

EXERCISE-01

CHECK YOUR GRASP

SELECT THE CORRECT ALTERNATIVE (ONLY ONE CORRECT ANSWER)

1. A body of mass m_1 exerts a force on another body of mass m_2 . If the magnitude of acceleration of m_2 is a_2 , then the magnitude of the acceleration of m_1 is (considering only two bodies in space)

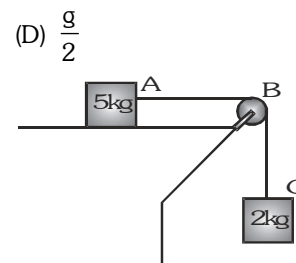
(A) Zero (B) $\frac{m_2 a_2}{m_1}$ (C) $\frac{m_1 a_2}{m_2}$ (D) a_2

2. A monkey is descending from the branch of a tree with constant acceleration. If the breaking strength of branch is 75% of the weight of the monkey, the minimum acceleration with which the monkey can slide down without breaking the branch is

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

3. A trolley of mass 5 kg on a horizontal smooth surface is pulled by a load of mass 2 kg by means of uniform rope ABC of length 2 m and mass 1 kg. As the load falls from $BC=0$ to $BC=2m$, its acceleration in m/s^2 changes-

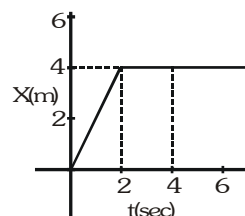
(A) $\frac{20}{6}$ to $\frac{20}{5}$ (B) $\frac{20}{8}$ to $\frac{30}{8}$ (C) $\frac{20}{5}$ to $\frac{30}{6}$



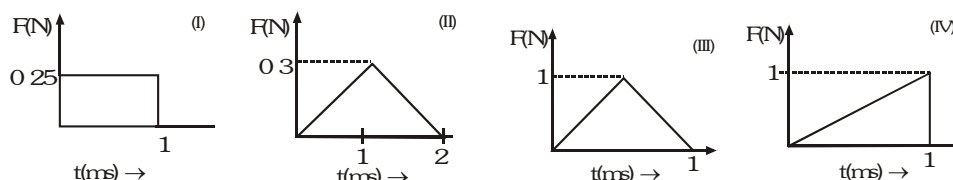
(D) None of the above

4. In the figure, the position-time graph of a particle of mass 0.1 kg is shown. The impulse at $t=2$ second is

(A) 0.2 $kgms^{-1}$ (B) -0.2 $kgms^{-1}$
(C) 0.1 $kgms^{-1}$ (D) -0.4 $kgms^{-1}$



5. Figures I, II, III and IV depicts variation of force with time



In which situation impulse will be maximum

(A) I & II (B) III & I (C) III & IV (D) Only IV

6. A body kept on a smooth inclined plane inclination 1 in x will remain stationary relative to the inclined plane if the plane is given a horizontal acceleration equal to :-

(A) $\sqrt{x^2 - 1}g$ (B) $\frac{\sqrt{x^2 - 1}}{x}g$ (C) $\frac{gx}{\sqrt{x^2 - 1}}$ (D) $\frac{g}{\sqrt{x^2 - 1}}$

7. A monkey is sitting on the pan of a spring balance which is placed on an elevator. The maximum reading of the spring balance will be when :

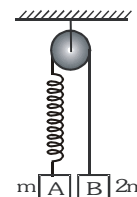
(A) the elevator is stationary
(B) the string of the elevator breaks and it drops freely towards the earth
(C) the elevator is accelerated downwards
(D) the elevator is accelerated upwards.

8. A pulley is attached to the ceiling of a lift moving upwards. Two particles are attached to the two ends of a string passing over the pulley. The masses of the particles are in the ratio 2 : 1. If the acceleration of the particles is $g/2$, then the acceleration of the lift will be

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

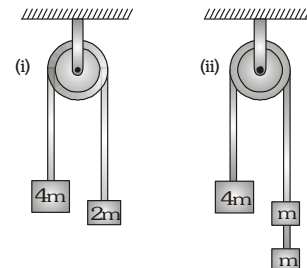
9. Two blocks A and B of masses m & $2m$ respectively are held at rest such that the spring is in natural length. What is the acceleration of both the blocks just after release?

(A) $g \downarrow, g \downarrow$ (B) $\frac{g}{3} \downarrow, \frac{g}{3} \uparrow$
(C) $0, 0$ (D) $g \downarrow, 0$



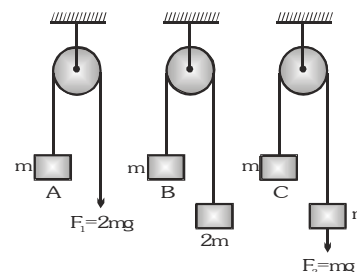
10. In the arrangement shown in figure, pulley is smooth and massless and all the strings are light. Let F_1 be the force exerted on the pulley in case (i) and F_2 the force in case (ii). Then

(A) $F_1 > F_2$
(B) $F_1 < F_2$
(C) $F_1 = F_2$
(D) $F_1 = 2F_2$



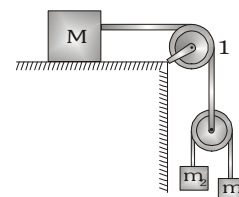
11. In the figure, the blocks A, B and C of mass m , each have accelerations a_1 , a_2 and a_3 respectively. F_1 and F_2 are external forces of magnitudes $2mg$ and mg respectively.

(A) $a_1 = a_2 = a_3$
(B) $a_1 > a_3 > a_2$
(C) $a_1 = a_2, a_2 > a_3$
(D) $a_1 > a_2, a_2 = a_3$



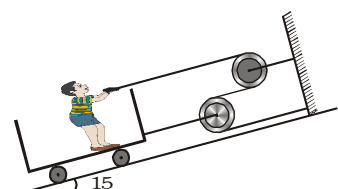
12. In the arrangement shown in figure $m_1 = 1\text{kg}$, $m_2 = 2\text{kg}$. Pulleys are massless and strings are light. For what value of M the mass m_1 moves with constant velocity (Neglect friction)

(A) 6 kg (B) 4 kg
(C) 8 kg (D) 10 kg

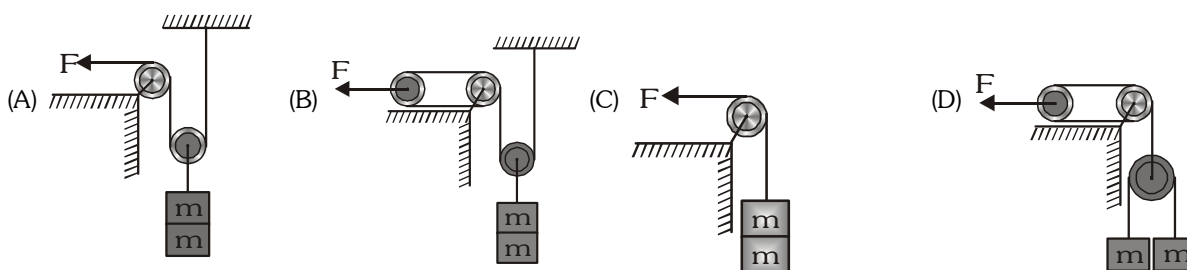


13. A trolley is being pulled up an incline plane by a man sitting on it (as shown in figure). He applies a force of 250 N. If the combined mass of the man and trolley is 100 kg, the acceleration of the trolley will be [$\sin 15^\circ = 0.26$]

(A) 2.4 m/s^2 (B) 9.4 m/s^2
(C) 6.9 m/s^2 (D) 4.9 m/s^2

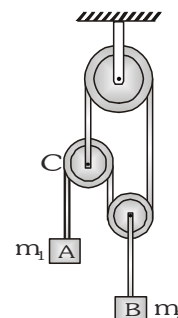


14. A man thinks about 4 arrangements as shown to raise two small bricks each having mass m . Which of the arrangement would take minimum time?



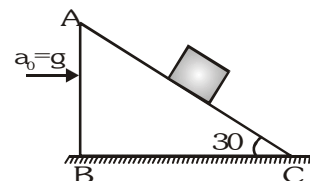
15. In the arrangement shown in figure neglect the masses of the pulley and string and also friction. The accelerations of blocks A and B are

(A) $g, g/2$
(B) $g/2, g$
(C) $3g/2, 3g/4$
(D) g, g



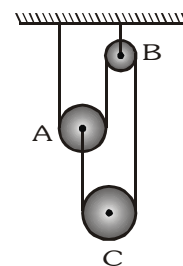
16. A block is placed on an inclined plane moving towards right horizontally with an acceleration $a_0 = g$. The length of the plane $AC = 1\text{m}$. Friction is absent everywhere. The time taken by the block to reach from C to A is
($g = 10 \text{ m/s}^2$)

(A) 1.2 s
(B) 0.74 s
(C) 2.56 s
(D) 0.42 s

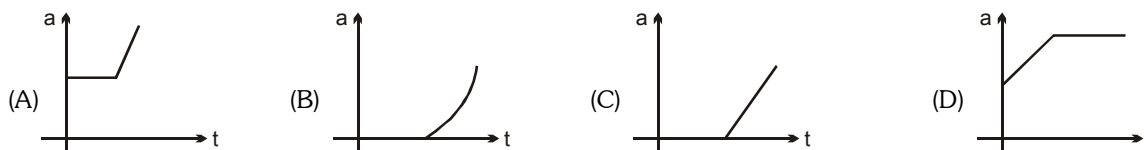


17. In the arrangement shown in figure pulley A and B are massless and the thread is inextensible. Mass of pulley C is equal to m . If friction in all the pulleys is negligible, then

(A) tension in thread is equal to $1/2 mg$
(B) acceleration of pulley C is equal to $g/2$ (downward)
(C) acceleration of pulley A is equal to $g/2$ (upward)
(D) acceleration of pulley A is equal to $2g$ (upward)

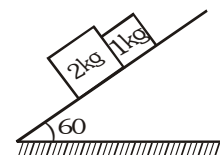


18. A block is placed on a rough horizontal plane. A time dependent horizontal force $F = kt$ acts on the block. Here k is a positive constant. Acceleration-time graph of the block is



19. In the figure shown if friction coefficient of block 1kg and 2kg with inclined plane is $\mu_1 = 0.5$ and $\mu_2 = 0.4$ respectively, then

