SECTION - II : MULTIPLE CORRECT ANSWER TYPE

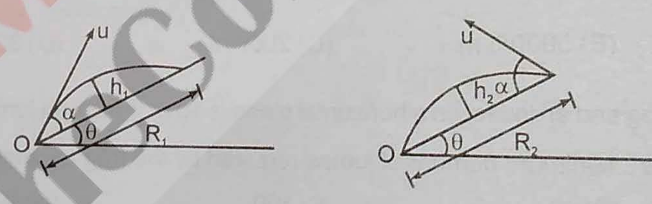
3.15 A particle is projected at an angle θ from ground with speed u ($g = 10\ m/s^2$) :
(A) if u = 10 m/s and $\theta = 30^0$, then time of flight will be 1 sec.
(B) if $u = 10\sqrt{3}$ m/s and $\theta = 60^0$, then time of flight will be 3 sec.
(C) if $u = 10\sqrt{3}$ m/s and $\theta = 60^0$, then after 2 sec velocity becomes perpendicular to initial velocity.
(D) if u = 10 m/s and $\theta = 30^0$, then velocity never becomes perpendicular to initial velocity during its flight.

3.16 A particle is projected vertically upwards with a velocity u from a point O . When it returns to the point of projection :
(A) its average velocity is zero
(B) its displacement is zero
(C) its average speed is u/2
(D) its average speed is u.

3.17 A particle of mass m moves along a curve $y = x^2$. When particle has x – co-ordinate as 1/2 and x-component of velocity as 4m/s then:
(A) the position coordinate of particle are (1/2, 1/4)
(B) the velocity of particle will be along the line $4x - 4y - 1 = 0$.
(C) the magnitude of velocity at that instant is $4\sqrt{2}$ m/s
(D) the magnitude of angular momentum of particle about origin at that position is 0.

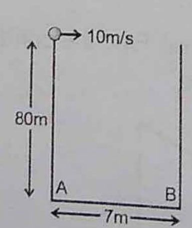
3.18 A stone is projected from level ground at time t=0. Let v_x and v_y are the horizontal and vertical components of velocity at any time t ; x and y are displacements along horizontal and vertical from the point of projection at any time t. Then:
(A) v_y – t graph is a straight line
(B) x – t graph is a straight line passing through origin
(C) y – t graph is a straight line passing through origin
(D) v_x – t graph is a straight line

3.19 Two balls are thrown from an inclined plane at angle of projection α with the plane one up the incline plane and other down the incline as shown in the figure. If R_1 & R_2 be their respective ranges and h_1 & h_2 be their respective maximum height then



(A) $h_1 = h_2$
(B) $R_2 - R_1 = T_1^2$
(C) $R_2 - R_1 = g \sin\theta\ T_2^2$
(D) $R_2 - R_1 = g \sin\theta\ T_1^2$
[here T_1 & T_2 are times of flight in the two cases respectively]

3.20 A ball is projected horizontally from top of a 80 m deep well with velocity 10 m/s. Then particle will fall on the bottom at a distance of (all the collisions with the wall are elastic) :



(A) 5 m from A
(B) 5 m from B
(C) 2 m from A
(D) 2 m from B

SECTION - III : ASSERTION AND REASON TYPE

3.21 **Statement-1 :** Two stones are simultaneously projected from level ground from same point with same speed but different angles with horizontal. Both stones move in same vertical plane. Then the two stones may collide in mid air.

Statement-2 : For two stones projected simultaneously from same point with same speed at different angles with horizontal, their trajectories may intersect at some point.

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

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

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

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

3.22 **Statement–1 :** During flight under action of gravity, the change in velocity of a projectile in same time intervals is same. (Neglect air friction)

Statement–2 : Neglecting air friction, the acceleration of projectile is constant during flight.

(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

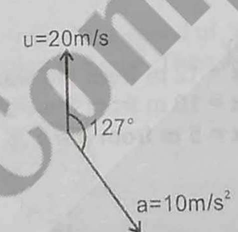
(C) Statement-1 is True, Statement-2 is False

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

SECTION - IV : COMPREHENSION TYPE

Comprehension

The direction of velocity of a particle at time t=0 is as shown in the figure and has magnitude u = 20m/s. The acceleration of particle is always constant and has magnitude $10 m/s^2$. The angle between its initial velocity and acceleration is 127°. (Take sin 37° = 3/5)



3.23 The instant of time at which acceleration and velocity are perpendicular is :

(A) 0.6 sec. (B) 1.2 sec. (C) 2.4 sec. (D) None of these

3.24 The instant of time at which speed of particle is least :

(A) 0.6 sec. (B) 1.2 sec. (C) 2.4 sec. (D) None of these

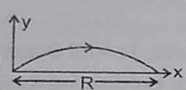
3.25 The instant of time t at which acceleration of particle is perpendicular to its displacement (displacement from t = 0 till that instant t) is :

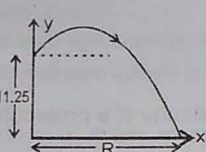
(A) 0.6 sec. (B) 1.2 sec. (C) 2.4 sec. (D) None of these

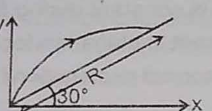
SECTION - V : MATRIX - MATCH TYPE

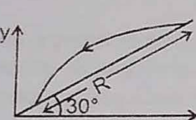
3.26 In the column-I, the path of a projectile (initial velocity 10 m/s and angle of projection with horizontal 60° in all cases) is shown in different cases. Range 'R' is to be matched in each case from column-II. Take g = 10 m/s^2. Arrow on the trajectory indicates the direction of motion of projectile.
Match each entry of column–I with its corresponding entry in column–II

Column-I

(A) 

(B) 

(C) 

(D) 

Column-II

(p) $R = \frac{15\sqrt{3}}{10}$ m

(q) $R = \frac{40}{3}$ m

(r) $R = 5\sqrt{3}$m

(s) $R = \frac{20}{3}$ m

(t) R = 100 m

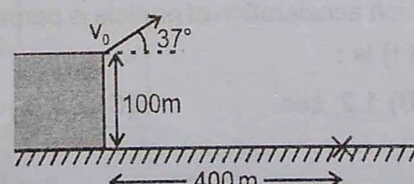
3.27 A ball is thrown at an angle 75° with the horizontal at a speed of 20 m/s towards a high wall at a distance d. If the ball strikes the wall, its horizontal velocity component reverses the direction without change in magnitude and the vertical velocity component remains same. Ball stops after hitting the ground. Match the statement of column I with the distance of the wall from the point of throw in column II .

Column I	Column II
(A) Ball strikes the wall directly	(p) d = 8 m
(B) Ball strikes the ground at x = 12 m from the wall	(q) d = 10 m
(C) Ball strikes the ground at x = 10 m from the wall	(r) d = 15 m
(D) Ball strikes the ground at x = 5 m from the wall	(s) d = 25 m
	(t) d = 30 m

SECTION - VI : INTEGER TYPE

3.28 A stone is dropped from a height of 45 m from horizontal level ground. There is horizontal wind blowing due to which horizontal acceleration of the stone becomes 10 m/s^2 . (Take g= 10m/s^2) Find time taken by stone to reach the ground. (in m/s)

3.29 A projectile is fired into the air from the edge of a 100 m high cliff at an angle of 37° above the horizontal. The projectile hits a target 400 m away from the base of the cliff. If initial velocity of the projectile, v_0 is $x\sqrt{5}$ m/s then x is ? (Neglect air friction and assume x-axis to be horizontal and y-axis to be vertical).



