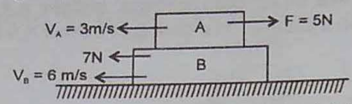
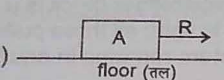
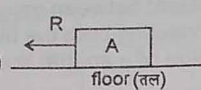
6.16 In the following figure, find the direction of friction on the blocks and ground respectively .

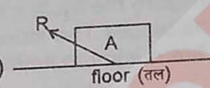


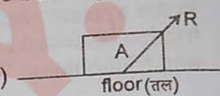
(A) Block A (left), block B(right due to block A, right due to ground)
(B) Block A (right), block B(left due to block A, left due to ground)
(C) Block A (right), block B(left due to block A, right due to ground)
(D) Block A (left), block B(left due to block A, left due to ground)

6.17 A box 'A' is lying on the horizontal floor of the compartment of a train running along horizontal rails from left to right. At time 't', it decelerates. Then the reaction R by the floor on the box is given best by :

(A) 

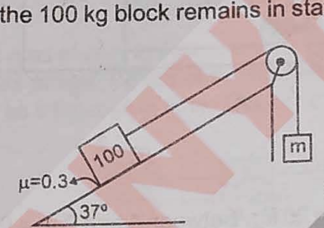
(B) 

(C) 

(D) 

SECTION - II : MULTIPLE CORRECT ANSWER TYPE

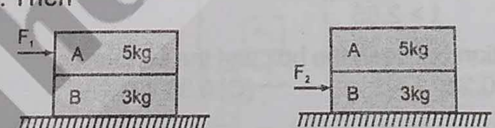
6.18 The value of mass m for which the 100 kg block remains in static equilibrium is :



(A) 35 kg   (B) 37 kg   (C) 83 kg   (D) 85 kg

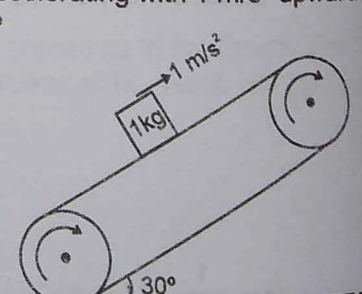
6.19 The force F_1 that is necessary to move a body up an inclined plane is double the force F_2 that is necessary to just prevent it from sliding down, then :
(A) $F_2 = w \sin(\theta - \phi) \sec\phi$ (B) $F_1 = w \sin(\theta - \phi) \sec\phi$
(C) $\tan\phi = 3\tan\theta$ (D) $\tan\theta = 3\tan\phi$

6.20 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

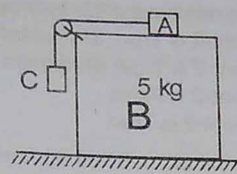
6.21 A block of mass 1 kg is stationary with respect to a conveyer belt that is accelerating with 1 m/s^2 upwards at an angle of 30° as shown in figure. Which of the following is/are correct?
(A) Force of friction on block is 6 N upwards.
(B) Force of friction on block is 1.5 N upwards.



(C) Contact force between the block & belt is 10.5 N.

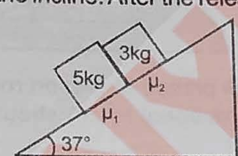
(D) Contact force between the block & belt is $5\sqrt{3}$ N.

6.22 All the blocks shown in the figure are at rest. The pulley is smooth and the strings are light. Coefficient of friction at all the contacts is 0.2. A frictional force of 10 N acts between A and B. The block A is about to slide on block B. The normal reaction and frictional force exerted by the ground on the block B is.



(A) The normal reaction exerted by the ground on the block B is 110N
(B) The normal reaction exerted by the ground on the block B is 50 N
(C) the frictional force exerted by the ground on the block B is 20N
(D) the frictional force exerted by the ground on the block B is zero

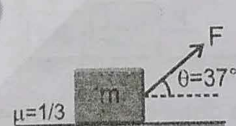
6.23 Two blocks of masses 5 kg and 3kg are placed in contact over an inclined surface of angle 37°, as shown. μ_1 is friction coefficient between 5kg block and the surface of the incline and similarly, μ_2 is friction coefficient between the 3kg block and the surface of the incline. After the release of the blocks from the inclined surface,



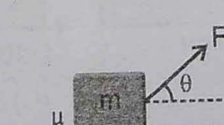
(A) if $\mu_1 = 0.5$ and $\mu_2 = 0.3$ then 5 kg block exerts 3N force on the 3 kg block
(B) if $\mu_1 = 0.5$ and $\mu_2 = 0.3$ then 5 kg block exters 8 N force on the 3 kg block
(C) if $\mu_1 = 0.3$ and $\mu_2 = 0.5$ then 5 kg block exerts 1 N force on the 3kg block.
(D) if $\mu_1 = 0.3$ and $\mu_2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

SECTION - III : ASSERTION AND REASON TYPE

6.24 **Statement-1 :** A block of mass m is placed at rest on rough horizontal surface. The coefficient of friction between the block and horizontal surface is $\mu = \frac{1}{3}$. The minimum force F applied at angle $\theta = 37°$ (as shown in figure) to pull the block horizontally is not equal to μmg. (Take $\sin 37° = \frac{3}{5}$, $\cos 37° = \frac{4}{5}$)



Statement-2 : For a block of mass m placed on rough horizontal surface, the minimum horizontal force required to pull the block is μmg. The minimum force F applied at angle θ (as shown in figure) to pull the block horizontally may be less than μmg. (Where μ is co-efficient of friction).



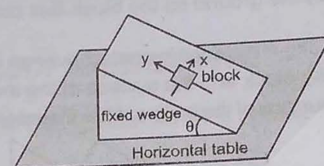
(A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.
(B) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1
(C) Statement-1 is True, Statement-2 is False
(D) Statement-1 is False, Statement-2 is True

6.25 **Statement-1 :** A body is lying at rest on a rough horizontal surface. A person accelerating with acceleration $a\hat{i}$ (where a is positive constant and $\hat{i}$ is a unit vector in horizontal direction) observes the body. With respect to him, the block experiences a kinetic friction.