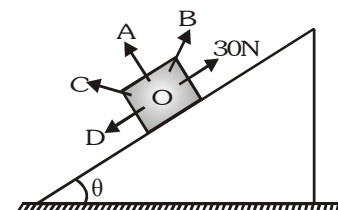
(A) both block will move together
(B) both block will move separately
(C) there is a non zero contact force between two blocks
(D) None of these



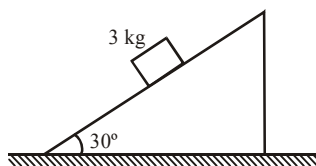
20. A block of mass of 10 kg lies on a rough inclined plane of inclination $\theta = \sin^{-1}\left(\frac{3}{5}\right)$ with the horizontal when a force of 30N is applied on the block parallel to and upward the plane, the total force exerted by the plane on the block is nearly

along (coefficient of friction is $\mu = \frac{3}{4}$) ($g = 10 \text{ m/s}^2$)

(A) OA
(B) OB
(C) OC
(D) OD

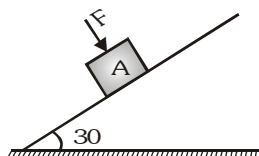


21. A block of mass 3 kg is at rest on a rough inclined plane as shown in the figure. The magnitude of net force exerted by the surface on the block will be ($g=10 \text{ m/s}^2$)



- (A) 26N (B) 19.5N (C) 10N (D) 30 N

22. A block of mass $m = 2 \text{ kg}$ is resting on a rough inclined plane of inclination 30° as shown in figure. The coefficient of friction between the block and the plane is $\mu = 0.5$. What minimum force F should be applied perpendicular to the plane on the block, so that block does not slip on the plane ($g=10 \text{ m/s}^2$)



- (A) zero (B) 6.24 N (C) 2.68 N (D) 4.34 N

23. A block of mass 0.1 kg is held against a wall applying a horizontal force of 5N on the block. If the coefficient of friction between the block and the wall is 0.5, the magnitude of the frictional force acting on the block is :-

- (A) 2.5 N (B) 0.98 N (C) 4.9 N (D) 0.49 N

24. A 40 kg slab rests on a frictionless floor. A 10 kg block rests on top of the slab. The static coefficient of friction between the block and slab is 0.60 while the kinetic coefficient is 0.40. The 10 kg block is acted upon by a horizontal force of 100N. If $g = 9.8 \text{ m/s}^2$, the resulting acceleration of the slab will be :-



- (A) 0.98 m/s^2 (B) 1.47 m/s^2 (C) 1.52 m/s^2 (D) 6.1 m/s^2

25. The rear side of a truck is open and a box of mass 20 kg is placed on the truck 4m away from the open end, $\mu = 0.15$ and $g=10 \text{ m/sec}^2$. The truck starts from rest with an acceleration of 2 m/sec^2 on a straight road. The distance moved by the truck when box starts fall down.

- (A) 4 m (B) 8 m (C) 16 m (D) 32 m

26. In the arrangement shown in figure, coefficient of friction between the two blocks is $\mu = \frac{1}{2}$. The force of friction acting between the two blocks is

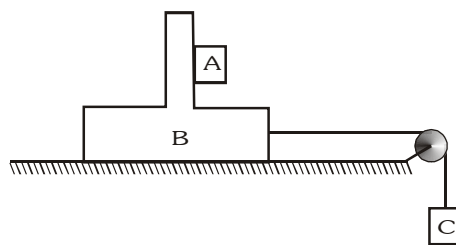


- (A) 8 N (B) 10 N (C) 6 N (D) 4 N

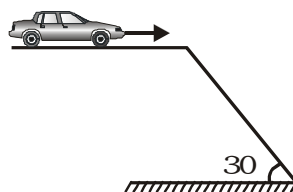
27. ϕ is the angle of the incline when a block of mass m just starts slipping down. The distance covered by the block if thrown up the incline with an initial speed v_0 is :

- (A) $\frac{v_0^2}{4g \sin \phi}$ (B) $\frac{4v_0^2}{g \sin \phi}$ (C) $\frac{v_0^2 \sin \phi}{4g}$ (D) $\frac{4v_0^2 \sin \phi}{g}$

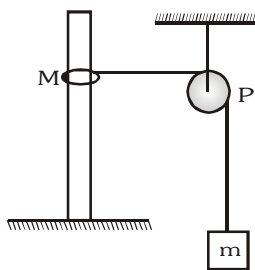
28. In the arrangement shown in the figure, mass of the block B and A is $2m$ and m respectively. Surface between B and floor is smooth. The block B is connected to the block C by means of a string pulley system. If the whole system is released, then find the minimum value of mass of block C so that A remains stationary w.r.t. B. Coefficient of friction between A and B is μ .



- (A) $\frac{m}{\mu}$ (B) $\frac{2m+1}{\mu+1}$ (C) $\frac{3m}{\mu-1}$ (D) $\frac{6m}{\mu+1}$
29. A car is going at a speed of 6 m/s when it encounters a 15 m slope of angle 30° . The friction coefficient between the road and tyre is 0.5 . The driver applies the brakes. The minimum speed of car with which it can reach the bottom is ($g = 10 \text{ m/s}^2$)



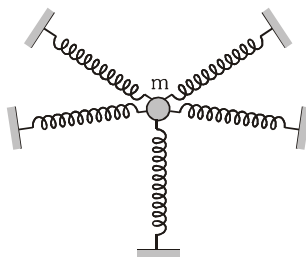
- (A) 4 m/s (B) 3 m/s (C) 7.49 m/s (D) 8.45 m/s
30. In the figure shown a ring of mass M and a block of mass m are in equilibrium. The string is light and pulley P does not offer any friction and coefficient of friction between pole and M is μ . The frictional force offered by the pole on M is



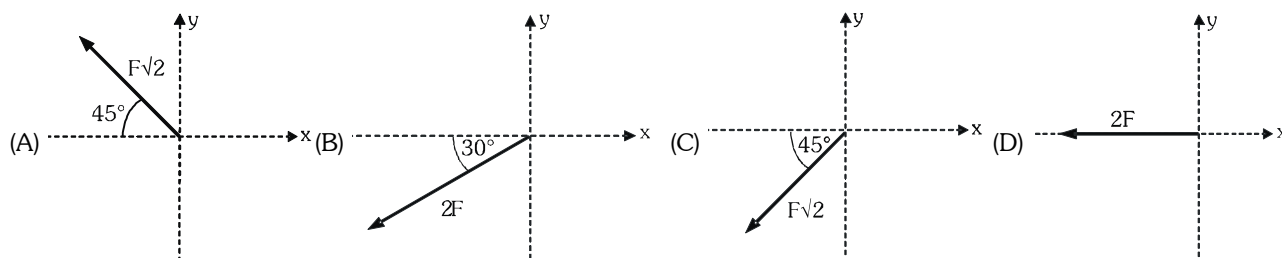
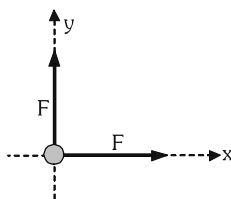
- (A) Mg directed up (B) μmg directed up
(C) $(M - m)g$ directed down (D) μmg direction down
31. If you want to pile up sand onto a circular area of radius R . The greatest height of the sand pile that can be erected without spilling the sand onto the surrounding area, if μ is the coefficient of friction between sand particle is :-

- (A) R (B) $\mu^2 R$ (C) μR (D) $\frac{R}{\mu}$

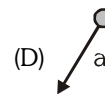
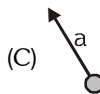
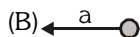
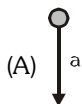
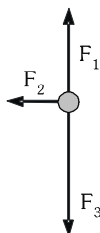
32. A sphere of mass m is kept in equilibrium with the help of several springs as shown in the figure. Measurement shows that one of the springs applies a force \vec{F} on the sphere. With what acceleration the sphere will move immediately after this particular spring is cut?



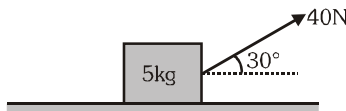
- (A) zero (B) \vec{F}/m (C) $-\vec{F}/m$ (D) insufficient information
33. Two forces are simultaneously applied on an object. What third force would make the net force to point to the left ($-x$ direction)?



34. Three forces F_1 , F_2 and F_3 act on an object simultaneously. These force vectors are shown in the following free-body diagram. In which direction does the object accelerate?



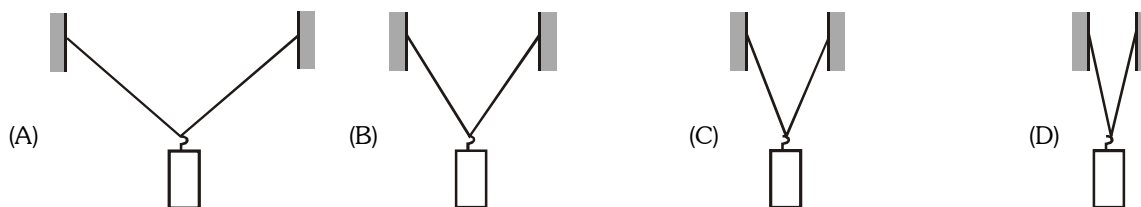
35. The adjoining figure shows a force of 40 N pulling a body of mass 5 kg in a direction 30° above the horizontal. The body is in rest on a smooth horizontal surface. Assuming acceleration of free-fall is 10 m/s^2 . Which of the following statements I and II is/are correct?



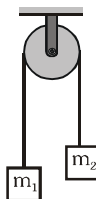
I. The weight of the 5 kg mass acts vertically downwards

II. The net vertical force acting on the body is 30 N.

- (A) Only I. (B) Only II. (C) Both I and II. (D) None of them
36. A block of weight W is suspended by a string of fixed length. The ends of the string are held at various positions as shown in the figures below. In which case, if any, is the magnitude of the tension along the string largest?