TOPIC 4 RELATIVE MOTION

SECTION - I : STRAIGHT OBJECTIVE TYPE

4.1 A train is standing on a platform, a man inside a compartment of the train drops a stone. At the same instant train starts to move with constant acceleration. The path of the particle as seen by the person who drops the stone is :
(A) parabola
(B) straight line for sometime & parabola for the remaining time
(C) straight line
(D) variable path that cannot be defined

4.2 A man wearing a hat of extended length 12 cm is running in rain falling vertically downwards with speed 10 m/s. The maximum speed with which man can run, so that rain drops does not fall on his face (the length of his face below the extended part of the hat is 16 cm) will be :
(A) 7.5 m/s (B) 13.33 m/s (C) 10 m/s (D) zero

4.3 A car starts with constant acceleration $a = 2m/s^2$ at $t = 0$. Two coins are released from the car at $t = 3$ & $t = 4$. Each coin takes 1 second to fall on ground. Then the distance between the two coins will be : (Assume coin sticks to the ground)
(A) 9 m (B) 7 m (C) 15 m (D) 2m

4.4 A swimmer crosses the river along the line making an angle of 45° with the direction of flow. Velocity of the river is 5 m/s. Swimmer takes 6 seconds to cross the river of width 60 m. The velocity of the swimmer with respect to water will be:
(A) 10 m/s (B) 12 m/s (C) $5\sqrt{5}$ m/s (D) $10\sqrt{2}$ m/s

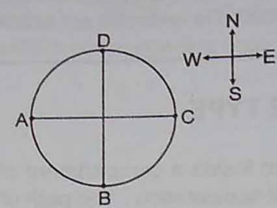
4.5 A man in a balloon, throws a stone downwards with a speed of 5 m/s with respect to balloon. The balloon is moving upwards with a constant acceleration of $5 m/s^2$. Then velocity of the stone relative to the man after 2 second is :

(A) 10 m/s (B) 30 m/s (C) 15 m/s (D) 35 m/s

4.6 Three stones A, B and C are simultaneously projected from same point with same speed. A is thrown upwards, B is thrown horizontally and C is thrown downwards from a building. When the distance between stone A and C becomes 10 m, then distance between A and B will be:
(A) 10 m (B) 5 m (C) $5\sqrt{2}$ m (D) $10\sqrt{2}$ m

4.7 A projectile A is projected from ground. An observer B running on ground with uniform velocity of magnitude 'v' observes A to move along a straight line. The time of flight of A as measured by B is T. Then the range R of projectile on ground is :
(A) $R = vT$
(B) $R < vT$
(C) $R > vT$
(D) information insufficient to draw inference

4.8 Two aeroplanes fly from their respective position 'A' and 'B' starting at the same time and reach the point 'C' (along straight line) simultaneously when wind was not blowing. On a windy day they head towards 'C' but both reach the point 'D' simultaneously in the same time which they took to reach 'C'. Then the wind is blowing in :



(A) North-East direction
(B) North-West direction
(C) Direction making an angle $0 < \theta < 90$ with North towards West.
(D) North direction

4.9 A particle is thrown up inside a stationary lift of sufficient height. The time of flight is T. Now it is thrown again with same initial speed v_0 with respect to lift. At the time of second throw, lift is moving up with speed v_0 and uniform acceleration g upward (the acceleration due to gravity). The new time of flight is:

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

4.10 A swimmer crosses a river with minimum possible time 10 second. And when he reaches the other end starts swimming in the direction towards the point from where he started swimming. Keeping the direction fixed the swimmer crosses the river in 15 sec. The ratio of speed of swimmer with respect to water and the speed of river flow is (Assume constant speed of river & swimmer) :

(A) $\frac{3}{2}$ (B) $\frac{9}{4}$ (C) $\frac{2}{\sqrt{5}}$ (D) $\frac{\sqrt{5}}{2}$

4.11 A taxi leaves the station X for station Y every 10 minutes. Simultaneously, a taxi also leaves the station Y for station X every 10 minutes. The taxis move at the same constant speed and go from X to Y or vice versa in 2 hours. How many taxis coming from the other side will meet each taxi enroute from Y to X:

(A) 11 (B) 12 (C) 23 (D) 24

4.12 Consider a collection of a large number of particles each with speed v. The direction of velocity is randomly distributed in the collection. The magnitude of the relative velocity between a pair of particles averaged over all the pairs in the collection is :

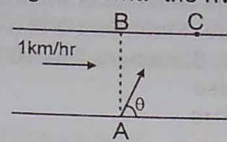
(A) greater than v (B) less than v (C) equal to v (D) we can't say anything

4.13 An aeroplane is flying in geographic meridian vertical plane at an angle of 30^0 above with the horizontal (north) and wind is blowing from west. A package is dropped from an aeroplane. The velocity of the wind if package hits a kite flying in the space with a position vector $\vec{R} = (400\sqrt{3}\hat{i} + 80\hat{j} + 200\hat{k})$ m with respect to the point of dropping.(Here $\hat{i}$ and $\hat{j}$ are the unit vectors along north and vertically up respectively and $\hat{k}$ be the unit vector due east. :

(A) 50 m/sec (B) 25 m/sec (C) 20 m/sec (D) 10 m/sec

SECTION - II : MULTIPLE CORRECT ANSWER TYPE

4.14 A river is flowing with a speed of 1 km/hr. A swimmer wants to go to point 'C' starting from 'A'. He swims with a speed of 5 km/hr, at an angle θ w.r.t. the river. If AB = BC = 400 m. Then :

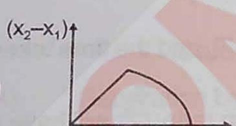


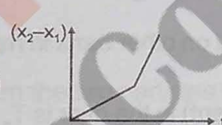
(A) the value of θ is 53^o
(B) time taken by the man is 6 min
(C) time taken by the man is 8 min
(D) the value of θ is 45^o

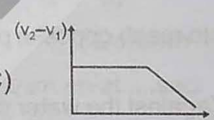
4.15 A swimmer who can swim in a river with speed *mv* (with respect to still water) where *v* is the speed of river current, jumps into the river from one bank to cross the river: m in a position contant]
(A) If $m \le 1$ he can not reach a point on other bank directly opposite to his starting point
(B) If $m < 1$ he can not cross the river
(C) If $m > 1$ then only he can reach a point on other bank
(D) He can reach the other bank at some point, whatever be the value of *m*.

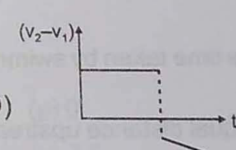
4.16 A man is standing on a road and observes that rain is falling at angle 45° with the vertical. The man starts running on the road with constant acceleration $0.5\ m/s^2$. After a certain time from the start of the motion, it appears to him that rain is still falling at angle 45° with the vertical, with speed $2\sqrt{2}$ m/s . Motion of the man is in the same vertical plane in which the rain is falling. Then which of the following statement(s) are true:
(A) It is not possible
(B) Speed of the rain relative to the ground is 2 m/s.
(C) Speed of the man when he finds rain to be falling at angle 45° with the vertical, is 4m/s.
(D) The man has travelled a distance 16m on the road by the time he again finds rain to be falling at angle 45°.

4.17 Two stones are thrown vertically upwards simultaneously from the same point on the ground with initial speed u_1 = 30 m/sec and u_2 = 50 m/sec. Which of the curve represents correct variation (for the time interval in which both reach the ground) of
$(x_2 - x_1)$ = the relative position of second stone with respect to first with time (t).
$(v_2 - v_1)$ = the relative velocity of second stone with respect to first with time (t).
Assume that stones do not rebound after hitting the ground

(A) 

(B) 

(C) 

(D) 

SECTION - III : ASSERTION AND REASON TYPE

4.18 **Statement-1 :** The magnitude of velocity of two boats relative to river is same. Both boats start simultaneously from same point on one bank may reach opposite bank simultaneously moving along different paths.
Statement-2 : For boats to cross the river in same time. The component of their velocity relative to river in direction normal to flow should be same.
(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

4.19 **Statement-1 :** Three projectiles are moving in different paths in the air. Vertical component of relative velocity between any of the pair does not change with time as long as they are in air. Neglect the effect of air friction.
Statement-2 : Relative acceleration between any of the pair of projectiles is zero.
(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

4.20 **Statement–1:** Two stones are projected with different velocities from ground from same point and at same instant of time. Then these stones cannot collide in mid air. (Neglect air friction)
Statement–2 : If relative acceleration of two particles initially at same position is always zero, then the distance between the particle either remains constant or increases continuously with time.
(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

Paragraph for Question Nos. 24 to 26

A swimmer can swim with a speed v in still water.