Statement-2 : Whenever there is relative motion between the contact surfaces then kinetic friction acts.

(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

6.26 **Statement-1 :** A fixed wedge of inclination θ lies on horizontal table. x and y axes are drawn on inclined surface as shown, such that x axis is horizontal and y-axis is along line of greatest slope. A block of mass m is placed (at rest) on inclined surface at origin. The coefficient of friction between block and wedge is μ, such that $\tan\theta = \mu$. Then a force $F > \mu mg \cos\theta$ applied to block parallel to inclined surface and along x-axis can move the block along x-axis.



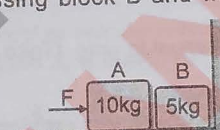
Statement-2 : To move the block placed at rest on rough inclined surface along the inclined surface, the net force on block (except frictional force) should be greater than μN. (N = normal reaction on block).

(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

SECTION - IV : COMPREHENSION TYPE

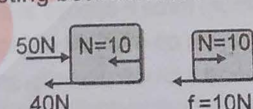
Comprehension # 1

Two bodies A and B of masses 10 kg and 5 kg are placed very slightly separated as shown in figure. The coefficients of friction between the floor and the blocks are as $\mu_s = \mu_k = 0.4$. 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 –



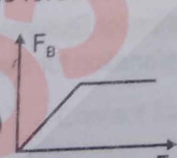
6.27 If F = 20 N, with how much force does block A presses the block B
(A) 10 N (B) 20 N (C) 30 N (D) Zero

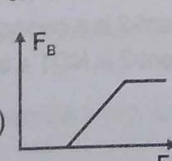
6.28 If F = 50 N, the friction force acting between block B and ground will be :

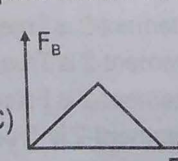


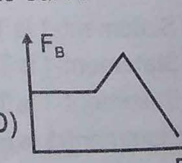
(A) 10 N (B) 20 N (C) 30 N (D) None

6.29 The force of friction acting on B varies with the applied force F according to curve :

(A) 

(B) 

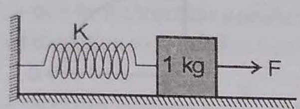
(C) 

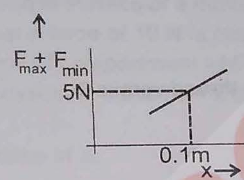
(D) 

Comprehension # 2

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, $F_{max} - F_{min} = 2$ N.

Also shown is the variation of $F_{max} + F_{min}$ versus x, the elongation of the spring.





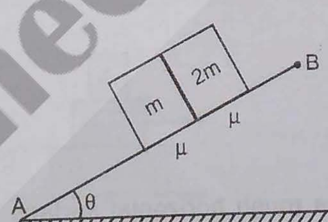
6.30 The coefficient of friction between the block and the horizontal surface is :
(A) 0.1 (B) 0.2 (C) 0.3 (D) 0.4

6.31 The spring constant of the spring is:
(A) 25 N/m (B) 20 N/m (C) 2.5 N/m (D) 50 N/m

6.32 The value of F_{min} , if x = 3 cm is :
(A) 0 (B) 0.2N (C) 5N (D) 1N

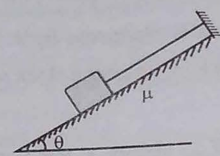
SECTION - V : MATRIX - MATCH TYPE

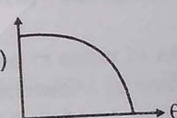
6.33 Two blocks of mass m and 2m are slowly just placed in contact with each other on a rough fixed inclined plane as shown. Initially both the blocks are at rest on inclined plane. The coefficient of friction between either block and inclined surface is μ. There is no friction between both the blocks. Neglect the tendency of rotation of blocks on the inclined surface. Column I gives four situation. Column II gives condition under which statements in column I are true. Match the statement in column I with corresponding conditions in column II.



Column I	Column II
(A) The magnitude of acceleration of both blocks are same if	(p) $\mu = 0$
(B) The normal reaction between both the blocks is zero if	(q) $\mu > 0$
(C) The net reaction exerted by inclined surface on each block make same angle with inclined surface (AB) if	(r) $\mu > \tan\theta$
(D) The net reaction exerted by inclined surface on block of mass 2m is double that of net reaction exerted by inclined surface on block of mass m if	(s) $\mu < \tan\theta$
	(t) $\mu = \tan\theta$

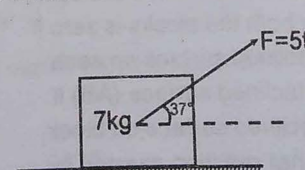
6.34 A block of mass m is put on a rough inclined plane of inclination θ, and is tied with a light thread shown. Inclination θ is increased gradually from θ = 0° to θ = 90°. Match the columns according to corresponding curve.



Column I	Column II
(A) Tension in the thread versus θ	(p) 
(B) Normal reaction between the block and the incline versus θ	(q) 
(C) friction force between the block and the incline versus θ	(r) 
(D) Net interaction force between the block and the incline versus θ	(s) 
	(t) 

SECTION - VI : INTEGER TYPE

6.35 A block of 7 kg is placed on a rough horizontal surface and is pulled through a variable force F(in N) = 5t, where 't' is time in second, at an angle of 37° with the horizontal as shown in figure. The coefficient of static friction of the block with the surface is one. If the force starts acting at t = 0 s, Find the time (in sec.) at which the block starts to slide. (Take g = 10 m/s^2) :



6.36 The rear side of a t... shown. The coeffici... truck starts from re... the box fall off the...

6.37 A block of mass... an observer sitti... move the box ir... horizontal direc... the block and t...

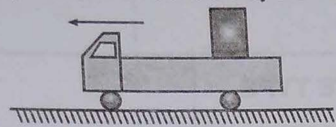
LONG SUBJECTIV...