37. An ideal string is passing over a smooth pulley as shown. Two blocks m_1 and m_2 are connected at the ends of the string. If $m_1 = 1 \text{ kg}$ and tension in the string is 10 N, mass m_2 is equal to ($g = 10 \text{ m/s}^2$)



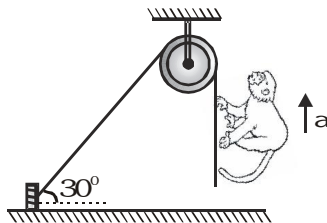
- (A) 1 kg (B) 1.5 kg (C) 2 kg (D) 0.5 kg

CHECK YOUR GRASP								ANSWER KEY								EXERCISE -1				
Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	B	C	B	B	C	D	D	B	A	C	B	C	D	A	D	B	D	C	B	B
Que.	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37			
Ans.	D	C	B	A	C	A	A	C	C	A	C	C	C	D	A	A	A			

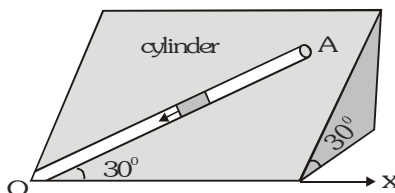
EXERCISE-02**BRAIN TEASURES**

Select the correct alternatives (one or more than one correct answers)

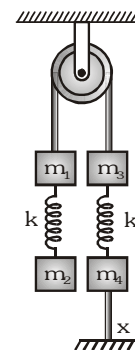
1. A light string fixed at one end to a clamp on ground passes over a fixed pulley and hangs at the other side. It makes an angle of 30° with the ground. A monkey of mass 5 kg climbs up the rope. The clamp can tolerate a vertical force of 40 N only. The maximum acceleration in upward direction with which the monkey can climb safely is (neglect friction and take $g = 10 \text{ m/s}^2$) :



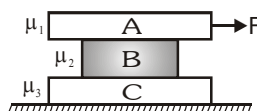
- (A) 2 m/s^2 (B) 4 m/s^2 (C) 6 m/s^2 (D) 8 m/s^2
2. An inclined plane makes an angle 30° with the horizontal. A groove $OA=5\text{m}$ cut in the plane makes an angle 30° with OX . A short smooth cylinder is free to slide down the influence of gravity. The time taken by the cylinder to reach from A to O is ($g = 10 \text{ m/s}^2$)



- (A) 4s (B) 2s (C) $2\sqrt{2} \text{ s}$ (D) 1s
3. A block is kept on a smooth inclined plane of angle of inclination 30° that moves with a constant acceleration so that the block does not slide relative to the inclined plane. Let F_1 be the contact force between the block and the plane. Now the inclined plane stops and let F_2 be the contact force between the two in this case. Then F_1/F_2 is
- (A) 1 (B) $\frac{4}{3}$ (C) 2 (D) $\frac{3}{2}$
4. For the system shown in the figure, the acceleration of the mass m_4 immediately after the lower thread x is cut will be, (assume that the threads are weightless and inextensible, the spring are weightless, the mass of pulley is negligible and there is no friction)

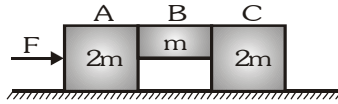


- (A) 0 (B) $\left(\frac{m_1 + m_2 - m_3}{m_4} \right) g$
- (C) $\left(\frac{m_1 + m_2 - m_3 - m_4}{m_4} \right) g$ (D) $\frac{g}{4}$
5. Given $m_A = 30 \text{ kg}$, $m_B = 10 \text{ kg}$, $m_C = 20 \text{ kg}$. The coefficient of friction between A and B $\mu_1 = 0.3$, between B and C $\mu_2 = 0.2$ and between C, and ground, $\mu_3 = 0.1$. The least horizontal force F to start motion of any part of the system of three blocks resting upon one another as shown in figure is ($g = 10 \text{ m/s}^2$)



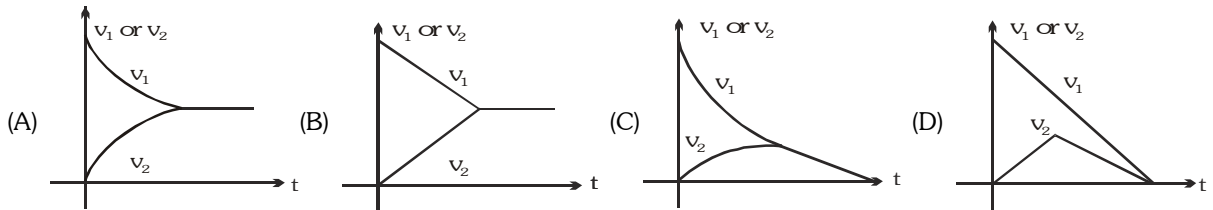
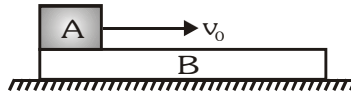
- (A) 60 N (B) 90 N (C) 80 N (D) 150 N

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

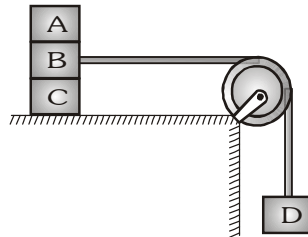


- (A) $\left(\frac{3}{2\mu}\right)mg$ (B) $\left(\frac{5}{2\mu}\right)mg$ (C) $\left(\frac{5}{2}\right)\mu mg$ (D) $\left(\frac{3}{2}\right)\mu mg$

7. A block A is placed over a long rough plank B of same mass as shown in figure. The plank is placed over a smooth horizontal surface. At time $t=0$, block A is given a velocity v_0 in horizontal direction. Let v_1 and v_2 be the velocities of A and B at time t . Then choose the correct graph between v_1 or v_2 and t .

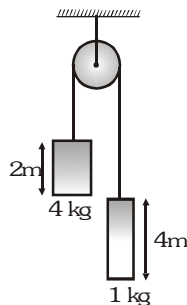


8. Three blocks A, B and C of equal mass m are placed one over the other on a smooth horizontal ground as shown in figure. Coefficient of friction between any two blocks of A, B and C is $\frac{1}{2}$. The maximum value of mass of block D so that the blocks A, B and C move without slipping over each other is



- (A) 6 m (B) 5 m (C) 3 m (D) 4 m

9. In figure shown, both blocks are released from rest. The time to cross each other is



- (A) 2 second (B) 3 second (C) 1 second (D) 4 second

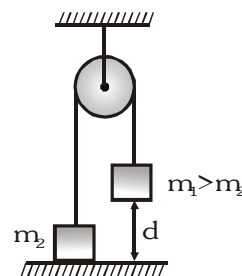
10. If masses are released from the position shown in figure then time elapsed before mass m_1 collides with the floor will be :

(A) $\sqrt{\frac{2m_1gd}{m_1+m_2}}$

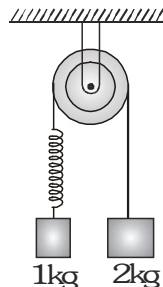
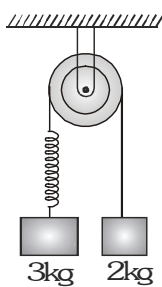
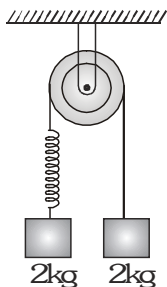
(B) $\sqrt{\frac{2(m_1+m_2)d}{(m_1-m_2)g}}$

(C) $\sqrt{\frac{2(m_1-m_2)d}{(m_1+m_2)g}}$

(D) None of these

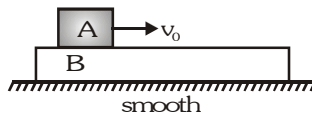


11. Same spring is attached with 2kg, 3kg and 1 kg blocks in three different cases as shown in figure. If x_1 , x_2 and x_3 be the extensions in the spring in these three cases then



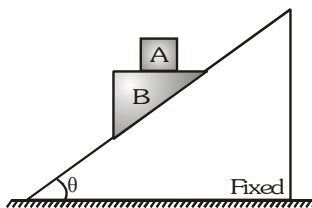
- (A) $x_1 = 0$, $x_3 > x_2$ (B) $x_2 > x_1 > x_3$ (C) $x_3 > x_1 > x_2$ (D) $x_1 > x_2 > x_3$

12. A block A of mass m is placed over a plank B of mass $2m$. Plank B is placed over a smooth horizontal surface. The coefficient of friction between A and B is 0.5. Block A is given a velocity v_0 towards right. Acceleration of B relative to A is



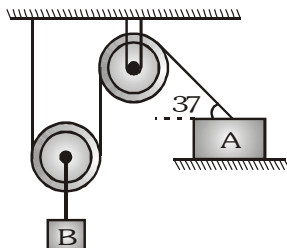
- (A) $\frac{g}{2}$ (B) g (C) $\frac{3g}{4}$ (D) zero

13. Block A of mass m is placed over a wedge B of same mass m . Assuming all surfaces to be smooth. The displacement of block A in 1 s if the system is released from rest is



- (A) $g \frac{(1 + \sin^2 \theta)}{(1 - \sin^2 \theta)}$ (B) $\frac{g \sin \theta}{2}$ (C) $g \frac{\cos^2 \theta}{1 + \sin^2 \theta}$ (D) $g \frac{\sin^2 \theta}{1 + \sin^2 \theta}$

14. In the figure shown block B moves down with a velocity 10 m/s. The velocity of A in the position shown is

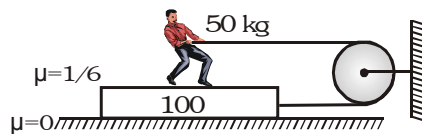


- (A) 12.5 m/s (B) 25 m/s (C) 6.25 m/s (D) None of these

15. A particle is moving along the circle $x^2 + y^2 = a^2$ in anticlockwise direction. The x-y plane is a rough horizontal stationary surface. At the point $(a \cos \theta, a \sin \theta)$, the unit vector in the direction of friction on the particle is

(A) $\cos \theta \vec{i} + \sin \theta \vec{j}$ (B) $-(\cos \theta \vec{i} + \sin \theta \vec{j})$ (C) $\sin \theta \vec{i} - \cos \theta \vec{j}$ (D) $\cos \theta \vec{i} - \sin \theta \vec{j}$

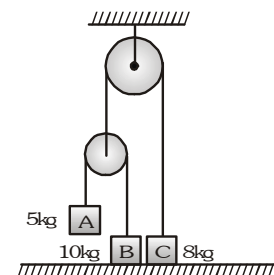
16. A man of mass 50 kg is pulling on a plank of mass 100 kg kept on a smooth floor as shown with force of 100 N. If both man & plank move together, find force of friction acting on man.