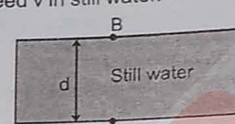


fig (i)

4.21 If the swimmer crosses a swimming pool of width 'd' from A to directly opposite point B on other side in time t_1 as shown in figure (i) and in a flowing river (river velocity 'u') of same width d from A′ to directly opposite point B′ on other bank in time t_2, then (t_1/t_2) is equal to : (Assume v > u)

(A) $\sqrt{1-\frac{v^2}{u^2}}$ (B) $\sqrt{1+\frac{u^2}{v^2}}$ (C) $\sqrt{1-\frac{u^2}{v^2}}$ (D) 1

4.22 If the minimum time taken by swimmer in swimming pool to reach opposite bank is t_1' and minimum. time to reach opposite bank in river is t_2', then the ratio $\frac{t_1'}{t_2'}$ will have a value :

(A) 1 (B) $\frac{\sqrt{v^2+u^2}}{v}$ (C) $\frac{\sqrt{v^2-u^2}}{u}$ (D) $\frac{u}{v}$

4.23 If the time taken by swimmer to reach opposite point on other bank in river is T_1 and the time taken to travel an equal distance upstream (against the water current) in the river is T_2, then ratio $\frac{T_2}{T_1}$ will have a value :

(A) $\sqrt{\frac{1-u/v}{1+u/v}}$ (B) $\sqrt{\frac{1+u/v}{1-u/v}}$ (C) $\frac{\sqrt{v^2-u^2}}{(v+u)}$ (D) $\frac{\sqrt{v^2-u^2}}{v}$

Comprehension

Raindrops are falling with a velocity $10\sqrt{2}$ m/s making an angle of 45° with the vertical. The drops appear to be falling vertically to a man running with constant velocity. The velocity of rain drops change such that the rain drops appear to be falling vertically with now the velocity it appeared earlier to the same person running with same velocity.

4.24 The magnitude of velocity of man with respect to ground is:

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

4.25 After the velocity of rain drops change, the magnitude of velocity of raindrops with respect to ground is:

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

4.26 The angle (in degrees) between the initial and the final velocity vectors of the raindrops with respect to the ground is:

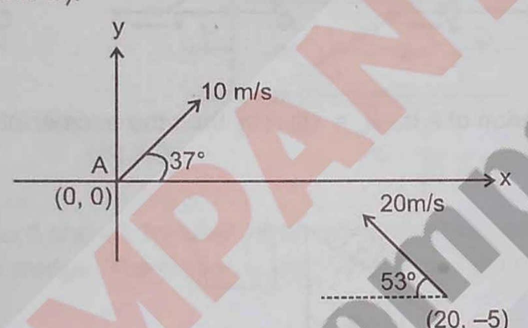
(A) 8 (B) 15 (C) 22.5 (D) 37

SECTION - V : MATRIX - MATCH TYPE

4.27 Two particles A and B moving in x-y plane are at origin at t = 0 sec. The initial velocity vectors of A and B are $\vec{u}_A = 8\hat{i}$ m/s and $\vec{u}_B = 8\hat{j}$ m/s. The acceleration of A and B are constant and are $\vec{a}_A = -2\hat{i}$ m/s^2 and $\vec{a}_B = -2\hat{j}$ m/s^2. Column I gives certain statements regarding particle A and B. Column II gives corresponding results. Match the statements in column I with corresponding results in Column II.

Column I	Column II
(A) The time (in seconds) at which velocity of A relative to B is zero	(p) $16\sqrt{2}$
(B) The distance (in metres) between A and B when their relative velocity is zero.	(q) $8\sqrt{2}$
(C) The time (in seconds) after t = 0 sec, at which A and B are at same position	(r) 8
(D) The magnitude of relative velocity of A and B at the instant they are at same position.	(s) 4
	(t) 6 secconds

4.28 Two particles A & B are projected as shown in fig in x–y plane. Under the effect of force which provide a constant acceleration a =11 m/s^2 in negative y-direction. Then match situation in column-I with the corresponding results in column-II (All positions are given in metre) ($\vec{V}_{AB}$ = velocity of A w.r.t. B; $\vec{r}_{AB}$ = Position of A w.r.t. B).



Column–I	Column–II
(A) Separation between the two particles is minimum at ....sec.	(p) 0
(B) Minimum separation between the two particles is ....m.	(q) 0.5
(C) Time when velocities of both particles are perpendicular each other at .... sec.	(r) 0.9
(D) At the time of minimum separation $\vec{V}_{AB}.\vec{r}_{AB}$ =	(s) 2
	(t) $2\sqrt{5}$

SECTION - VI : INTEGER TYPE

4.29 When two bodies move uniformly towards each other, the distance between them diminishes by 16 m every 10 s. If velocity of one body is reversed the distance between them will decrease 3 m every 5 s.

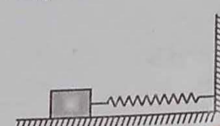
Itspeed of second body is $\frac{10}{x}$ m/s then x is.

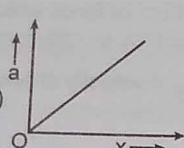
4.30 A swimmer jumps from a bridge over a canal and swims 1km upstream. After that first km, he passes a floating cork. He continues swimming for half an hour and then turns around and swims back to the bridge. The swimmer and the cork reach the bridge at the same time. The swimmer has been swimming at a constant speed. If speed of water in canal is X km/hr., then X is

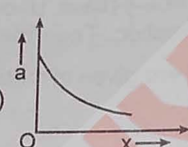
TOPIC 5 NEWTON'S LAW OF MOTION

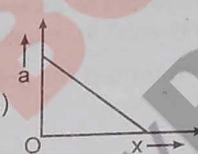
SECTION - I : STRAIGHT OBJECTIVE TYPE

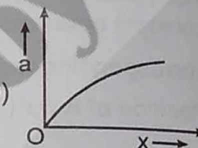
5.1 A light spring is compressed and placed horizontally between a vertical fixed wall and a block free to slide over a smooth horizontal table top as shown in the figure. The system is released from rest. The graph which represents the relation between the magnitude of acceleration 'a' of the block and the distance 'x' travelled by it (as long as the spring is compressed) is:



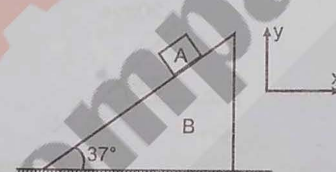
(A) 

(B) 

(C) 

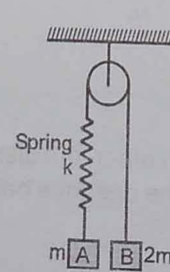
(D) 

5.2 In the figure shown the acceleration of A is, $\vec{a}_A = 15\hat{i} + 15\hat{j}$ then the acceleration of B is: (A remains in contact with B)



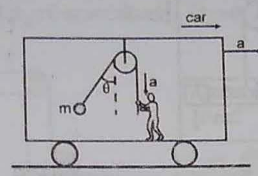
(A) $6\hat{i}$ (B) $-15\hat{i}$ (C) $-10\hat{i}$ (D) $-5\hat{i}$

5.3 Two blocks A and B of masses m & 2m respectively are held at rest such that the spring is in natural length. Find out the accelerations of both the blocks just after release:



(A) g ↓, g ↓ (B) $\frac{g}{3}$ ↓, $\frac{g}{3}$ ↑ (C) 0, 0 (D) g ↓, 0

5.4 A bob is hanging over a pulley inside a car through a string . The second end of the string is in the hand of a person standing in the car . The car is moving with constant acceleration 'a' directed horizontally as shown in figure . Other end of the string is pulled with constant acceleration 'a' vertically downward. The tension in the string is equal to :

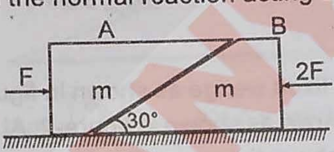


(A) $m\sqrt{g^2+a^2}$ (B) $m\sqrt{g^2+a^2} - ma$ (C) $m\sqrt{g^2+a^2} + ma$ (D) $m(g + a)$

5.5 Inside a horizontally moving box, an experimenter finds that when an object is placed on a smooth horizontal table and is released, it moves with an acceleration of $10\ m/s^2$. In this box if 1 kg body is suspended with a light string, the tension in the string in equilibrium position. (w.r.t. experimenter) will be. (Take $g = 10\ m/s^2$)