6.38 A block of ma... surface. The... each mass a... pulley is pull... acceleratior...

6.39 In the figu... between A... force 'F(ir... 5 kg.

6.40 In the f... friction... B, up...

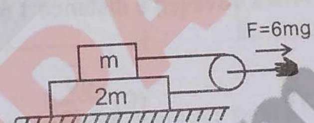
6.36 The rear side of a truck is open and a box of 40 kg mass is placed 5 m away from the open end as shown. The coefficient of friction between the box & the surface below it is 0.15. On a straight road, the truck starts from rest and accelerates with 2 ms^{-2}. At what distance (in m.) from the starting point does the box fall off the truck (i.e. distance travelled by the truck)? [Ignore the size of the box]



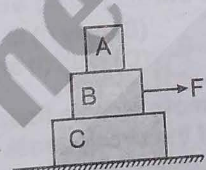
6.37 A block of mass 5 kg is placed on a rough horizontal surface of a moving compartment . It is seen by an observer sitting inside the compartment, that a force of 10 N is required in horizontal direction to move the box in a direction parallel to the motion of compartment while a force of 20 N is required in horizontal direction to move the box in opposite direction. If coefficient of friction between the surface of the block and the surface is $\frac{X}{10}$ then find out value of X.

LONG SUBJECTIVE

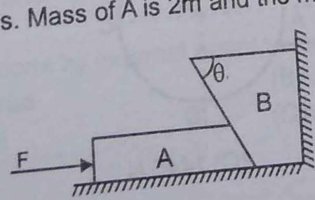
6.38 A block of mass m is placed on top of a block of mass 2m which in turn is placed on fixed horizontal surface. The coefficient of friction between all surfaces is $\mu = 1$. A massless string is connected to each mass and wraps halfway around a massless and frictionless pulley, as shown in the figure. The pulley is pulled by horizontal force of magnitude F = 6 mg towards right as shown. If the magnitude of acceleration of pulley is $\frac{X}{2}$ m/s², fill the value of X. (Take g = 10 m/s²)



6.39 In the figure shown, the coefficient of static friction between C and ground is 0.5, coefficient of static friction between A and B is 0.25, coefficient of static friction between B and C is zero. Find the minimum value of force 'F(in Newton)', to cause sliding between A and B. Masses of A, B and C are respectively 2 kg, 4 kg and 5 kg.



6.40 In the figure shown, the coefficient of static friction between B and the wall is 2/3 and the coefficient of kinetic friction between B and the wall is 1/3. Other contacts are smooth. Find the minimum force 'F' required to lift B, up. It is $\frac{xmg}{2}$ then x is. Mass of A is 2m and the mass of B is m. Take tan θ = 3/4.



TOPIC 7 WORK, POWER & ENERGY

SECTION - I : STRAIGHT OBJECTIVE TYPE

7.1 Work done by static friction on an object:
(A) may be positive (B) must be negative (C) must be zero (D) none of these

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

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

7.3 The potential energy of a particle of mass m free to move along x-axis is given by $U = \frac{1}{2}kx^2$ for $x < 0$ and $U = 0$ for $x \geq 0$ (x denotes the x-coordinate of the particle and k is a positive constant). If the total mechanical energy of the particle is E, then its speed at $x = -\sqrt{\frac{2E}{k}}$ is

(A) zero (B) $\sqrt{\frac{2E}{m}}$ (C) $\sqrt{\frac{E}{m}}$ (D) $\sqrt{\frac{E}{2m}}$

7.4 The blocks A and B shown in the figure have masses $M_A = 5$ kg and $M_B = 4$ kg. The system is released from rest. The speed of B after A has travelled a distance 1 m along the incline is

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

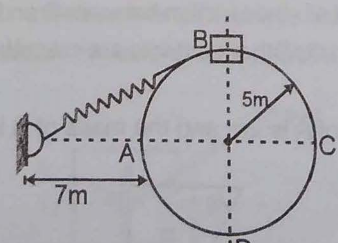
7.5 Of the sentences given

(i) Internal forces acting on the system cannot change $\frac{1}{2}mv_{cm}^2$, where m is the total mass of the system.

(ii) Internal forces acting on a system cannot change kinetic energy of system with respect to centre of mass

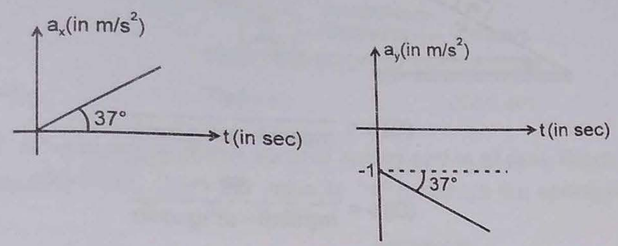
(A) both (i) and (ii) are correct (B) only (i) is correct
(C) only (ii) is correct (D) Both (i) and (ii) are wrong.

