K = \frac{1}{2} mv^2$$

as seen from belts frame,

$$w_{friction} = \text{heat dissipated} = -\frac{1}{2} mv^2$$

$$w_{motor} = mv^2$$

Q.19 (B)

$W_T + W_g = \Delta KE$

$40 \times (0.5 - 0.1) - 0.8 \times 10 \times 0.4 = 1/2\ mv^2 - 0$

Q.20 (A)

Contact between them will be maintained until the spring reaches its natural length.

Q.21 (BCD)

Work done by F_2 is $W_2 = 30 \times 6 = 180$ J

Work done by F_3 is $W_3 = 15 \times \left(\frac{2\pi \times 6}{4}\right) = 45\ \pi J$

$\vec{F}_1$ is a central force with a constant magnitude. So its work done depends on initial & find positons only.]

Q.24 (D)

Force on the particle will be given as $\vec{F} = \nabla U$

$$= \frac{\partial U}{\partial x}\hat{i} - \frac{\partial U}{\partial y}\hat{j} = -(6xy^2 + 6)\hat{i} - (6x^2y)\hat{j}$$

Now, for acceleration at (t = 0) and x = 1, y = 1

$$\vec{a} = \frac{\vec{F}}{M} = 12\hat{i} - 6\hat{j}$$

$$|\vec{a}| = \sqrt[6]{5}\ m/s^2$$

Particle is at rest at x = 1, y = 1, then

P.E. + K.E. = M.E.

u (1, 1) + K.E. (1, 1) = M.E.

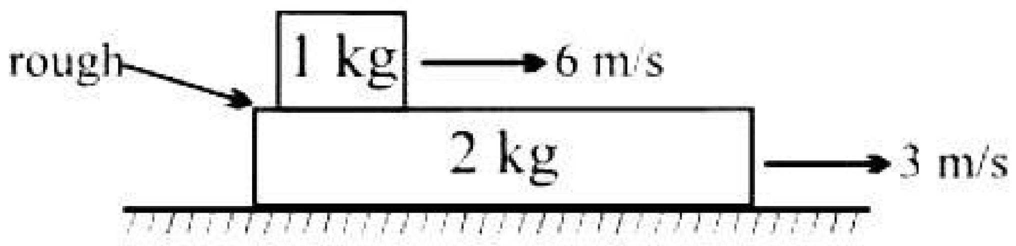
$\Rightarrow$ M.E. = 9 J

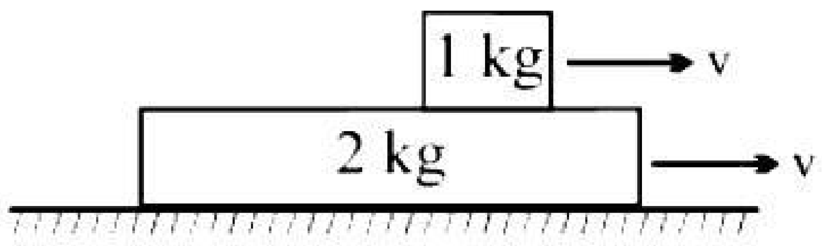
$\Delta U + \Delta K = \Delta W$

$\Delta W = \Delta U = U(0, 0) - U(1, 1)$

$\Delta W = -9$ J

Q.25 (A) Q; (B) P,S; (C) P,T; (D) R, Q





When relative motion stop, both block will move with same velocity v, momentum conservation gives,

$$1 \times 6 + 2 \times 3 = 3v$$

$\Rightarrow$ $v = 4$ m/s

Work done by friction on block = change in K.E.

(A) $\Rightarrow$ $W_{f1} = \frac{1}{2} \times 1 \times (4)^2 - \frac{1}{2} \times 1 \times (6)^2 = -10$ J

(B) $W_{f2} = \frac{1}{2} \times 2 \times (4)^2 - \frac{1}{2} \times 2 \times (3)^2 = 7$ J

(C) $4 \times 2 - 3 \times 2 = 2$ N-s

(D) Now total work done by friction = $(-10 + 7) = -3$J

$\therefore$ Total change in K.E. = -3J