(A) $\frac{100}{3}$ N towards left (B) $\frac{100}{3}$ N towards right
(C) $\frac{250}{3}$ N towards left (D) $\frac{250}{3}$ N towards right

17. In the following arrangement the system is initially at rest. The 5 kg block is now released. Assuming the pulleys and string to be massless and smooth, the acceleration of blocks is

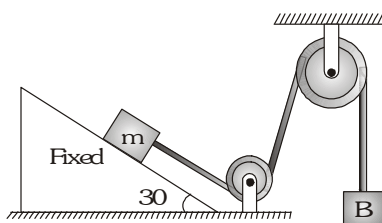
(A) $a_A = \frac{g}{7}$ (B) $a_B = 0 \text{ m/s}^2$
(C) $a_C = \frac{5}{7} \text{ m/s}^2$ (D) $2a_C = a_A$



18. In order to raise a mass of 100 kg a man of mass 60 kg fastens a rope to it and passes the rope over a smooth pulley. He climbs the rope with an acceleration $5g/4$ relative to rope. The tension in the rope is ($g = 10 \text{ m/s}^2$)

(A) 1432 N (B) 928 N (C) 1218 N (D) 642 N

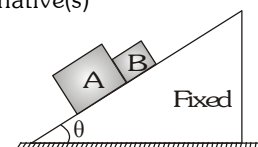
19. Two blocks A and B of equal mass m are connected through a massless string and arranged as shown in figure. Friction is absent everywhere. When the system is released from rest.



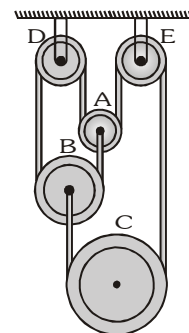
(A) tension in string is $\frac{mg}{2}$ (B) tension in string is $\frac{mg}{4}$
(C) acceleration of A is $\frac{g}{2}$ (D) acceleration of A is $\frac{3}{4}g$

20. In the arrangement shown in figure all surfaces are smooth. Select the correct alternative(s)
(A) for any value of θ acceleration of A and B are equal

(B) contact force between the two blocks is zero if $\frac{m_A}{m_B} = \tan \theta$
(C) contact force between the two is zero for any value of m_A or m_B
(D) normal reactions exerted by the wedge on the blocks are equal



21. In the pulley system shown in figure the movable pulleys A, B and C are of mass 1 kg each. D and E are fixed pulleys. The strings are light and inextensible. Choose the correct alternative(s). All pulleys are frictionless.



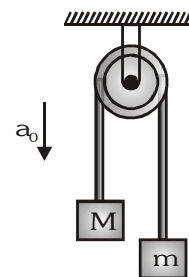
- (A) tension in the string is 6.5 N
(B) acceleration of pulley A is $g/3$ downward
(C) acceleration of pulley B is $g/6$ upward
(D) acceleration of pulley C is $g/3$ upward

22. A block is placed over a plank. The coefficient of friction between the block and the plank is $\mu = 0.2$. Initially both are at rest, suddenly the plank starts moving with acceleration $a_0 = 4 \text{ m/s}^2$. The displacement of the block in 1s is ($g=10 \text{ m/s}^2$)

- (A) 1 m relative to ground
(B) 1 m relative to plank
(C) zero relative to plank
(D) 2 m relative to ground

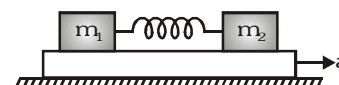
23. If the acceleration of the elevator $a_0 > g$, then

- (A) the acceleration of the masses will be a_0
(B) the acceleration of the masses will be $(a_0 - g)$
(C) the tension in the string will be $\frac{mM}{M+m}(g - a_0)$
(D) tension in the string will be zero.



24. Two blocks of masses m_1 and m_2 are connected with a massless 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 $a \leq \mu g$
(C) spring will neither be compressed nor be stretched for $a \leq \mu g$
(D) spring will be in its natural length under all conditions



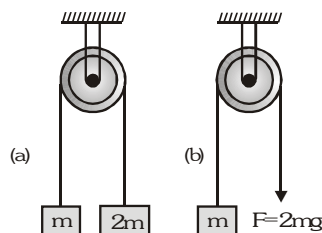
BRAIN TEASERS					ANSWER KEY					EXERCISE -2						
Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
Ans.	C	B	B	C	A	B	B	C	C	B	B	C	D	B	C	
Que.	16	17	18	19	20	21	22	23	24							
Ans.	A	A,B,C,D	C	B,D	A,C	A,B,D	A,B	D	D							

EXERCISE-03

MISCELLANEOUS TYPE QUESTIONS

TRUE / FALSE

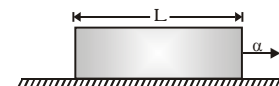
- The pulley arrangements of figure (a) and (b) are identical. The mass of the rope is negligible. In (a) the mass m is lifted up by attaching a mass $2m$ to the other end of the rope. In (b), m is lifted up by pulling the other end of the rope with a constant downward force $F = 2mg$. The acceleration of m is the same in both cases.



- A car with closed windows makes a left turn. A helium filled balloon in the car will be pushed to the left side.
- A simple pendulum with a bob of mass m swings with an angular amplitude of 40° . When its angular displacement is 20° , the tension in the string is greater than $mg \cos 20^\circ$.
- When a person walks on a rough surface, the frictional force exerted by the surface on the person is opposite to the direction of his motion.
- The force of friction on a body may be zero even if it is on a rough surface.
- The frictional force is always in a direction opposite to the direction in which the body tends to move relative to the other.
- Two identical trains are moving on rails along the equator on the earth in opposite directions with the same speed. They will exert the same pressure on the rails.

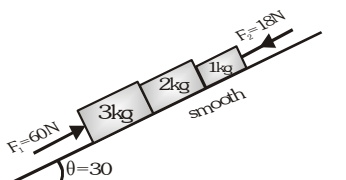
FILL IN THE BLANKS

- 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 newtons.
- A uniform rod of length L & density ρ is being pulled along a smooth floor with a horizontal acceleration α (see figure). The magnitude of the stress (force/area) at the transverse cross-section through the mid-point of the rod is



MATCH THE COLUMN

- In the diagram shown in figure ($g = 10 \text{ m/s}^2$)



Column I

- Acceleration of 2kg block
- Net force on 3kg block
- Normal reaction between 2kg and 1kg
- Normal reaction between 3kg and 2kg

Column II

- 8 SI unit
- 25 SI unit
- 2 SI unit
- 45 N
- None

2. Velocity of three particles A, B and C varies with time t as, $\vec{v}_A = (2t\vec{i} + 6\vec{j})$ m/s $\vec{v}_B = (3\vec{i} + 4\vec{j})$ m/s and $\vec{v}_C = (6\vec{i} - 4t\vec{j})$ m/s. Regarding the pseudo force match the following table :-

Column I	Column II
(A) On A as observed by B	(p) Along positive x-direction
(B) On B as observed by C	(q) Along negative x-direction
(C) On A as observed by C	(r) Along positive y-direction
(D) On C as observed by A	(s) Along negative y-direction
	(t) Zero

ASSERTION & REASON

These questions contains, Statement I (assertion) and Statement II (reason).

1. **Statement-I** : A stationary object placed on ground may experience a pseudo force as observed by the reference frame attached to the ground.

because

Statement-II : Earth (a rotating body) is a non-inertial frame.

- (A) Statement-I is true, Statement-II is true ; Statement-II is correct explanation for Statement-I.
 (B) Statement-I is true, Statement-II is true ; Statement-II is NOT a correct explanation for statement-I
 (C) Statement-I is true, Statement-II is false
 (D) Statement-I is false, Statement-II is true

2. **Statement-I** : A man who falls from a height on a cement floor receive more injury than when he falls from the same height on a heap of sand.

because

Statement-II : The impulse applied by a cement floor is more than the impulse by sand floor.

- (A) Statement-I is true, Statement-II is true ; Statement-II is correct explanation for Statement-I.
 (B) Statement-I is true, Statement-II is true ; Statement-II is NOT a correct explanation for statement-I
 (C) Statement-I is true, Statement-II is false
 (D) Statement-I is false, Statement-II is true

3. **Statement-I** : In Karate a brick is broken with a bare hand.

because

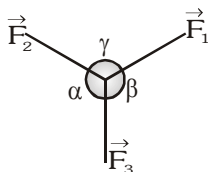
Statement-II : In this process the impulse is sharp.

- (A) Statement-I is true, Statement-II is true ; Statement-II is correct explanation for Statement-I.
 (B) Statement-I is true, Statement-II is true ; Statement-II is NOT a correct explanation for statement-I
 (C) Statement-I is true, Statement-II is false
 (D) Statement-I is false, Statement-II is true

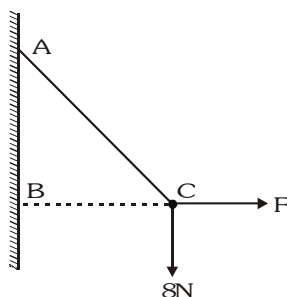
4. **Statement-I** : Aeroplanes always fly at low altitudes.
because
Statement-II : According to Newton's third law of motion, for every action there is an equal and opposite reaction.
 (A) Statement-I is true, Statement-II is true ; Statement-II is correct explanation for Statement-I.
 (B) Statement-I is true, Statement-II is true ; Statement-II is NOT a correct explanation for statement-I
 (C) Statement-I is true, Statement-II is false
 (D) Statement-I is false, Statement-II is true
5. **Statement-I** : A larger force is required to start the motion than to maintain it.
because
Statement-II : Kinetic friction coefficient is always less than (or equal to) static friction coefficient.
 (A) Statement-I is true, Statement-II is true ; Statement-II is correct explanation for Statement-I.
 (B) Statement-I is true, Statement-II is true ; Statement-II is NOT a correct explanation for statement-I
 (C) Statement-I is true, Statement-II is false
 (D) Statement-I is false, Statement-II is true
6. **Statement-I** : When brakes are applied on a wet road , a car is likely to skid.
because
Statement-II : Because brakes prevent rotation of the wheels, and there is not sufficient friction between the road and the wheels.
 (A) Statement-I is true, Statement-II is true ; Statement-II is correct explanation for Statement-I.
 (B) Statement-I is true, Statement-II is true ; Statement-II is NOT a correct explanation for statement-I
 (C) Statement-I is true, Statement-II is false
 (D) Statement-I is false, Statement-II is true
7. **Statement-I** : Pulling a lawn roller is easier than pushing it.
because
Statement-II : Pushing increases the apparent weight and hence the force of friction.
 (A) Statement-I is true, Statement-II is true ; Statement-II is correct explanation for Statement-I.
 (B) Statement-I is true, Statement-II is true ; Statement-II is NOT a correct explanation for statement-I
 (C) Statement-I is true, Statement-II is false
 (D) Statement-I is false, Statement-II is true
8. **Statement-I** : A block of mass m is kept at rest on an inclined plane, the net force applied by the surface to the block will be mg .
because
Statement-II : Contact force is the resultant of normal contact force and friction force.
 (A) Statement-I is true, Statement-II is true ; Statement-II is correct explanation for Statement-I.
 (B) Statement-I is true, Statement-II is true ; Statement-II is NOT a correct explanation for statement-I
 (C) Statement-I is true, Statement-II is false
 (D) Statement-I is false, Statement-II is true
9. **Statement-I** : Two teams having a tug of war always pull equally hard on one another.
because
Statement-II : The team that pushes harder against the ground, in a tug of war, wins.
 (A) Statement-I is true, Statement-II is true ; Statement-II is correct explanation for Statement-I.
 (B) Statement-I is true, Statement-II is true ; Statement-II is NOT a correct explanation for statement-I
 (C) Statement-I is true, Statement-II is false
 (D) Statement-I is false, Statement-II is true