7.6 A collar 'B' of mass 2 kg is constrained to move along a horizontal smooth and fixed circular track of radius 5 m. The spring lying in the plane of the circular track and having spring constant 200 N/m is undeformed when the collar is at 'A'. If the collar starts from rest at 'B', the normal reaction exerted by the track on the collar when it passes through 'A' is :



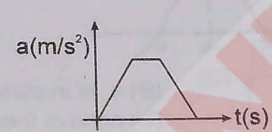
(A) 360 N (B) 720 N (C) 1440 N (D) 2880 N

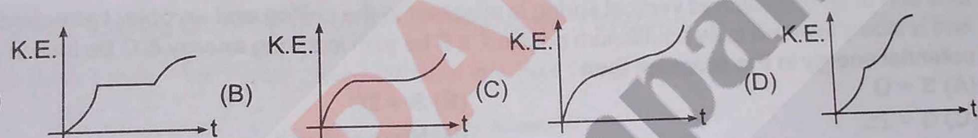
7.7 In the figure the variation of components of acceleration of a particle of mass 1 kg is shown w.r.t. time. The initial velocity of the particle is $\vec{u} = (-3\hat{i} + 4\hat{j})$ m/s. The total work done by the resultant force on the particle in time interval from t = 0 to t = 4 seconds is :



(A) 22.5 J (B) 10 J (C) 0 (D) None of these

7.8 For a particle moving on a straight line the variation of acceleration with time is given by the graph as shown. Initially the particle was at rest. Then the corresponding kinetic energy of the particle versus time graph will be

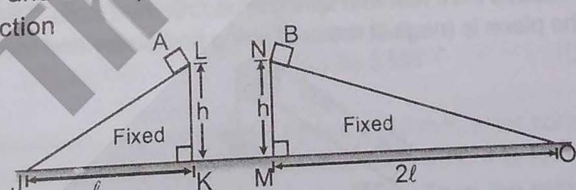




7.9 The potential energy (in SI units) of a particle of mass 2 kg in a conservative field is U = 6x – 8y. If the initial velocity of the particle is $\vec{u} = -1.5\,\hat{i} + 2\,\hat{j}$ then the total distance travelled by the particle in first two seconds is :

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

7.10 Two identical blocks A and B are placed on two inclined planes as shown in diagram. Neglect air resistance and other friction



Read the following statements and choose the correct options.

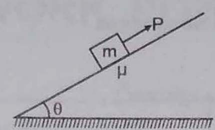
Statements I : Kinetic energy of 'A' on sliding to J will be greater than the kinetic energy of B on falling to M.

Statements II : Acceleration of 'A' will be greater than acceleration of 'B' when both are released to slide on inclined plane

Statements III : Work done by external agent to move block slowly from position B to O is negative

(A) only statement I is true (B) only statement II is true
(C) only I and III are true (D) only II and III are true

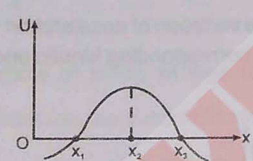
7.11 A block of mass m is being pulled up the rough incline by an agent delivering constant power P. The coefficient of friction between the block and the incline is μ. The maximum speed of the block during the course of ascent is



(A) $v = \frac{P}{mg\sin\theta + \mu mg\cos\theta}$ (B) $v = \frac{P}{mg\sin\theta - \mu mg\cos\theta}$

(C) $v = \frac{2P}{mg\sin\theta - \mu mg\cos\theta}$ (D) $v = \frac{3P}{mg\sin\theta - \mu mg\cos\theta}$

7.12 In the figure shown the potential energy U of a particle is plotted against its position 'x' from origin. Then which of the following statement is correct.

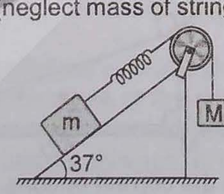


(A) x_1 is in stable equilibrium (B) x_2 is in stable equilibrium
(C) x_3 is in stable equilibrium (D) none of these

7.13 One end of an unstretched vertical spring is attached to the ceiling and an object attached to the other end is slowly lowered to its equilibrium position. If S be gain in spring energy & G be loss in gravitational potential energy in the process, then
(A) S = G (B) S = 2G
(C) G = 2S (D) None of these

7.14 The potential energy function associated with the force $\vec{F} = 4xy\hat{i} + 2x^2\hat{j}$ is :
(A) $U = -2x^2y$ (B) $U = -2x^2y$ + constant
(C) $U = 2x^2y$ + constant (D) not defined

7.15 A block of mass m is attached with a massless spring of force constant k. The block is placed over a fixed rough inclined surface for which the coefficient of friction is $\mu = \frac{3}{4}$. The block of mass m is initially at rest. The block of mass M is released from rest with spring in unstretched state. The minimum value of M required to move the block up the plane is (neglect mass of string and pulley and friction in pulley.)

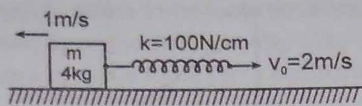


(A) $\frac{3}{5}m$ (B) $\frac{4}{5}m$ (C) $\frac{6}{5}m$ (D) $\frac{3}{2}m$

7.16 The potential energy for a force field $\vec{F}$ is given by U (x,y) = cos (x + y). The force acting on a particle at position given by coordinates $\left(0, \frac{\pi}{4}\right)$ is :-

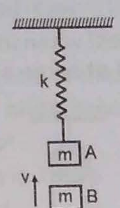
(A) $-\frac{1}{\sqrt{2}}(\hat{i}+\hat{j})$ (B) $\frac{1}{\sqrt{2}}(\hat{i}+\hat{j})$ (C) $\left(\frac{1}{2}\hat{i}+\frac{\sqrt{3}}{2}\hat{j}\right)$ (D) $\left(\frac{1}{2}\hat{i}-\frac{\sqrt{3}}{2}\hat{j}\right)$

7.17 The spring block system lies on a smooth horizontal surface. The free end of the spring is being pulled towards right with constant speed $v_0 = 2$m/s. At t = 0 sec, the spring of constant k = 100 N/cm is unstretched and the block has a speed 1 m/s to left. The maximum extension of the spring is



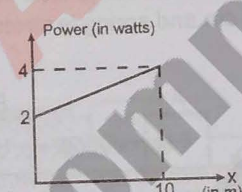
(A) 2 cm (B) 4 cm (C) 6 cm (D) 8 cm

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



(A) $\sqrt{\frac{60\ mg^2}{k}}$ (B) $\sqrt{\frac{6\ mg^2}{k}}$ (C) $\sqrt{\frac{10\ mg^2}{k}}$ (D) none of these