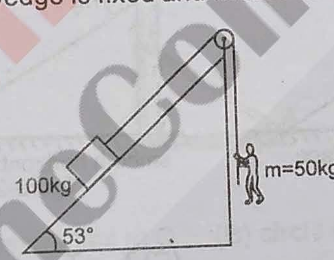
(A) $10\ m/s^2$. (B) $10\sqrt{2}\ m/s^2$. (C) $20\ m/s^2$. (D) zero

5.6 Two blocks 'A' and 'B' each of mass 'm' are placed on a smooth horizontal surface. Two horizontal force F and 2F are applied on both the blocks 'A' and 'B' respectively as shown in figure. The block A does not slide on block B. Then the normal reaction acting between the two blocks is :



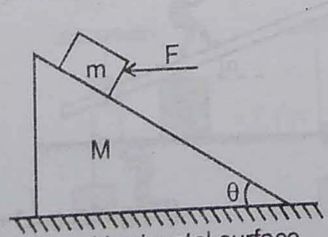
(A) F (B) F/2 (C) $\frac{F}{\sqrt{3}}$ (D) 3F

5.7 In the arrangement shown, by what acceleration the boy must go up so that 100 kg block remains stationary on the wedge. The wedge is fixed and friction is absent everywhere. (Take $g = 10\ m/s^2$)



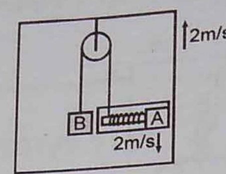
(A) $2\ m/s^2$ (B) $4\ m/s^2$ (C) $6\ m/s^2$ (D) $8\ m/s^2$

5.8 A block of mass m lies on wedge of mass M, which lies on fixed horizontal surface. The wedge is free to move on the horizontal surface. A horizontal force of magnitude F is applied on block as shown, neglecting friction at all surfaces, the value of force F such that block has no relative motion w.r.t. wedge will be : (where g is acceleration due to gravity)



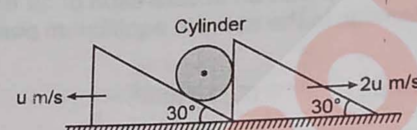
(A) $(M + m)\ g \tan\theta$ (B) $(M + m)\ g \cot\theta$ (C) $\frac{m}{M}(M + m)\ g \tan\theta$ (D) $\frac{m}{M}(M + m)\ g \cot\theta$

5.9. In the figure shown the velocity of lift is 2 m/s while string is winding on the motor shaft with velocity 2 m/s and block A is moving downwards with a velocity of 2 m/s, then find out the velocity of block B.



(A) 2 m/s ↑ (B) 2 m/s ↓ (C) 4 m/s ↑ (D) 8 m/s ↑

5.10 System is shown in the figure. Assume that cylinder remains in contact with the two wedges. The velocity of cylinder is -



(A) $\sqrt{19-4\sqrt{3}}\,\frac{u}{2}$ m/s (B) $\frac{\sqrt{13}u}{2}$ m/s (C) $\sqrt{3}u$ m/s (D) $\sqrt{7}u$ m/s

5.11 A block of mass m_1 lies on top of fixed wedge as shown in figure-1 and another block of mass m_2 lies on top of wedge which is free to move as shown in figure-2. At time t = 0, both the blocks are released from rest from a vertical height h above the respective horizontal surface on which the wedge is placed as shown. There is no frcition between block and wedge in both the figures. Let T_1 and T_2 be the time taken by block in figure-1 and block in figure-2 respectively to just reach the horizontal surface, then :

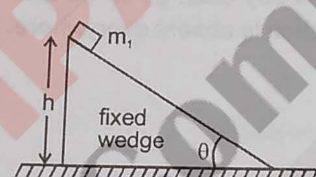


figure-1

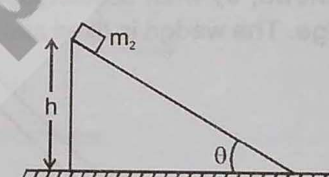
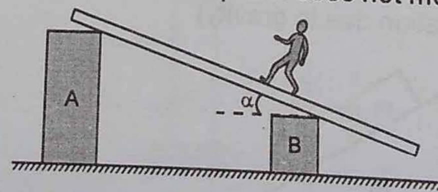


figure-2

(A) $T_1 > T_2$ (B) $T_1 < T_2$ (C) $T_1 = T_2$ (D) Data insufficient

5.12 A plank is held at an angle α to the horizontal (Fig.) on two fixed supports A and B. The plank can slide against the supports (without friction) because of its weight Mg. Acceleration and direction in which a man of mass m should move so that the plank does not move.



(A) $g \sin\alpha \left(1+\frac{m}{M}\right)$ down the incline (B) $g \sin\alpha \left(1+\frac{M}{m}\right)$ down the incline

(C) $g \sin\alpha \left(1+\frac{m}{M}\right)$ up the incline (D) $g \sin\alpha \left(1+\frac{M}{m}\right)$ up the incline

5.13 In the situation shown in figure all the string are light and inextensible and pullies are light. There is no friction at any surface and all block are of cuboidal shape. A horizontal force of magnitude F is applied to right most free end of string in both cases of figure 1 and figure 2 as shown. At the instant shown, the tension in all strings are non zero. Let the magnitude of acceleration of large blocks (of mass M) in figure 1 and figure 2 are a_1 and a_2 respectively. Then :

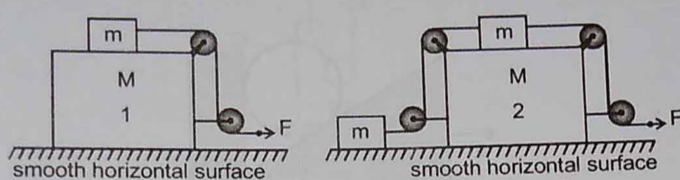
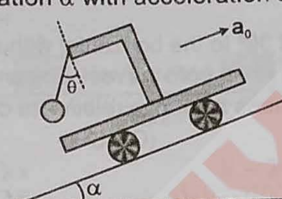


figure-1 figure-2

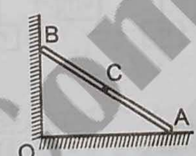
(A) $a_1 = a_2 \neq 0$ (B) $a_1 = a_2 = 0$ (C) $a_1 > a_2$ (D) $a_1 < a_2$

5.14 A pendulum of mass m hangs from a support fixed to a trolley. The direction of the string when the trolley rolls up a plane of inclination α with acceleration a_0 is



(A) $\theta = \tan^{-1}\alpha$ (B) $\theta = \tan^{-1}\left(\frac{a_0}{g}\right)$ (C) $\theta = \tan^{-1}\left(\frac{g}{a_0}\right)$ (D) $\theta = \tan^{-1}\left(\frac{a_0 + g\sin\alpha}{g\cos\alpha}\right)$

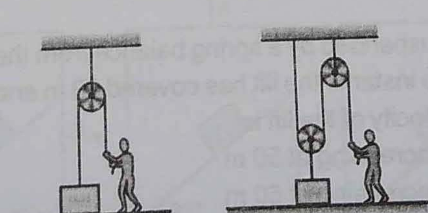
5.15 A rod of length 2ℓ is moving such that its ends A and B move in contact with the horizontal floor and vertical wall respectively as shown in figure. O is the intersection point of the vertical wall and horizontal floor. The velocity vector of the centre of rod C is always directed along tangent drawn at C to the



(A) circle of radius $\frac{\ell}{2}$ whose centre lies at O (B) circle of radius ℓ whose centre lies at O

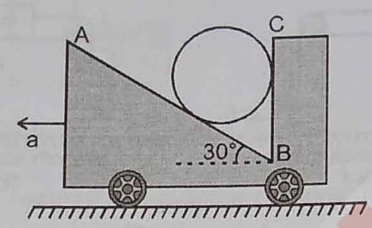
(C) circle of radius 2ℓ whose centre lies at O (D) None of these

5.16 In the figure shown, a person wants to raise a block lying on the ground to a height h. In both the cases if time required is same then in which case he has to exert more force. Assume pulleys and strings light.