COMPREHENSION BASED QUESTIONS**Comprehension # 1**

If three concurrent forces \vec{F}_1 , \vec{F}_2 and \vec{F}_3 are in equilibrium then according to Lami's theorem, $\frac{F_1}{\sin \alpha} = \frac{F_2}{\sin \beta} = \frac{F_3}{\sin \gamma}$

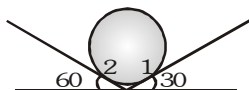


1. One end of a string 0.5 m long is fixed to a point A and other end is fastened to a small object of weight 8N. The object is pulled aside by a horizontal force F, until it is 0.3 m from the vertical through A. The magnitude of the tension T in the string and the force F will be



- (A) 6N, 10N (B) 10N, 6N (C) 8N, 10N (D) 3N, 4N

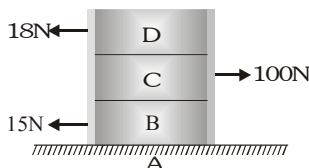
2. A solid sphere of mass 10 kg is placed over two smooth inclined planes as shown in figure. Normal reaction at 1 and 2 will be : ($g = 10 \text{ m/s}^2$)



- (A) $50\sqrt{3}\text{N}, 50\text{N}$ (B) 50N, 50N (C) $50\text{N}, 50\sqrt{3}\text{N}$ (D) 60N, 40N

Comprehension # 2

Each of the three plates has a mass of 10 kg. If the coefficients of static and kinetic friction at each surface of contact are $\mu_s = 0.3$ and $\mu_k = 0.2$, respectively ($g=10 \text{ ms}^{-2}$)



- The acceleration of block B is
 (A) zero (B) 3.336 m/s^2 (C) 4.11 m/s^2 (D) 5 m/s^2
- The acceleration of block C is :
 (A) zero (B) 3.336 m/s^2 (C) 4 m/s^2 (D) 5 m/s^2
- The acceleration of block D is :
 (A) 2 m/s^2 (B) 0.2 m/s^2 (C) 5 m/s^2 (D) 3.36 m/s^2

Comprehension # 3

Experiment 1 : The student pushes horizontally (rightward) on the crate and gradually increases the strength of this push force. The crate does not begin to move until the push force reaches 400 N.

Experiment 2 : The student applies a constant horizontal (rightward) push force for 1.0 s and measures how far the crate moves during that time interval. In each trial the crate starts at rest, and the student stops pushing after the 1.0 s interval. The following table summarizes the results.

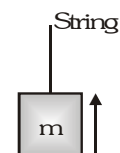
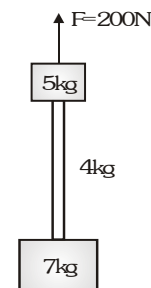
Trial	Push force (N)	Distance (m)
1	500	1.5
2	600	2
3	700	2.5

- The coefficient of static friction between the crate and floor is approximately :
(A) 0.25 (B) 0.40 (C) 2.5 (D) 4.0
- In experiment 1, when the rightward push force was 50N the crate didn't move. Why didn't it move ?
(A) The push force was weaker than the frictional force on the crate
(B) The push force had the same strength as the gravitational force on the crate
(C) The push force was stronger than the frictional force on the crate
(D) The push force had the same strength as the frictional force on the crate
- The coefficient of kinetic friction between the crate and the floor is approximately :
(A) 0.20 (B) 2.0 (C) 3.0 (D) 5.0
- In trial 3, what is the crate's speed at the moment the student stops pushing it ?
(A) 1.0 m/s (B) 2.0 m/s (C) 3.0 m/s (D) 5.0 m/s

Comprehension # 4

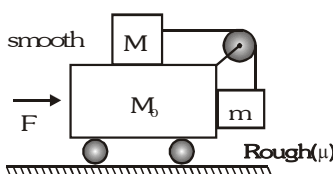
If a string is attached with a block, then it can only pull the block, it can't push the block.

- Two blocks shown in figure are connected by a heavy rope of mass 4kg. An upward force of 200 N is applied as shown. The tension at the mid-point of the rope is ($g = 10 \text{ ms}^{-2}$)
(a) 225N
(B) 112.5 N
(C) 90N
(D) None of these
- A block of mass m is attached with a massless instretchable string. Breaking strength of string is 4 mg . Block is moving up. The maximum acceleration and maximum retardation of the block can be.
(A) $4g, 3g$ (B) $4g, g$
(C) $3g, g$ (D) $3g, 4g$

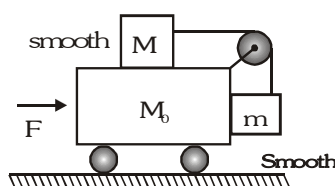


Comprehension # 5

Imagine a situation in which the horizontal surface of block M_0 is smooth and its vertical surface is rough with a coefficient of friction μ .



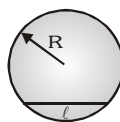
- Identify the correct statement(s)
 - If $F = 0$, the blocks cannot remain stationary
 - for one unique value of F , the blocks M and m remain stationary with respect to M_0
 - the limiting friction between m and M_0 is independent of F
 - there exist a value of F at which friction force is equal to zero
- In above problem, choose the correct value(s) of F which the blocks M and m remain stationary with respect to M_0
 - $(M_0 + M + m) \frac{g}{\mu}$
 - $\frac{m(M_0 + M + m)g}{M - \mu m}$
 - $(M_0 + M + m) \frac{mg}{M}$
 - None of these
- Consider a special situation in which both the faces of the block M_0 are smooth, as shown in adjoining figure. Mark out the correct statement(s)



- If $F = 0$, the blocks cannot remain stationary
 - for one unique value of F , the blocks M and m remain stationary with respect to block M_0
 - there exist as a range of F for which blocks M and m remain stationary with respect to block M_0
 - since there is no friction, therefore, blocks M and m cannot be in equilibrium with respect to M_0
- In above problem, the value(s) of F for which M and m are stationary with respect to M_0
 - $(M_0 + M + m)g$
 - $(M_0 + M + m) \frac{mg}{M}$
 - $(M_0 + M + m) \frac{Mg}{m}$
 - None of these

Comprehension # 6

A rod of length $\ell (< 2R)$ is kept inside a smooth spherical shell as shown in figure. Mass of the rod is m .

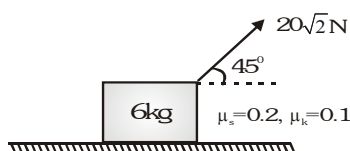


- Keeping mass to be constant if length of the rod is increased (but always $< 2R$) the normal reactions at two ends of the rod.
 - Will remain constant
 - Will increase
 - Will decrease
 - May increase or decrease
- The normal reaction when $\ell = R$ is :-
 - $\frac{mg}{2}$
 - $\frac{mg}{4}$
 - $\frac{mg}{2\sqrt{3}}$
 - $\frac{mg}{\sqrt{3}}$

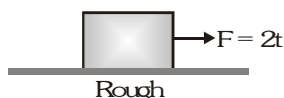
Comprehension # 7

Contact force (\vec{F}_c) between two bodies is the resultant of force of friction and normal reaction.

1. Contact force for shown position is ($g = 10 \text{ ms}^{-2}$)



- (a) 40N (B) $\sqrt{1616}$ N (C) 4N (D) None of these
2. A time varying force is applied on a block placed over a rough surface as shown in figure. Let θ be the angle between contact force on the block and the normal reaction, then with time, θ will :

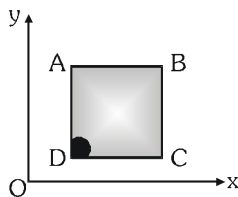


- (A) Remain constant
(B) First increase to a maximum value (say θ_{\max}) and then becomes constant in a value less than θ_{\max}
(C) First decrease to a minimum value (say θ_{\min}) and then becomes constant in a value more than θ_{\min}
(D) None of the above

MISCELLANEOUS TYPE QUESTION		ANSWER KEY		EXERCISE -3	
<ul style="list-style-type: none"><u>True / False</u> 1. F 2. T 3. T 4. F 5. T 6. T 7. F					
<ul style="list-style-type: none"><u>Fill in the Blanks</u> 1. 5 2. $\frac{\rho L \alpha}{2}$					
<ul style="list-style-type: none"><u>Match the Column</u> 1. (A)-r, (B)-t, (C) -q, (D) -t 2. (A)-t, (B)-r, (C)-r, (D)-q					
<ul style="list-style-type: none"><u>Assertion - Reason</u> 1. A 2. C 3. A 4. A 5. A 6. A 7. A 8. A 9. B					
<ul style="list-style-type: none"><u>Comprehension Based Questions</u> Comprehension #1 : 1. B 2. A Comprehension #2 : 1. A 2. C 3. B Comprehension #3: 1. B 2. D 3. A 4. D Comprehension #4 : 1. B 2. C Comprehension #5 : 1. A,D 2. B,C 3. A,B 4. B Comprehension #6 : 1. B 2. D Comprehension #7 : 1. B 2. B					

EXERCISE-04 [A]**CONCEPTUAL SUBJECTIVE EXERCISE**

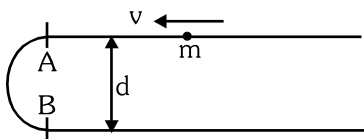
1. A solid sphere of mass 2 kg is resting inside a cube as shown in figure. The cube is moving with a velocity $\vec{v} = (5t\hat{i} + 2t\hat{j})$ m/sec. Here t is the time in second. All surface are smooth. The sphere is at rest with respect to the cube. What is the total force exerted by the sphere on the cube ? (Take $g = 10 \text{ ms}^{-2}$)



2. If contact force between 2kg and 4kg is f_1 and between 4kg and 6 kg is f_2 . Find out f_1 and f_2 .



3. Fig. shows a bead of mass m moving with uniform speed v through a U-shaped smooth wire the wire has a semicircular bending between A and B. Calculate The average force exerted by the bead on the part AB of the wire.