7.19 A particle A of mass $\frac{10}{7}$ kg is moving in the positive x direction. Its initial position is x = 0 & initial velocity is 1 m/s. The velocity at x = 10 is in m/s (use the graph given)



(A) 4 m/s (B) 2 m/s (C) $3\sqrt{2}$ m/s (D) 100/3 m/s

7.20 A fire hose has a diameter of 2.5 cm and is required to direct a jet of water to a height of at least 40 m. The minimum power of the pump needed for this hose is :

(A) 21.5 kW (B) 40 kW (C) 36.5 kW (D) 48 kW

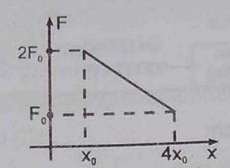
7.21 A particle is projected vertically upwards with a speed of 16 m/s, after some time, when it again passes through the point of projection, its speed is found to be 8 m/s. It is known that the work done by air resistance is same during upward and downward motion. Then the maximum height attained by the particle is (Take g = 10 m/s^2) :

(A) 8 m (B) 4.8 m (C) 17.6 m (D) 12.8 m

7.22 An engine can pull 4 coaches at a maximum speed of 20 m/s. Mass of the engine is twice the mass of every coach. Assuming resistive forces to be proportional to the weight, approximate maximum speeds in m/s of the engine when it pulls 6 coaches are (power of engine remains constant) :

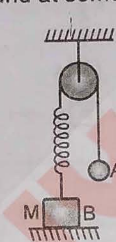
(A) 8.5 m/s and 15 m/s respectively
(B) 6.5 m/s and 8 m/s respectively
(C) 8.5 m/s and 13 m/s respectively
(D) 10.5 m/s and 15 m/s respectively

7.23 A particle of mass m moving along a straight line experiences force F which varies with the distance x travelled as shown in the figure. If the velocity of the particle at x_0 is $\sqrt{\dfrac{2F_0x_0}{m}}$, then velocity at $4x_0$ is:-



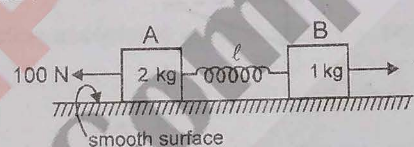
(A) $2\sqrt{\dfrac{2F_0x_0}{m}}$ (B) $2\sqrt{\dfrac{F_0x_0}{m}}$ (C) $\sqrt{\dfrac{F_0x_0}{m}}$ (D) none of these

7.24 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) 2 M (B) M (C) M/2
(D) A function of M and the force constant of the spring.

7.25 In the figure shown initially spring is in unstretched state & blocks are at rest. Now 100 N force is applied on block A & B as shown in the figure. After some time velocity of 'A' becomes 2 m/s & that of 'B' is 4 m/s & block A displaced by amount 10 cm and spring is stretched by amount 30 cm. Then work done by spring (in joule) force on A will be :



(A) 9/3 J (B) – 6 J (C) 6 J (D) None of these

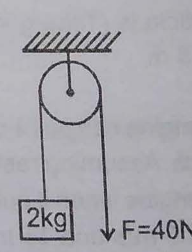
SECTION - II : MULTIPLE CORRECT ANSWER TYPE

7.26 Which of the following is/are conservative force(s) ?

(A) $\vec{F} = 2r^3\hat{r}$ (B) $\vec{F} = -\dfrac{5}{r}\hat{r}$

(C) $\vec{F} = \dfrac{3(x\hat{i}+y\hat{j})}{(x^2+y^2)^{3/2}}$ (D) $\vec{F} = \dfrac{3(y\hat{i}+x\hat{j})}{(x^2+y^2)^{3/2}}$

7.27 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. The kinetic energy of the particle increase 40 J in a given interval of time. Then : (g = 10 m/s²)



(A) tension in the string is 40 N
(B) displacement of the block in the given interval of time is 2 m
(C) work done by gravity is – 20 J
(D) work done by tension is 80 J

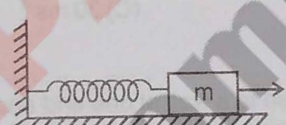
7.28 There are two massless springs A and B of spring constant K_A and K_B respectively and $K_A > K_B$. If W_A and W_B be denoted as work done on A and work done on B respectively, then
(A) If they are compressed to same distance, $W_A > W_B$
(B) If they are compressed by same force (upto equilibrium state) $W_A < W_B$
(C) If they are compressed by same distance, $W_A = W_B$
(D) If they are compressed by same force (upto equilibrium state) $W_A > W_B$

7.29 Work done by a force on an rigid object having no rotational motion will be zero, if :
(A) the force is always perpendicular to acceleration of object.
(B) the object is at rest relative to ground but the point of application of force moves on the object.
(C) the force is always perpendicular to velocity of object.
(D) The point of application of force is fixed relative to ground but the object moves.

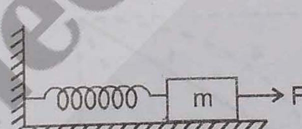
7.30 The potential energy (in joules) of a particle of mass 1kg moving in a plane is given by $V = 3x + 4y$, the position coordinates of the point being x and y, measured in metres. If the particle is at rest at (6, 4) ; then
(A) its acceleration is of magnitude $5 m/s^2$
(B) its speed when it crosses the y–axis is 10m/s
(C) it crosses the y-axis ($x = 0$) at $y = -4$
(D) it moves in a striaght line passing through the origin (0, 0)

SECTION - III : ASSERTION AND REASON TYPE

7.31 **Statement-1 :** One end of ideal massless spring is connected to fixed vertical wall and other end to a block of mass m initially at rest on smooth horizontal surface. The spring is initially in natural length. Now a horizontal force F acts on block as shown. Then the maximum extension in spring is equal to maximum compression in spring.



Statement-2 : To compress and to expand an ideal unstretched spring by equal amount, same work is to be done on spring.