(i) (ii)

(A) (i) (B) (ii) (C) same in both (D) Cannot be determined

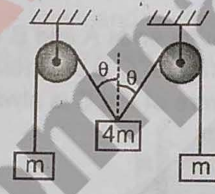
5.17 A cylinder rests in a supporting carriage as shown. The side AB of carriage makes an angle 30° with the horizontal and side BC is vertical. The carriage lies on a fixed horizontal surface and is being pulled towards left with an horizontal acceleration '*a*'. The magnitude of normal reactions exerted by sides AB and BC of carriage on the cylinder be N_{AB} and N_{BC} respectively. Neglect friction everywhere. Then as the magnitude of acceleration '*a*' of the carriage is increased, pick up the correct statement :



(A) N_{AB} increases and N_{BC} decreases.
(B) Both N_{AB} and N_{BC} increase.
(C) N_{AB} remains constant and N_{BC} increases.
(D) N_{AB} increases and N_{BC} remains constant.

5.18 A car is moving on a plane inclined at 30° to the horizontal with an acceleration of 9.8 m/s^2 parallel to the plane upward. A bob is suspended by a string from the roof. The angle in degrees which the string makes with the vertical is : (Assume that the bob does not move relative to car) [g = 9.8 m/s^2]
(A) 20° (B) 30° (C) 45° (D) 60°

5.19 In the figure shown, the pulleys and strings are massless. The acceleration of the block of mass 4m just after the system is released from rest is ($\theta = \sin^{-1}\frac{3}{5}$)

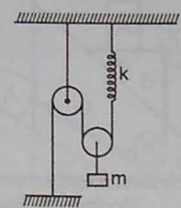


(A) $\frac{2g}{5}$ downward (B) $\frac{2g}{5}$ upwards (C) $\frac{5g}{11}$ upwards (D) $\frac{5g}{11}$ downwards

5.20 Five persons A, B, C, D & E are pulling a cart of mass 100 kg on a smooth surface and cart is moving with acceleration 3 m/s^2 in east direction. When person 'A' stops pulling, it moves with acceleration 1m/s^2 in the west direction. When person 'B' stops pulling, it moves with acceleration 24 m/s^2 in the north direction. The magnitude of acceleration of the cart when only A & B pull the cart keeping their directions same as the old directions, is :
(A) 26 m/s^2 (B) $3\sqrt{71}$ m/s^2 (C) 25 m/s^2 (D) 30 m/s^2

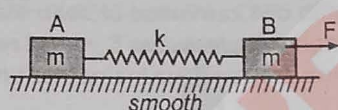
5.21 A body of mass 32 kg is suspended by a spring balance from the roof of a vertically operating lift and going downward from rest. At the instants the lift has covered 20 m and 50 m, the spring balance showed 30 kg & 36 kg respectively. The velocity of the lift is:
(A) decreasing at 20 m & increasing at 50 m
(B) increasing at 20 m & decreasing at 50 m
(C) continuously decreasing at a constant rate throught the journey
(D) continuously increasing at constant rate throughout the journey

5.22 Mass m shown in the figure is in equilibrium. If it is displaced further by x and released find its acceleration just after it is released. Take pulleys to be light & smooth and strings light.



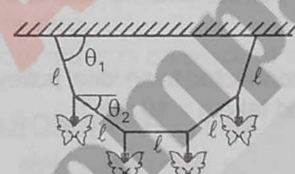
(A) $\frac{4kx}{5m}$ (B) $\frac{2kx}{5m}$ (C) $\frac{4kx}{m}$ (D) none of these

5.23 Initially the spring is undeformed. Now the force 'F' is applied to 'B' as shown in the figure . When the displacement of 'B' w.r.t. 'A' is 'x' towards right in some time then the relative acceleration of 'B' w.r.t. 'A' at that moment is:



(A) $\frac{F}{2\,m}$ (B) $\frac{F - kx}{m}$ (C) $\frac{F - 2\,kx}{m}$ (D) none of these

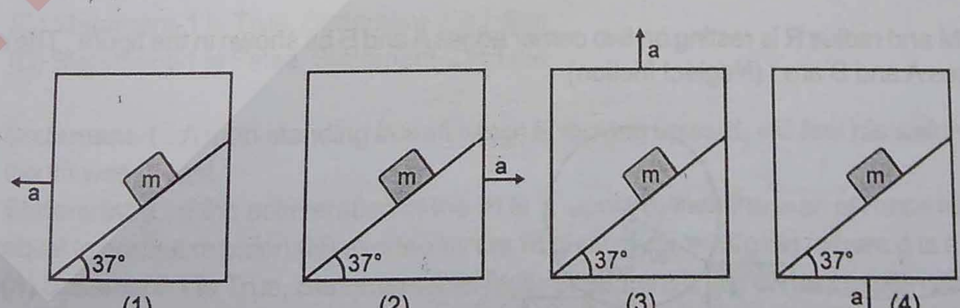
5.24 Four identical metal butterflies are hanging from a light string of length 5ℓ at equally placed points as shown in the figure . The ends of the string are attached to a horizontal fixed support. The middle section of the string is horizontal. The relation between the angle θ_1 and θ_2 is given by



(A) $\sin\theta_1 = 2\sin\theta_2$ (B) $2\cos\theta_1 = \sin\theta_2$
(C) $\tan\theta_1 = 2\tan\theta_2$ (D) $\theta_2 < \theta_1$ and no other conclusion can be derived.

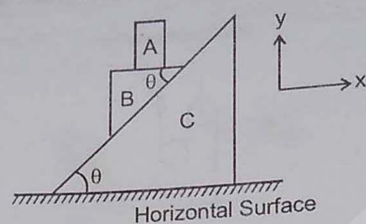
SECTION - II : MULTIPLE CORRECT ANSWER TYPE

5.25 A block of mass m is placed on a wedge. The wedge can be accelerated in four manners marked as (1), (2), (3) and (4) as shown. If the normal reactions in situation (1), (2), (3) and (4) are N_1, N_2, N_3 and N_4 respectively and acceleration with which the block slides on the wedge in situations are b_1, b_2, b_3 and b_4 respectively then :



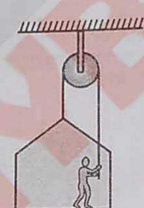
(A) $N_3 > N_1 > N_2 > N_4$ (B) $N_4 > N_3 > N_1 > N_2$ (C) $b_2 > b_3 > b_4 > b_1$ (D) $b_2 > b_3 > b_1 > b_4$

5.26 In the figure shown all the surface are smooth. All the blocks A, B and C are movable, x-axis is horizontal and y-axis vertical as shown. Just after the system is released from the position as shown.



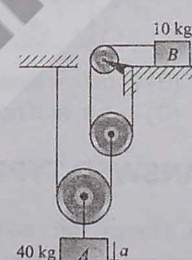
(A) Acceleration of 'A' relative to ground is in negative y-direction
(B) Acceleration of 'A' relative to B is in positive x-direction
(C) The horizontal acceleration of 'B' relative to ground is in negative x-direction.
(D) The acceleration of 'B' relative to ground directed along the inclined surface of 'C' is greater than $g \sin\theta$.

5.27 A painter is applying force himself to raise him and the box with an acceleration of 5 m/s^2 by a massless rope and pulley arrangement as shown in figure. Mass of painter is 100 kg and that of box is 50 kg. If $g = 10 \text{ m/s}^2$, then:



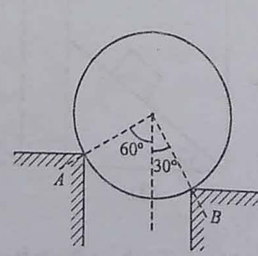
(A) tension in the rope is 1125 N
(B) tension in the rope is 2250 N
(C) force of contact between the painter and the floor is 375 N
(D) none of these

5.28 Figure shows two blocks A and B connected to an ideal pulley string system. In this system when bodies are released then : (neglect friction and take $g = 10 \text{ m/s}^2$)



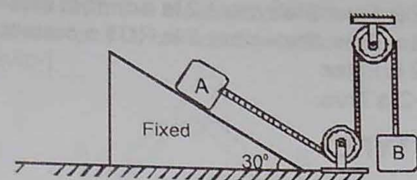
(A) Acceleration of block A is 1 m/s^2
(B) Acceleration of block A is 2 m/s^2
(C) Tension in string connected to block B is 40 N
(D) Tension in string connected to block B is 80 N

5.29 A cylinder of mass M and radius R is resting on two corner edges A and B as shown in the figure . The normal reaction at the edges A and B are : (Neglect friction)



(A) $N_A = \sqrt{2} N_B$
(B) $N_B = \sqrt{3} N_A$
(C) $N_A = \dfrac{Mg}{2}$
(D) $N_B = \dfrac{2\sqrt{3}Mg}{5}$

5.30 Two blocks A and B of equal mass m are connected through a massless string and arranged as shown in the figure . The wedge is fixed on horizontal surface. Friction is absent everywhere. When the system is released from rest.