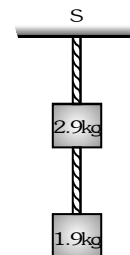
4. A monkey of mass 40 kg climbs on a rope which can stand a maximum tension of 600 N. Calculate tension in rope in following cases. In which case will the rope break :



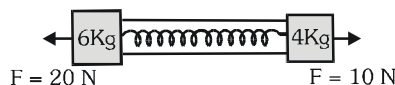
- (i) The monkey climbs up with an acceleration of 6 m s^{-2} .
- (ii) The monkey climbs down with an acceleration of 4 m s^{-2} .
- (iii) The monkey climbs up with a uniform speed of 5 m s^{-1} . Neglect the mass of string.

5. Two blocks of mass 2.9 kg and 1.9 kg are suspended from a rigid support S by two inextensible wires each of length 1m (see figure). The upper wire has negligible mass and the lower wire has a uniform mass of 0.2 kg/m . The whole system of blocks, wires and support have an upward acceleration of 0.2 m/s^2 . The acceleration due to gravity is 9.8 m/s^2 .

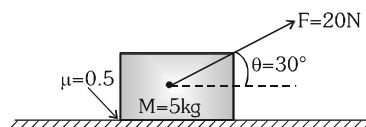
- (i) Find the tension at the midpoint of the lower wire.
- (ii) Find the tension at the midpoint of the upper wire.



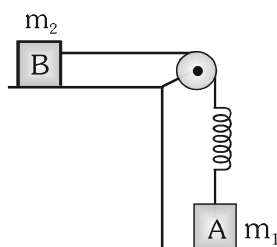
6. A dynamometer is attached to two blocks of masses 6 kg and 4 kg. Forces of 20 N and 10 N are applied on the blocks as shown in figure. Find the dynamometer reading.



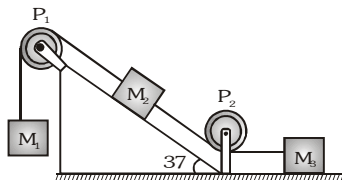
7. Calculate the force of friction for shown situation.



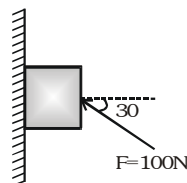
8. If the two blocks moves with a constant uniform speed then find coefficient of friction between the surface of the block B and the table. The spring is massless and the pulley is frictionless.



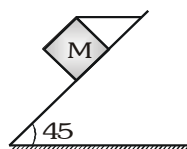
9. Masses M_1 , M_2 and M_3 are connected by strings of negligible mass which pass over massless and frictionless pulleys P_1 and P_2 as shown in fig. The masses move such that the portion of the string between P_1 and P_2 is parallel to the inclined plane and the portion of the string between P_2 and M_3 is horizontal. The masses M_2 and M_3 are 4.0 kg each and the coefficient of kinetic friction between the masses and the surfaces is 0.25. The inclined plane makes an angle of 37° with the horizontal. If the mass M_1 moves downwards with a uniform velocity, find the mass of M_1 .



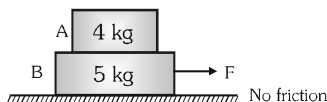
10. A block of mass m rests on a horizontal floor with which it has a coefficient of static friction μ . It is desired to make the body move by applying the minimum possible force F . Find the magnitude of F and the direction in which it has to be applied.
11. A force of 100N is applied on a block of mass 3 kg as shown in figure. The coefficient of friction between the wall and the surface of the block is $\frac{1}{4}$. Calculate frictional force acting on the block.



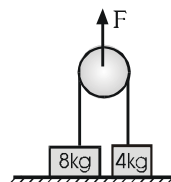
12. A block of mass 15kg is resting on a rough inclined plane as shown in figure. The block is tied up by a horizontal string which has a tension of 50N. Calculate the coefficient of friction between the block and inclined plane.



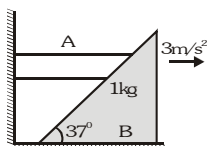
13. 12 N of force required to be applied on A to slip on B. Find the maximum horizontal force F to be applied on B so that A and B moves together.



14. Two block of mass 8 kg and 4kg are connected by a string as shown. Calculate their acceleration if they are initially at rest on the floor, when a force of 100N is applied on the pulley in upward direction ($g = 10\text{ms}^{-2}$)



15. Find force in newton which mass A exerts on mass B if B is moving towards right with 3 ms^{-2} . All surfaces are smooth and $g=10\text{m/s}^2$.



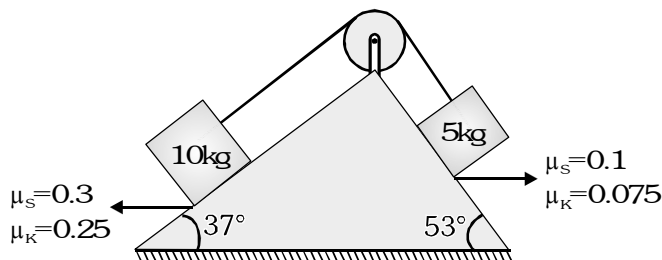
16. A thin rod of length 1 m is fixed in a vertical position inside a train, which is moving horizontally with constant acceleration 4 m/s^2 . A bead can slide on the rod, and friction coefficient between them is $1/2$. If the bead is released from rest at the top of the rod, find the time when it will reach at the bottom. ($g=10\text{m/s}^2$)

CONCEPTUAL SUBJECTIVE EXERCISE		ANSWER KEY		EXERCISE-4(A)
1. $(-10\vec{i} - 24\vec{j})\text{ N}$	2. 22N, 18N	3. $\frac{4mv^2}{\pi d}$	4. (i) 632 N, (ii) 232 N (iii) 392 N, case (a)	
5. (i) 20 N (ii) 50 N	6. 14 N	7. 17.3 N	8. $\frac{m_1}{m_2}$	
9. 4.2 kg	10. $\frac{\mu mg}{\sqrt{1+\mu^2}}$, $\theta = \tan^{-1}(\mu)$ from horizontal	11. 20N vertically downward		
12. 0.5	13. 15N 14. For 4 kg $a = 2.5\text{ ms}^{-2}$, For 8 kg $a=0$	15. 5N	16. $\frac{1}{2}\text{ s}$	

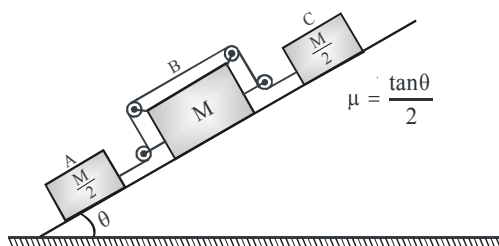
EXERCISE-04 [B]

BRAIN STORMING SUBJECTIVE EXERCISE

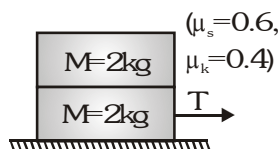
1. A system of two blocks and a light string are kept on two inclined faces (rough) as shown in the figure below. All the required data are mentioned in the diagram. Pulley is light and frictionless. (Take $g = 10 \text{ m/s}^2$, $\sin 37^\circ = 3/5$) If the system is released from rest then what is the range of the tension in the string?



2. As shown in the figure blocks of masses $\frac{M}{2}$, M and $\frac{M}{2}$ are connected through a light string as shown, pulleys are light and smooth. Friction is only between block C and floor. System is released from rest. Find the acceleration of blocks A, B and C and tension in the string.



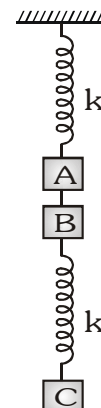
3. The coefficient of static and kinetic friction between the two blocks and also between the lower block and the ground are $\mu_s = 0.6$ and $\mu_k = 0.4$. Find the value of tension T applied on the lower block at which the upper block begins to slip relative to lower block.



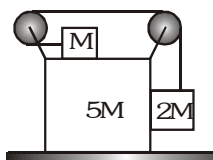
4. The system shown is in equilibrium. Find the acceleration of the blocks A, B & C all of equal masses m at the instant when (Assume springs to be ideal)

- the spring between ceiling & A is cut.
- The string (inextensible) between A & B is cut.
- The spring between B & C is cut.

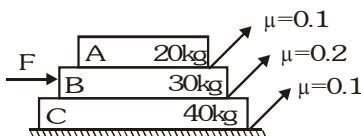
Also find the tension in the string when the system is at rest and in the above 3 cases.