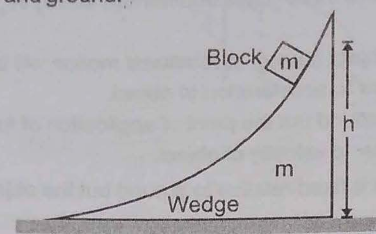
(A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.
(B) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1
(C) Statement-1 is True, Statement-2 is False
(D) Statement-1 is False, Statement-2 is True

7.32 **Statement-1 :** work done by friction is always negative
Statement-2 : If frictional force acts on a body its K.E. may decrease.
(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

SECTION - IV : COMPREHENSION TYPE

Comprehension # 1

A block of mass m slides down a wedge of mass m as shown. The whole system is at rest, when the height of the block is h = 10 m. Above the ground. The wedge surface is smooth and gradually flattens. There is no friction between wedge and ground.



Smooth ground

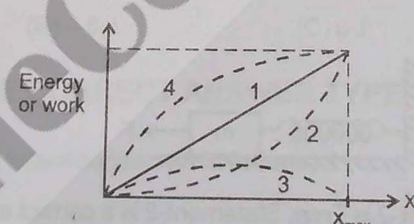
7.33 As the block slides down, which of the following quantities associated with the system remains conserved?
(A) Total linear momentum of the system of wedge and block
(B) Total mechanical energy of the complete system
(C) Total kinetic energy of the system
(D) Both linear momentum as well as mechanical energy of the system

7.34 If there would have been friction between wedge and block, which of the following quantities would still remain conserved ?
(A) Linear momentum of the system along horizontal direction
(B) Linear momentum of the system along vertical direction
(C) Linear momentum of the system along a tangent to the curved surface of the wedge
(D) Mechanical energy of the system

7.35 If there is no friction any where, the speed of the wedge, as the block leaves the wedge is :
(A) 10 ms^{-1} (B) 20 ms^{-1} (C) 30 ms^{-1} (D) None of these

Comprehension # 2

A spring lies along an x axis attached to a wall at one end and a block at the other end. The block rests on a frictionless surface at x = 0. A force of constant magnitude F is applied to the block that begins to compress the spring, until the block comes to a maximum displacement x_{max}.



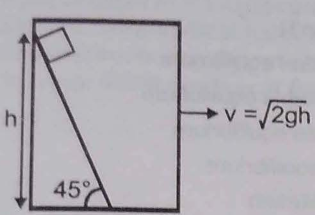
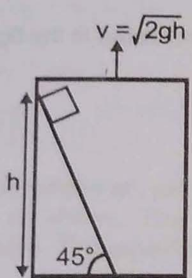
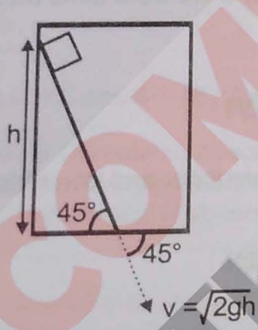
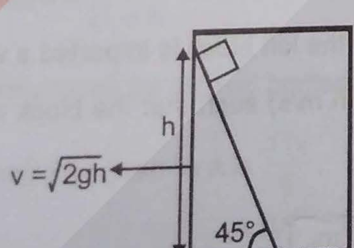
7.36 During the displacement, which of the curves shown in the graph best represents the kinetic energy of the block.
(A) 1 (B) 2 (C) 3 (D) 4

7.37 During the displacement, which of the curves shown in the graph best represents the work done on the spring block system by the applied force.
(A) 1 (B) 2 (C) 3 (D) 4

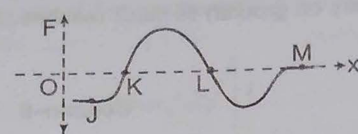
7.38 During the first half of the motion, applied force transfers more energy to the
(A) kinetic energy (B) potential energy
(C) equal to both (D) depends upon mass of the block

SECTION - V : MATRIX - MATCH TYPE

7.39 Figure shows four situations in which a small block of mass 'm' is released from rest (with respect to smooth fixed wedge) as shown in figure. Column-II shows work done by normal reaction on the block (with respect to an observer who is stationary on ground) till block reaches at the bottom of inclined wedge, match the appropriate column.

Column–I	Column–II
(A) 	(p) Positive
(B) 	(q) Negative
(C) 	(r) equal to mgh in magnitude
(D) 	(s) equal to zero

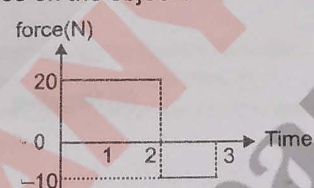
7.40 A particle moving along x-axis is being acted upon by one dimensional conservative force F. In the F–x curve shown, four points J, K, L, M are marked on the curve. Column II gives different type of equilibrium for the particle at different positions. Column I gives certain positions on the force position graphs. Match the positions in Column-I with the corresponding nature of equilibrium at these positions.



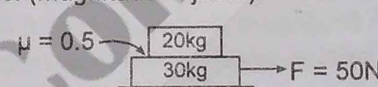
Column I	Column II
(A) Point J is position of	(p) Neutral equilibrium
(B) Point K is position of	(q) Unstable equilibrium
(C) Point L is position of	(r) Stable equilibrium
(D) Point M is position of	(s) No equilibrium
	(t) equilibrium

SECTION - VI : INTEGER TYPE

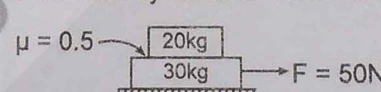
7.41 Starting at rest, a 5 kg object is acted upon by only one force as indicated in the figure. Find the total work done (in Joule) by the force on the object :-