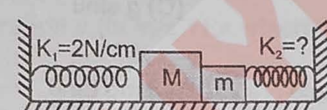


Starting Case

(A) tension in string is $\frac{mg}{2}$ (B) tension in string is $\frac{mg}{4}$

(C) acceleration of A is g/2 (D) acceleration of A is $\frac{3}{4}g$

5.31 Two blocks of mass M and m, are used to compress two different massless springs as shown in the figure. The left spring is compressed by 3 cm, while the right spring is compressed by an unknown amount. The system is at rest and all contact surfaces are smooth. Which of the following statements are true ?

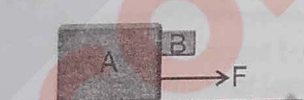


smooth horizontal surface

(A) The force exerted on block of mass m by the right spring is 6 N to the left.
(B) The force exerted on block of mass m by the right spring is impossible to determine.
(C) The net force on block of mass m is zero.
(D) The normal force exerted by block of mass m on block of mass M is 6 N.

SECTION - III : ASSERTION AND REASON TYPE

5.32 **Statement-1 :** Block A is moving on horizontal surface towards right under action of force F . All surfaces are smooth. At the instant shown the force exerted by block A on block B is equal to net force on block B.



Statement-2 : From Newton's third law, the force exerted by block A on B is equal in magnitude to force exerted by block B on A.
(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

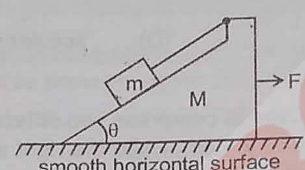
5.33 **Statement-1 :** A man standing in a lift which is moving upward, will feel his weight to be greater than when the lift was at rest.
Statement-2 : If the acceleration of the lift is 'a' upward, then the man of mass m shall feel his weight to be equal to normal reaction (N) exerted by the lift given by N = m(g+a) (where g is acceleration due to gravity)
(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

5.34 **Statement–1 :** According to the Newton's third law of motion, the magnitude of the action and reaction force in an action reaction pair is same only in an inertial frame of reference.
Statement–2 : Newton's laws of motion are applicable in every inertial reference frame.
(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

A light inextensible string connects a block of mass m and top of wedge of mass M. The string is parallel to inclined surface and the inclined surface makes an angle θ with horizontal as shown in the figure. All surfaces are smooth. Now a constant horizontal force of minimum magnitude F is applied to wedge towards right such that the normal reaction on block exerted by wedge just becomes zero.



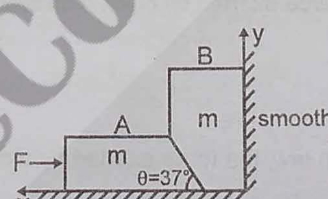
5.35 The magnitude of acceleration of wedge is
(A) g tanθ (B) g cotθ (C) g sinθ (D) g cosθ

5.36 The magnitude of tension in string is
(A) mg secθ (B) mg cosecθ (C) mg tanθ (D) mg cotθ

5.37 The magnitude of net horizontal force on wedge is :
(A) Mg cotθ (B) (M + m)g secθ (C) (M + m)g cotθ (D) Mg cosecθ

Comprehension # 2

Two smooth blocks are placed at a smooth corner as shown in the figure. Both the blocks are having mass m. We apply a force F on the small block m. Block A presses the block B in the normal direction, due to which pressing force on vertical wall will increase, and pressing force on the horizontal wall decrease, as we increase F. ($\theta = 37°$ with horizontal). As soon as the pressing force on the horizontal wall by block B becomes zero, it will loose the contact with the ground. If the value of F is further increased, the block B will accelerate in upward direction and simultaneously the block A will move toward right.



5.38 What is minimum value of F, to lift block B from ground :

(A) $\frac{25}{12}$ mg (B) $\frac{5}{4}$ mg (C) $\frac{3}{4}$ mg (D) $\frac{4}{3}$ mg

5.39 If both the blocks are stationary, the force exerted by ground on block A is :

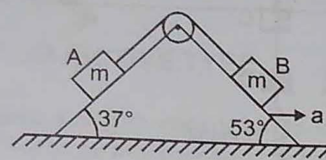
(A) $mg + \frac{3F}{4}$ (B) $mg - \frac{3F}{4}$ (C) $mg + \frac{4F}{3}$ (D) $mg - \frac{4F}{3}$

5.40 If acceleration of block A is a rightward, then acceleration of block B will be :

(A) $\frac{3a}{4}$ upwards (B) $\frac{4a}{3}$ upwards (C) $\frac{3a}{5}$ upwards (D) $\frac{4a}{5}$ upwards

Comprehension # 3

Two blocks A and B of equal masses m kg each are connected by a light thread, which passes over a massless pulley as shown in the figure. Both the blocks lie on wedge of mass m kg. Assume friction to be absent everywhere and both the blocks to be always in contact with the wedge. The wedge lying over smooth horizontal surface is pulled towards right with constant acceleration a (m/s^2). (g is acceleration due to gravity)



5.41 Normal reaction (in N) acting on block B is

(A) $\frac{m}{5}(3g + 4a)$ (B) $\frac{m}{5}(3g - 4a)$ (C) $\frac{m}{5}(4g + 3a)$ (D) $\frac{m}{5}(4g - 3a)$

5.42 Normal reaction (in N) acting on block A.

(A) $\frac{m}{5}(3g + 4a)$ (B) $\frac{m}{5}(3g - 4a)$ (C) $\frac{m}{5}(4g + 3a)$ (D) $\frac{m}{5}(4g - 3a)$

5.43 The maximum value of acceleration a (in m/s^2) for which normal reactions acting on the block A and block B are nonzero.

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

SECTION - V : MATRIX - MATCH TYPE

5.44 Column-I gives four different situations involving two blocks of mass m_1 and m_2 placed in different ways on a smooth horizontal surface as shown. In each of the situations horizontal forces F_1 and F_2 are applied on blocks of mass m_1 and m_2 respectively and also $m_2F_1 < m_1F_2$. Match the statements in column I with corresponding results in column-II .

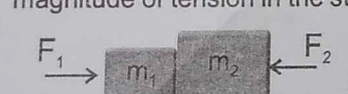
Column I

(A) 

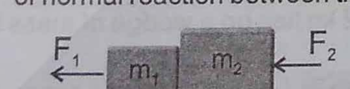
. Both the blocks are connected by massless inelastic string. The magnitude of tension in the string is

(B) 

. Both the blocks are connected by massless inelastic string. The magnitude of tension in the string is

(C) 

. The magnitude of normal reaction between the blocks is

(D) 

. The magnitude of normal reaction between the blocks is

Column II

(p) $\frac{m_1m_2}{m_1+m_2}\left(\frac{F_1}{m_1}-\frac{F_2}{m_2}\right)$

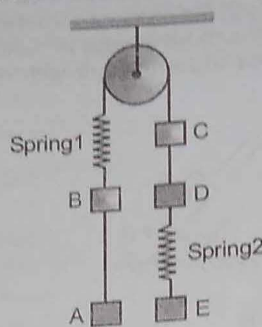
(q) $\frac{m_1m_2}{m_1+m_2}\left(\frac{F_1-F_2}{m_1+m_2}\right)$

(r) $\frac{m_1m_2}{m_1+m_2}\left(\frac{F_2}{m_2}-\frac{F_1}{m_1}\right)$

(s) $m_1m_2\left(\frac{F_1+F_2}{m_1+m_2}\right)$

(t) $\frac{m_1m_2}{m_1+m_2}\left(\frac{F_1}{m_1}+\frac{F_2}{m_2}\right)$

5.45 The system shown below is initially in equilibrium. Masses of the blocks A, B, C, D and E are respectively 3m, 3m, 2m, 2m and 2m. Match the conditions in column-I with the effects in column-II.