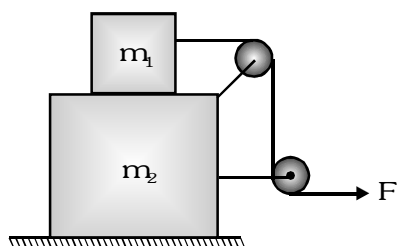
5. In the system shown. Find the initial acceleration of the wedge of mass $5M$. The pulleys are ideal and the chords are inextensible. (There is no friction anywhere)



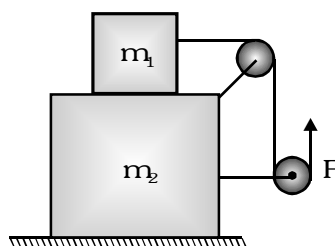
6. A system of masses is shown in the figure with masses & coefficients of friction indicated. Calculate :



- (i) the maximum value of F for which there is no slipping anywhere
(ii) the minimum value of F for which B slides on C
(iii) the minimum value of F for which A slips on B .
7. $m_1 = 20 \text{ kg}$, $m_2 = 30 \text{ kg}$. m_2 is on smooth surface. Surface between m_1 and m_2 has $\mu_s = 0.5$ and $\mu_k = 0.3$. Find the acceleration of m_1 and m_2 for the following figures (a) and (b). When

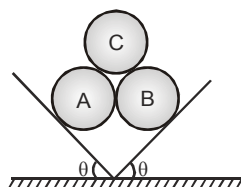


$F = 160 \text{ N}$, $F = 175 \text{ N}$

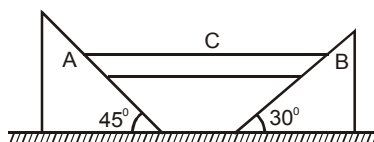


$F = 160 \text{ N}$

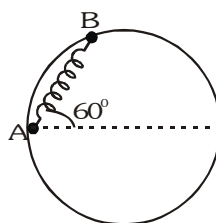
8. A car begins to move at time $t = 0$ and then accelerates along a straight track with a speed given by $V(t) = 2t^2 \text{ ms}^{-1}$ for $0 \leq t \leq 2$. After the end of acceleration, the car continues to move at a constant speed. A small block initially at rest on the floor of the car begins to slip at $t = 1 \text{ sec.}$ and stops slipping at $t = 3 \text{ sec.}$ Find the coefficient of static and kinetic friction between the block and the floor. ($g = 10 \text{ m/s}^2$)
9. Three identical rigid cylinders A, B and C are arranged on smooth inclined surfaces as shown in figure. Find the least value of θ that prevent the arrangement from collapse.



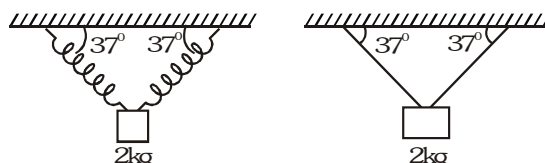
10. Block C descends vertically at 1 m/s . Find the velocity of A relative to B .



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



12. The blocks are of mass 2 kg shown in equilibrium. At $t=0$ right spring in figure(i) and right string in figure (ii) breaks. Find the ratio of instantaneous acceleration of blocks ?



BRAIN STORMING SUBJECTIVE EXERCISE

ANSWER KEY

EXERCISE-4(B)

1. 40 to 43 N

2. $a_A = a_C = \frac{3}{4}g \sin \theta$, $a_B = g \sin \theta$, $T = \frac{m}{2}g \sin \theta$ 3. 40 N

4. (i) $a_A = a_B = \frac{3g}{2} \downarrow$, $a_C = 0$ (ii) $a_A = 2g \uparrow$, $a_B = 2g \downarrow$, $a_C = 0$ (iii) $a_A = a_B = \frac{g}{2} \uparrow$, $a_C = g \downarrow$

5. $\frac{2g}{23}$

6. (i) 90 N (ii) 112.5 N (iii) 150 N

7. (i) (a) $a_{m_1} = a_{m_2} = 3.2\text{ms}^{-2}$ (b) $a_{m_1} = 5.75\text{ms}^{-2}$, $a_{m_2} = 2\text{ms}^{-2}$ (ii) $a_{m_1} = 5\text{ms}^{-2}$, $a_{m_2} = \frac{-10}{3}\text{ms}^{-2}$

8. $\mu_s = 0.4$, $\mu_k = 0.3$

9. $\theta = \tan^{-1}\left(\frac{1}{3\sqrt{3}}\right)$

10. $(1 + \sqrt{3})\text{ms}^{-1}$ towards left

11. $\left(1 - \frac{\sqrt{3}}{2}\right)mg$

12. $\frac{25}{24}$

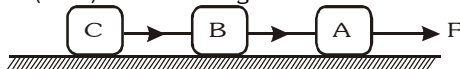
EXERCISE-05 [A]**PREVIOUS YEAR QUESTIONS**

1. When forces F_1 , F_2 , F_3 are acting on a particle of mass m such that F_2 and F_3 are mutually perpendicular, then the particle remains stationary. If the force F_1 is now removed then the acceleration of the particle is-

[AIEEE - 2002]

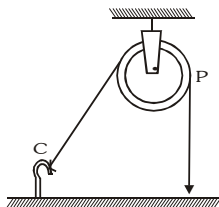
- (1) F_1/m (2) $F_2 F_3 / m F_1$ (3) $(F_2 - F_3)/m$ (4) F_2/m

2. Three identical blocks of masses $m = 2 \text{ kg}$ are drawn by a force F with an acceleration of 0.6 ms^{-2} on a frictionless surface, then what is the tension (in N) in the string between the blocks B and C [AIEEE - 2002]



- (1) 9.2 (2) 1.2 (3) 4 (4) 9.8

3. One end of massless rope, which passes over a massless and frictionless pulley P is tied to a hook C while the other end is free. Maximum tension that the rope can bear is 840 N. With what value of maximum safe acceleration (in ms^{-2}) can a man of 60 kg climb on the rope? [AIEEE - 2002]



- (1) 16 (2) 6 (3) 4 (4) 8

4. A light spring balance hangs from the hook of the other light spring balance and a block of mass $M \text{ kg}$ hangs from the former one. Then the true statement about the scale reading is- [AIEEE - 2003]

- (1) both the scales read $M \text{ kg}$ each
 (2) the scale of the lower one reads $M \text{ kg}$ and of the upper one zero
 (3) The reading of the two scales can be anything but the sum of the readings will be $M \text{ kg}$
 (4) both the scales read $M/2 \text{ kg}$

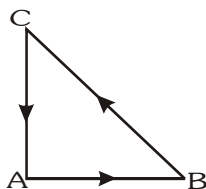
5. A spring balance is attached to the ceiling of a lift. A man hangs his bag on the spring and the spring reads 49 N, when the lift is stationary. If the lift moves downward with an acceleration of 5 m/s^2 , the reading of the spring balance will be- [AIEEE - 2003]

- (1) 24 N (2) 74 N (3) 15 N (4) 49 N

6. A rocket which has a mass of $3.5 \times 10^4 \text{ kg}$ is blasted upwards with an initial acceleration of 10 m/s^2 . Then the initial thrust of the blast is- [AIEEE - 2003]

- (1) $3.5 \times 10^5 \text{ N}$ (2) $7.0 \times 10^5 \text{ N}$ (3) $14.0 \times 10^5 \text{ N}$ (4) $1.75 \times 10^5 \text{ N}$

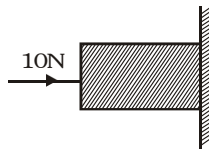
7. Three forces start acting simultaneously on a particle moving with velocity \vec{v} . These forces are represented in magnitude and direction by the three sides of a triangle ABC (as shown). The particle will now move with velocity- [AIEEE - 2003]



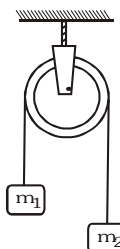
- (1) Less than \vec{v} (2) greater than \vec{v}
 (3) $|\vec{v}|$ in the direction of largest force BC (4) \vec{v} , remaining unchanged

8. A block of mass M is pulled along a horizontal frictionless surface by a rope of mass m . If a force P is applied at the free end of the rope, the force exerted by the rope on the block is- [AIEEE - 2003]
- (1) $\frac{Pm}{M+m}$ (2) $\frac{Pm}{M-m}$ (3) P (4) $\frac{PM}{M+m}$

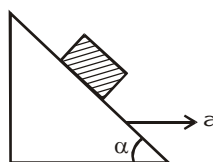
9. A horizontal force of 10 N is necessary to just hold a block stationary against a wall. The coefficient of friction between the block and the wall is 0.2. The weight of the block is- [AIEEE - 2003]



- (1) 20 N (2) 50 N (3) 100 N (4) 2 N
10. A marble block of mass 2 kg lying on ice when given a velocity of 6 m/s is stopped by friction in 10 s. Then the coefficient of friction is- [AIEEE - 2003]
- (1) 0.02 (2) 0.03 (3) 0.06 (4) 0.01
11. A machine gun fires a bullet of mass 40 g with a velocity 1200 ms^{-1} . The man holding it, can exert maximum force of 144 N on the gun. How many bullets can he fire per second at the most? [AIEEE - 2004]
- (1) One (2) Four (3) Two (4) Three
12. Two masses $m_1 = 5 \text{ kg}$ and $m_2 = 4.8 \text{ kg}$ tied to a string are hanging over a light frictionless pulley. What is the acceleration of the masses when they are free to move? ($g = 9.8 \text{ m/s}^2$) [AIEEE - 2004]



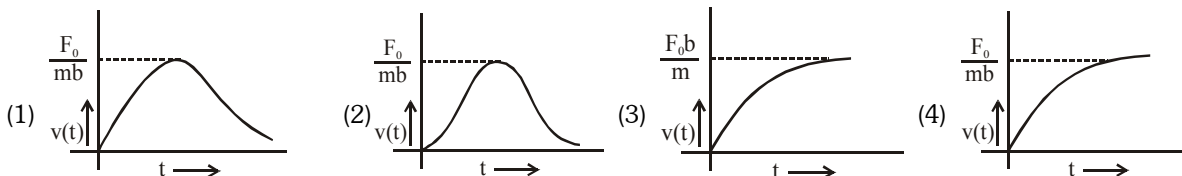
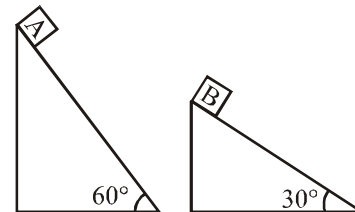
- (1) 0.2 m/s^2 (2) 9.8 m/s^2 (3) 5 m/s^2 (4) 4.8 m/s^2
13. A block rests on a rough inclined plane making an angle of 30° with the horizontal. The coefficient of static friction between the block and the plane is 0.8. If the frictional force on the block is 10 N, the mass of the block (in kg) is : (taken $g = 10 \text{ m/s}^2$) [AIEEE - 2004]
- (1) 2.0 (2) 4.0 (3) 1.6 (4) 2.5
14. A block is kept on a frictionless inclined surface with angle of inclination α . The incline is given an acceleration a to keep the block stationary. Then a is equal to- [AIEEE - 2005]