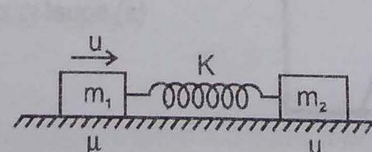
7.42 A small block of mass 20 kg rests on a bigger block of mass 30 kg, which lies on a smooth horizontal plane. Initially the whole system is at rest. The coefficient of friction between the blocks is 0.5. A horizontal force F = 50 N is applied on the lower block then. Find the work done (in Joule) by frictional force on upper block in t = 2sec. (magnitude in joule)



7.43 In previous is the magnitude of work done by frictional force on upper and lower block ?



7.44 The blocks of mass m_1 = 1 kg and m_2 = 2 kg are connected by a spring, rest on a rough horizontal surface. The spring is unstreched. The spring constant of spring is K = 2 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. Then what is the largest value of u (in m/s) such that the block of mass m_2 never moves.(Take g=10m/s^2)

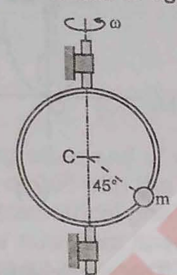


Fixed rough horizontal surface

TOPIC 8 CIRCULAR MOTION

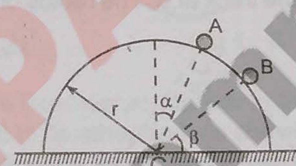
SECTION - I : STRAIGHT OBJECTIVE TYPE

8.1 A small bead of mass m = 1 kg is carried by a circular hoop having centre at C and radius r = 1 m which rotates about a fixed vertical axis (as shown). The coefficient of friction between bead and hoop is $\mu = 0.5$. The maximum angular speed of the hoop for which the bead does not have relative motion with respect to hoop: initial position of bead is shown in figure



(A) $(5\sqrt{2})^{1/2}$ (B) $(10\sqrt{2})^{1/2}$ (C) $(15\sqrt{2})^{1/2}$ (D) $(30\sqrt{2})^{1/2}$

8.2 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 looses 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) $2 \sin \beta = 3 \cos \alpha$

8.3 The member OA rotates about a horizontal axis through O with a constant counter clockwise velocity $\omega = 3$ rad/sec. As it passes the position $\theta = 0$, a small mass m is placed upon it at a radial distance $r = 0.5$ m. If the mass is observed to slip at $\theta = 37^\circ$, the coefficient of friction between the mass & the member is ______.

8.4 Two particles A & B separated by a distance 2R are moving counter clockwise along the same circular path of radius R each with uniform speed v. At time t = 0, A is given a tangential acceleration of magnitude $a = \dfrac{72 v^2}{25 \pi R}$.

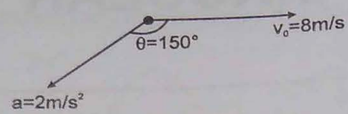
(A) the time lapse for the two bodies to collide is $\dfrac{6\pi R}{5V}$

(B) the angle covered by A is $\dfrac{11\pi}{6}$

(C) angular velocity of A is $\dfrac{11V}{5R}$

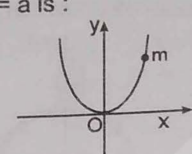
(D) radial acceleration of A is $\dfrac{289 v^2}{5R}$

8.5 The figure shows the velocity and acceleration of a point like body at the initial moment of its motion. The acceleration vector of the body remains constant. The minimum radius of curvature of trajectory of the body is (in m.)



(A) 2 m (B) 4 m (C) 8 m (D) 16 m

8.6 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 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) $\frac{g}{\sqrt{5}}$

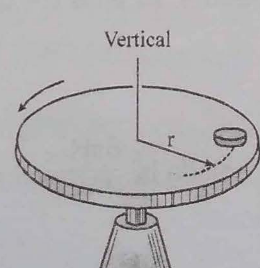
8.7 A particle is moving in a circular path. The acceleration and momentum vectors at an instant of time are $\vec{a} = 2\hat{i} + 3\hat{j}$ m/s² and $\vec{P} = 6\hat{i} - 4\hat{j}$ kgm/s. Then the motion of the particle is

(A) uniform circular motion
(B) circular motion with tangential acceleration
(C) circular motion with tangential retardation
(D) we cannot say anything from $\vec{a}$ and $\vec{P}$ a time only.

8.8 A section of fixed smooth circular track of radius 20 m. in vertical plane is shown in the figure. A block is released from position A and leaves the track at B. The radius of curvature of its trajectory when it just leaves the track at B is: (in m.)

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

8.9 A small coin of mass 40 g is placed on the horizontal surface of a rotating disc. The disc starts from rest and is given a constant angular acceleration $\alpha = 2$ rad/s². The coefficient of static friction between the coin and the disc is $\mu_s = 3/4$ and coefficient of kinetic friction is $\mu_k = 0.5$. The coin is placed at a distance r = 1 m from the centre of the disc. The magnitude of the resultant force on the coin exerted by the disc just before it starts slipping on the disc is :



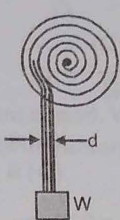
(A) 0.2 N (B) 0.3 N (C) 0.4 N (D) 0.5 N

8.10 A ring of mass 2π kg and of radius 0.25m is making 300rpm about an axis through its centre perpendicular to its plane. The tension (in newtons) developed in the ring is:

(A) 50 (B) 100 (C) 175 (D) 250

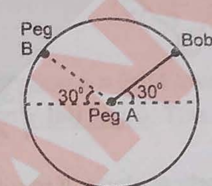
8.11 A car driver going at some speed suddenly finds a wide wall at a distance r. To avoid hitting the wall he should.
(A) apply the brakes
(B) should turn the car in a circle of radius r.
(C) apply the brakes and also turn the car in a circle of radius r.
(D) jump on the back seat.

8.12 A weight W attached to the end of a flexible rope of diameter d=0.75cm is raised vertically by winding the rope on a reel as shown. If the reel is turned uniformly at the rate of 2 r.p.s. What is the tension in rope. The inertia of rope may be neglected.