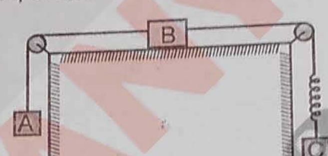


Column-I
(A) After spring 2 is cut, tension in string AB
(B) After spring 2 is cut, tension in string CD
(C) After string between C and pulley is cut, tension in string AB
(D) After string between C and pulley is cut, tension in string CD

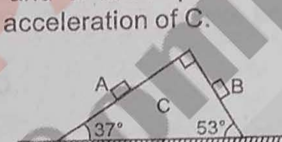
Column-II
(p) increases
(q) decreases
(r) decreases and then increases
(s) zero
(t) remain constant

SECTION - VI : INTEGER TYPE

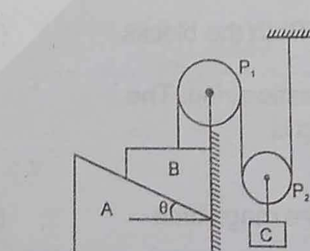
5.46 In the figure shown all the contacts are smooth. Strings and spring are light. Initially 'A' is held by someone and 'B' and 'C' are at rest and in equilibrium also. Find out the acceleration of block C in m/s^2 just after the block 'A' is released. Masses of A, B and C are M, M and 2M respectively.



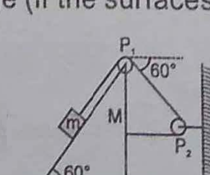
5.47 In the figure shown blocks 'A' and 'B' are kept on a wedge 'C'. A, B and C each have mass m. All surfaces are smooth. Find the acceleration of C.



5.48 In the figure shown P_1 and P_2 are massless pulleys. P_1 is fixed and P_2 can move. Masses of A, B and C are $\frac{9m}{64}$, 2m and m respectively. All contacts are smooth and the string is massless. $\theta = \tan^{-1}\left(\frac{3}{4}\right)$. Find the acceleration of block C in m/s^2.



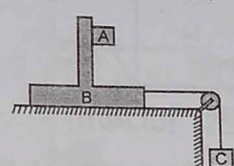
5.49 In the arrangement shown in the Fig., a block of mass m = 2 kg lies on a wedge of mass M = 8 kg. The initial acceleration of the wedge (if the surfaces are smooth) given by $\frac{3\sqrt{3}g}{x}$ m/s^2 then x is.



TOPIC 6 FRICTION

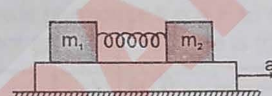
SECTION - I : STRAIGHT OBJECTIVE TYPE

6.1 In the arrangement shown in the figure mass of the block B and A are 2m, 8m respectively. Surface between B and floor is smooth. The block B is connected to block C by means of a pulley. If the whole system is released then the minimum value of mass of the block C so that the block A remains stationary with respect to B is : (Co-efficient of friction between A and B is μ.)



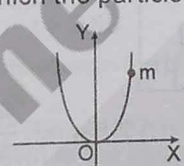
(A) $\frac{m}{\mu}$ (B) $\frac{2m}{\mu+1}$ (C) $\frac{10\ m}{1-\mu}$ (D) $\frac{10m}{\mu-1}$

6.2 Two block of masses m_1 and m_2 are connected with a massless unstretched spring and placed over a plank moving with an acceleration 'a' as shown in figure. The coefficient of friction between the blocks and platform is μ.



(A) spring will be stretched if $a > \mu g$
(B) spring will be compressed if $a \le \mu g$
(C) spring will neither be compressed nor be stretched for $a \le \mu g$
(D) spring will be in its natural length under all conditions

6.3 A bead of mass m is located on a parabolic wire with its axis vertical and vertex directed towards downward as in figure and whose equation is $x^2 = ay$. If the coefficient of friction is μ, the highest distance above the x-axis at which the particle will be in equilibrium is

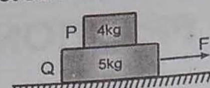


(A) μa (B) $\mu^2 a$ (C) $\frac{1}{4}\mu^2 a$ (D) $\frac{1}{2}\mu a$

6.4 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:

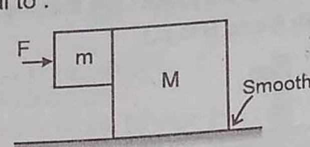
(A) 2 N, 6 N, 3.2 N (B) 2 N, 6 N, 0 N
(C) 1 N, 6 N, 2 N (D) data insufficient to calculate the required values.

6.5 The coefficient of friction between 4kg and 5 kg blocks is 0.2 and between 5 kg block and ground is 0.1 respectively. Choose the correct statement:



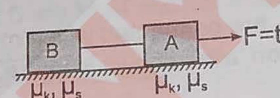
(A) Minimum force needed to cause system to move is 17 N
(B) When force is 4N static friction at all surfaces is 4N to keep system at rest
(C) Maximum acceleration of 4kg block is $2 m/s^2$
(D) Slipping between 4kg and 5 kg blocks start when F is 17N

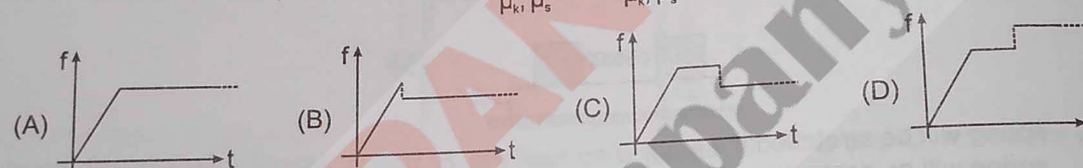
6.6 The two blocks, m = 10 kg and M = 50 kg are free to move as shown. The coefficient of static friction between the blocks is 0.5 and there is no friction between M and the ground. A minimum horizontal force F is applied to hold m against M that is equal to :



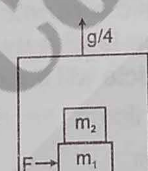
(A) 100 N (B) 50 N (C) 240 N (D) 180 N

6.7 A force F = t is applied to a block A as shown in figure, where t is time in seconds. The force is applied at t = 0 seconds when the system was at rest. Which of the following graph correctly gives the frictional force between A and horizontal surface as a function of time t.[Assume that at t = 0, tension in the string connecting the two blocks is zero].





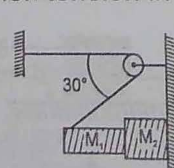
6.8 A plank of mass m_1 = 8 kg with a bar of mass m_2 = 2 kg placed on its rough surface, lie on a smooth floor of elevator ascending with an acceleration g/4. The coefficient of friction is $\mu = 1/5$ between m_1 and m_2. A horizontal force F = 30 N is applied to the plank. Then the acceleration of bar and the plank in the reference frame of elevator are:



(A) $3.5 m/s^2$, $5 m/s^2$ (B) $5 m/s^2$, $\frac{50}{8} m/s^2$ (C) $2.5 m/s^2$, $\frac{25}{8} m/s^2$ (D) $4.5 m/s^2$, $4.5 m/s^2$

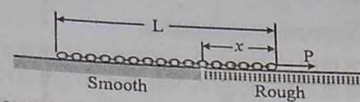
6.9 A block of mass 1 kg lies on a horizontal surface in a truck. The coefficient of static friction between the block and the surface is 0.6 If the acceleration of the truck is $5 m/s^2$, the frictional force acting on the block is :
(A) 5 N (B) 6 N (C) 10 N (D) 15 N

6.10 Two blocks with masses M_1 and M_2 of 10 kg and 20 kg respectively are placed as in fig. Coefficient of friction $\mu = 0.2$ between all surfaces, then tension in string and acceleration of M_2 block will be :



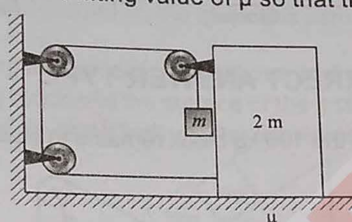
(A) 250 N, $3 m/s^2$ (B) 200 N, $6 m/s^2$ (C) 306 N, $4.7 m/s^2$ (D) 400 N, $6.5 m/s^2$

6.11 A chain of length L is placed on a horizontal surface as shown in figure. At any instant x is the length of chain on rough surface and the remaining portion lies on smooth surface. Initially x = 0. A horizontal force P is applied to the chain (as shown in the figure). In the duration x changes from x = 0 to x = L, for chain to move with constant speed:



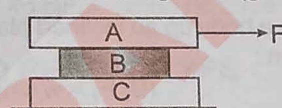
(A) the magnitude of P should increase with time
(B) the magnitude of P should decrease with time
(C) the magnitude of P should increase first and then decrease with time
(D) the magnitude of P should decrease first and then increase with time

6.12 In the system shown in figure the friction coefficient between ground and bigger block is μ. There is no friction between both the blocks. The string connecting both the block is light; all three pulleys are light and frictionless. Then the minimum limiting value of μ so that the system remains in equilibrium is



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

6.13 Given $m_A = 20$ kg, $m_B = 10$ kg, $m_C = 20$ kg. Between A and B $\mu_1 = 0.3$, between B and C $\mu_2 = 0.3$ and between C and ground $\mu_3 = 0.1$. The least horizontal force F to start the motion of any part of the system of three blocks resting upon one another as shown in figure is ($g = 10\ m/s^2$)



(A) 60 N (B) 90 N (C) 80 N (D) 50 N

6.14 A 1.5 kg box is initially at rest on a horizontal surface when at t = 0 a horizontal force $\vec{F} = (1.8t)\hat{i}N$ (with t in seconds), is applied to the box. The acceleration of the box as a function of time t is given by :

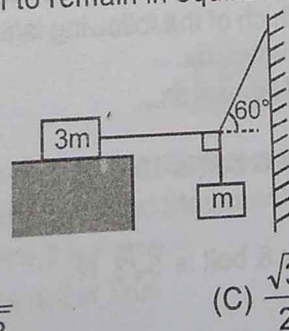
$\vec{a} = 0$ for $0 \le t \le 2.85$

$\vec{a} = (1.2t - 2.4)\hat{i}\ m/s^2$ for $t > 2.85$

The coefficient of kinetic friction between the box and the surface is :

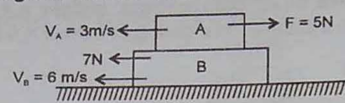
(A) 0.12 (B) 0.24 (C) 0.36 (D) 0.48

6.15 A mass *m* is supported as shown in the figure by ideal strings connected to a rigid wall and to a mass 3*m* at rest on a fixed horizontal surface. The string connected to larger mass is horizontal, that connected to smaller mass is vertical and the one connected to wall makes an angle 60° with horizontal. Then the minimum coefficient of static friction between the larger mass and the horizontal surface that permits the system to remain in equilibrium in the situation shown is:



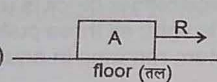
(A) $\frac{1}{\sqrt{3}}$ (B) $\frac{1}{3\sqrt{3}}$ (C) $\frac{\sqrt{3}}{2}$ (D) $\sqrt{\frac{3}{2}}$

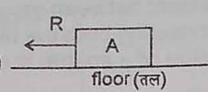
6.16 In the following figure, find the direction of friction on the blocks and ground respectively .

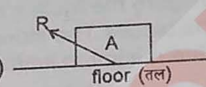


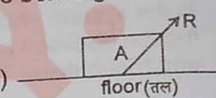
(A) Block A (left), block B(right due to block A, right due to ground)
(B) Block A (right), block B(left due to block A, left due to ground)
(C) Block A (right), block B(left due to block A, right due to ground)
(D) Block A (left), block B(left due to block A, left due to ground)

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) 

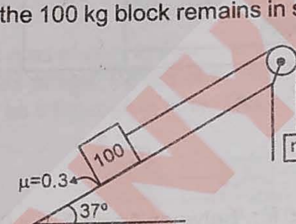
(B) 

(C) 

(D) 

SECTION - II : MULTIPLE CORRECT ANSWER TYPE

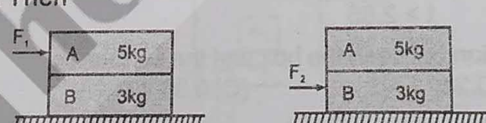
6.18 The value of mass m for which the 100 kg block remains in static equilibrium is :



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

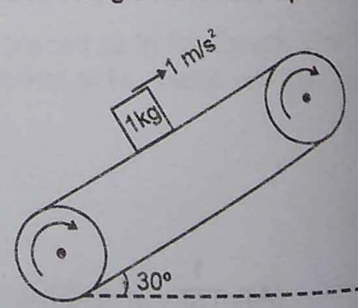
6.19 The force F_1 that is necessary to move a body up an inclined plane is double the force F_2 that is necessary to just prevent it from sliding down, then :
(A) $F_2 = w\sin(\theta-\phi)\sec\phi$ (B) $F_1 = w\sin(\theta-\phi)\sec\phi$
(C) $\tan\phi = 3\tan\theta$ (D) $\tan\theta = 3\tan\phi$

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



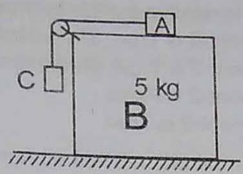
(A) F_1 (max) = F_2 (max) (B) F_1 (max) > F_2 (max)
(C) F_1 (max) < F_2 (max) (D) F_1 (max): F_2 (max) = 5: 3

6.21 A block of mass 1 kg is stationary with respect to a conveyer belt that is accelerating with 1 m/s² 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.



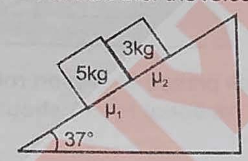
(C) Contact force between the block & belt is 10.5 N.
(D) Contact force between the block & belt is $5\sqrt{3}$ N.

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

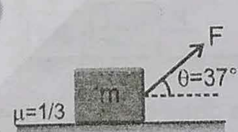
6.23 Two blocks of masses 5 kg and 3kg are placed in contact over an inclined surface of angle 37°, as shown. μ_1 is friction coefficient between 5kg block and the surface of the incline and similarly, μ_2 is friction coefficient between the 3kg block and the surface of the incline. After the release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

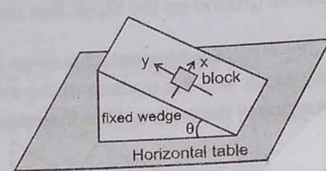
(A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.
(B) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1
(C) Statement-1 is True, Statement-2 is False
(D) Statement-1 is False, Statement-2 is True

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.



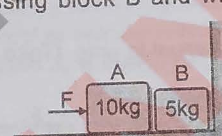
Statement-2 : To move the block placed at rest on rough inclined surface along the inclined surface, the net force on block (except frictional force) should be greater than μN. (N = normal reaction on block).

(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

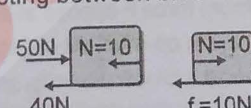
Comprehension # 1

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 –



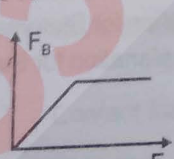
6.27 If F = 20 N, with how much force does block A presses the block B
(A) 10 N (B) 20 N (C) 30 N (D) Zero

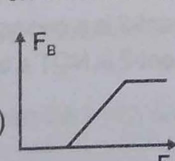
6.28 If F = 50 N, the friction force acting between block B and ground will be :

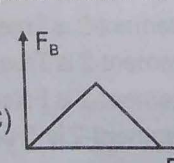


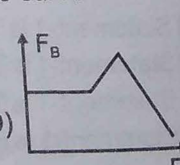
(A) 10 N (B) 20 N (C) 30 N (D) None

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

(A) 

(B) 

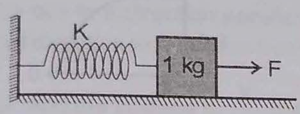
(C) 

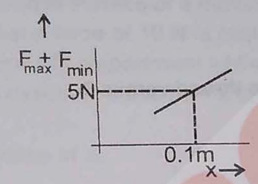
(D) 

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.





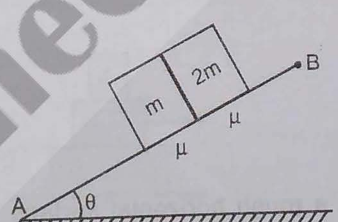
6.30 The coefficient of friction between the block and the horizontal surface is :
(A) 0.1 (B) 0.2 (C) 0.3 (D) 0.4

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) $\mu = \tan\theta$