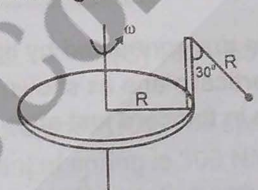
(A) 1.019W (B) 0.51W (C) 2.04W (D) W

8.13 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 30^0 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

8.14 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 velocity ω. The string is making an angle 30^0 with the rod. Then the angular velocity ω of disc is:

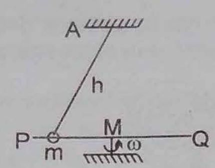


(A) $\left(\frac{\sqrt{3}g}{R}\right)^{1/2}$ (B) $\left(\frac{\sqrt{3}g}{2R}\right)^{1/2}$ (C) $\left(\frac{g}{\sqrt{3}R}\right)^{1/2}$ (D) $\left(\frac{2g}{3\sqrt{3}R}\right)^{1/2}$

8.15 One end of a light rod of length 1 m is attached with a string of length 1m. Other end of the rod is attached at point O such that rod can move in a vertical circle. Other end of the string is attached with a block of mass 2kg. The minimum velocity that must be given to the block in horizontal direction so that it can complete the vertical circle is (g = 10 m/s²).

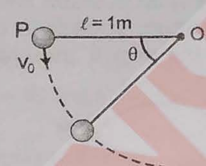
(A) $4\sqrt{5}$ (B) $5\sqrt{5}$ (C) 10 (D) $3\sqrt{5}$

8.16 A smooth rod PQ rotates in a horizontal plane about its mid point M which is h = 0.1 m vertically below a fixed point A at a constant angular velocity 14 rad/s. A light elastic string of natural length 0.1 m force contant 1.47 N/cm has one end fixed at A and its other end attached to a ring of mass m = 0.3 kg which is free to slide along the rod. When the ring is stationary relative to rod, then inclination of string with vertical, tension in string.



(A) $\cos\theta = 3/5$, T = 9.8 N
(B) θ = 60 , T = 0
(C) $\cos\theta = 2/5$, T = 4.9 N
(D) θ = 30 , T = 0

8.17 The sphere at P is given a downward velocity v_0 and swings in a vertical plane at the end of a rope of ℓ = 1m attached to a support at O. The rope breaks at angle 30° from horizontal, knowing that it can withstand a maximum tension equal to three times the weight of the sphere. Then the value of v_0 will be : ($g = \pi^2$ m/s^2)

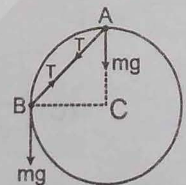


(A) $\frac{g}{2}$ m/s
(B) $\frac{2g}{3}$ m/s
(C) $\sqrt{\frac{3g}{2}}$ m/s
(D) $\frac{g}{3}$ m/s

8.18 A simple pendulum is oscillating in a vertical plane. If resultant acceleration of bob of mass m at a point A is in horizontal direction, find the tangential force at this point in terms of tension T and mg.

(A) mg
(B) $\frac{mg}{T}\sqrt{T^2-(mg)^2}$
(C) $\frac{mg}{T}\sqrt{(mg)^2+T^2}$
(D) $\frac{T}{mg}\sqrt{(mg)^2+T^2}$

8.19 Objects A and B each of mass m are connected by light inextensible cord. They are constrained to move on a frictionless ring in a vertical plane as shown in figure. The objects are released from rest at the positions shown. The tension in the cord just after release will be

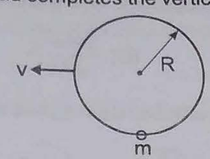


(A) $mg\sqrt{2}$
(B) $\frac{mg}{\sqrt{2}}$
(C) $\frac{mg}{2}$
(D) $\frac{mg}{4}$

8.20 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 :

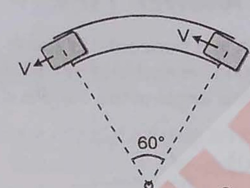
(A) $\tan^{-1}\frac{2}{3}$
(B) $\tan^{-1}\frac{3}{5}$
(C) $\tan^{-1}\frac{2}{5}$
(D) $\tan^{-1}\frac{1}{4}$

8.21 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 constant horizontal speed v with which the ring must be pulled such that the bead completes the vertical circle



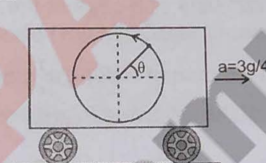
(A) $\sqrt{3gR}$ (B) $\sqrt{4gR}$ (C) $\sqrt{5gR}$ (D) $\sqrt{5.5gR}$

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



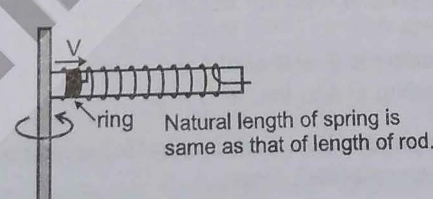
(A) $\frac{\pi}{3}$ (B) $\frac{\pi}{6}$ (C) $\frac{2\pi}{3}$ (D) $\frac{5\pi}{3}$

8.23 A bus is moving with a constant acceleration a = 3g/4 towards right. In the bus, a ball is tied with a rope and is rotated in vertical circle as shown in the figure. The tension in the rope will be minimum, when the rope makes an angle θ = ______ .



(A) 53° (B) 37° (C) 180 – 53° (D) 180 + 37°

8.24 A ring attached with a spring is fitted in a smooth rod. The spring is fixed at the outer end of the rod. The mass of the ring is 3kg & spring constant of spring is 300 N/m. The ring is given a velocity 'V' towards the outer end of the rod. And the rod is set to be rotating with an angular velocity ω. Then ring will move with constant speed with respect to the rod if :



(A) angular velocity of rod is increased continuously
(B) ω = 10 rad/s
(C) angular velocity of rod is decreased continuously.
(D) constant velocity of ring is not possible.