- (1) $g/\tan\alpha$ (2) $g \operatorname{cosec}\alpha$ (3) g (4) $g \tan\alpha$
15. A smooth block is released at rest on a 45° incline and then slides a distance d . The time taken to slide is n times as much to slide on rough incline than on a smooth incline. The coefficient of friction is- [AIEEE - 2005]

- (1) $\mu_k = 1 - \frac{1}{n^2}$ (2) $\mu_k = \sqrt{1 - \frac{1}{n^2}}$ (3) $\mu_s = 1 - \frac{1}{n^2}$ (4) $\mu_s = \sqrt{1 - \frac{1}{n^2}}$

16. The upper half of an inclined plane with inclination ϕ is perfectly smooth, while the lower half is rough. A body starting from rest at the top will again come to rest at the bottom, if the coefficient of friction for the lower half is given by- [AIEEE - 2005]
 (1) $2 \sin \phi$ (2) $2 \cos \phi$ (3) $2 \tan \phi$ (4) $\tan \phi$
17. Consider a car moving on a straight road with a speed of 100 m/s. The distance at which car can be stopped, is : [$\mu_k = 0.5$] [AIEEE - 2005]
 (1) 800 m (2) 1000 m (3) 100 m (4) 400 m
18. A player caught a cricket ball of mass 150 g moving at a rate of 20 m/s. If the catching process is completed in 0.1 s., the force of the blow exerted by the ball on the hand of the player is equal to- [AIEEE - 2006]
 (1) 150 N (2) 3 N (3) 30 N (4) 300 N
19. A block of mass m is connected to another block of mass M by a spring (massless) of spring constant k . The blocks are kept on a smooth horizontal plane. Initially the blocks are at rest and the spring is unstretched. Then a constant force F starts acting on the block of mass M to pull it. Find the force on the block of mass m :- [AIEEE - 2007]
 (1) $\frac{mF}{M}$ (2) $\frac{(M+m)F}{m}$ (3) $\frac{mF}{(m+M)}$ (4) $\frac{MF}{(m+M)}$
20. Two fixed frictionless inclined planes making an angle 30° and 60° with the vertical are shown in the figure. Two blocks A and B are placed on the two planes. What is the relative vertical acceleration of A with respect to B? [AIEEE - 2010]
 (1) 4.9 ms^{-2} in vertical direction.
 (2) 4.9 ms^{-2} in horizontal direction
 (3) 9.8 ms^{-2} in vertical direction
 (4) Zero
21. The minimum force required to start pushing a body up a rough (frictional coefficient μ) inclined plane is F_1 while the minimum force needed to prevent it from sliding down is F_2 . If the inclined plane makes an angle θ from the horizontal such that $\tan \theta = 2\mu$ then the ratio $\frac{F_1}{F_2}$ is :- [AIEEE - 2011]
 (1) 4 (2) 1 (3) 2 (4) 3
22. A particle of mass m is at rest at the origin at time $t = 0$. It is subjected to a force $F(t) = F_0 e^{-bt}$ in the x-direction. Its speed $v(t)$ is depicted by which of the following curves ? [AIEEE - 2012]



PREVIOUS YEARS QUESTIONS

ANSWER KEY

EXERCISE -5A

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	1	2	3	1	1	2	4	4	4	3	4	1	1	4	1
Que.	16	17	18	19	20	21	22								
Ans.	3	2	3	3	1	4	4								

EXERCISE-05 [B]

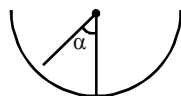
PREVIOUS YEAR QUESTIONS

MCQ'S WITH ONE CORRECT ANSWER

1. A long horizontal rod has a bead which can slide along its length and is initially placed at a distance L from one end A of the rod. The rod is set in angular motion about A with a constant angular acceleration, α . If the coefficient of friction between the rod and bead is μ , and gravity is neglected, then the time after which the bead starts slipping is :- [IIT-JEE 2000]

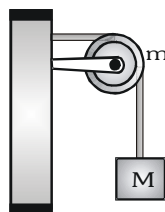
(A) $\sqrt{\frac{\mu}{\alpha}}$ (B) $\frac{\mu}{\sqrt{\alpha}}$ (C) $\frac{1}{\sqrt{\mu\alpha}}$ (D) infinitesimal

2. A insect crawls up a hemispherical surface very slowly (see the figure). The coefficient of friction between the surface and the insect is $\frac{1}{3}$. If the line joining the centre of the hemispherical surface to the insect makes an angle α with the vertical, the maximum possible value of α is given :- [IIT-JEE 2001]



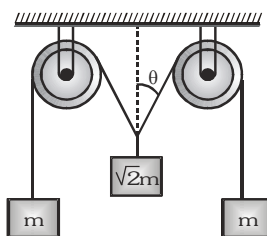
(A) $\cot \alpha = 3$ (B) $\tan \alpha = 3$ (C) $\sec \alpha = 3$ (D) $\operatorname{cosec} \alpha = 3$

3. A string of negligible mass going over a clamped pulley of mass m supports a block of mass M as shown in the figure. The force on the pulley by the clamp is given by :- [IIT-JEE 2001]



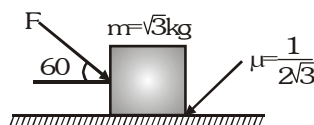
(A) $\sqrt{2} Mg$ (B) $\sqrt{2} mg$ (C) $\sqrt{(M+m)^2 + m^2}g$ (D) $(\sqrt{(M+m)^2 + M^2})g$

4. The pulleys and strings shown in the figure are smooth and of negligible mass. For the system to remain in equilibrium, the angle θ should be :- [IIT-JEE 2001]



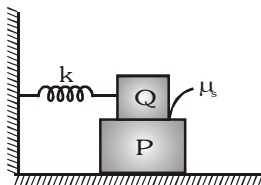
(A) 0 (B) 30 (C) 45 (D) 60

5. What is the maximum value of the force F such that the block shown in the arrangement, does not move :- [IIT-JEE 2003]



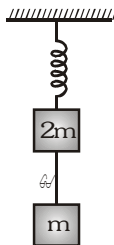
(A) 20 N (B) 10 N (C) 12 N (D) 15 N

6. A block P of mass m is placed on a horizontal frictionless plane. A second block of same mass m is placed on it and is connected to a spring of spring constant k , the two blocks are pulled by distance A . Block Q oscillates without slipping. What is the maximum value of frictional force between the two blocks:-



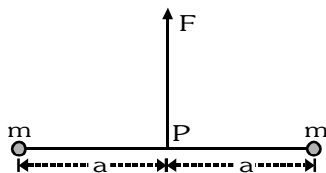
- (A) $\frac{kA}{2}$ (B) kA (C) $\mu_s mg$ (D) zero [IIT-JEE 2004]

7. System shown in figure is in equilibrium and at rest. The spring and string are massless, now the string is cut. The acceleration of mass $2m$ and m just after the string is cut will be :- [IIT-JEE 2006]



- (A) $\frac{g}{2}$ upwards, g downwards (B) g upwards, $\frac{g}{2}$ downwards
 (C) g upwards, $2g$ downwards (D) $2g$ upwards, g downwards

8. Two particles of mass m each are tied at the ends of a light string of length $2a$. The whole system is kept on a frictionless horizontal surface with the string held tight so that each mass is at the distance a from the centre P (as shown in the figure). Now, the mid-point of the string is pulled vertically upwards with a small but constant force F . As a result, the particles move towards each other on the surface. The magnitude of acceleration, when the separation between them become $2x$, is :- [IIT-JEE 2007]

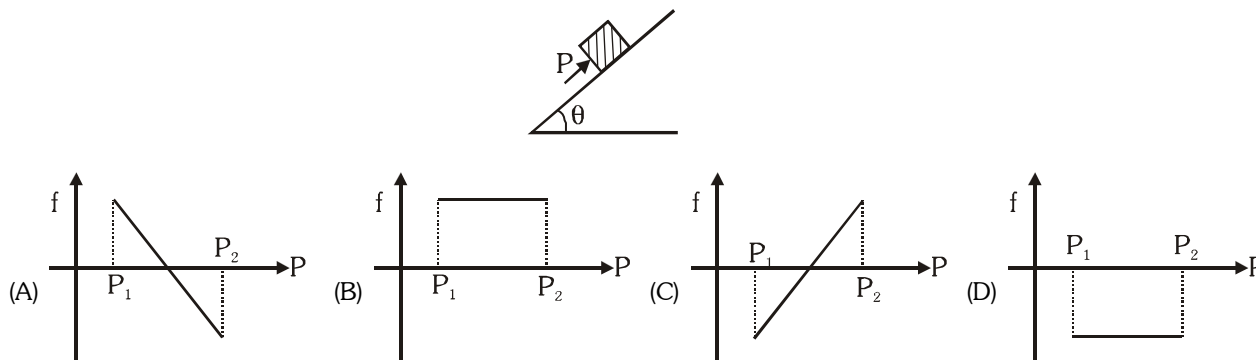


- (A) $\frac{F}{2m} \frac{a}{\sqrt{a^2 - x^2}}$ (B) $\frac{F}{2m} \frac{x}{\sqrt{a^2 - x^2}}$ (C) $\frac{F}{2m} \frac{x}{a}$ (D) $\frac{F}{2m} \frac{\sqrt{a^2 - x^2}}{x}$

9. A piece of wire is bent in the shape of a parabola $y = kx^2$ (y -axis vertical) with a bead of mass m on it. The bead can slide on the wire without friction. It stays at the lowest point of the parabola when the wire is at rest. The wire is now accelerated parallel to the x -axis with a constant acceleration a . The distance of the new equilibrium position of the bead, where the bead can stay at rest with respect to the wire, from the y -axis is :- [IIT-JEE 2009]

- (A) $\frac{a}{gk}$ (B) $\frac{a}{2gk}$ (C) $\frac{2a}{gk}$ (D) $\frac{a}{4gk}$

10. A block of mass m is on an inclined plane of angle θ . The coefficient of friction between the block and the plane is μ and $\tan\theta > \mu$. The block is held stationary by applying a force P parallel to the plane. The direction of force pointing up the plane is taken to be positive. As P is varied from $P_1 = mg(\sin\theta - \mu\cos\theta)$ to $P_2 = mg(\sin\theta + \mu\cos\theta)$, the frictional force f versus P graph will look like [IIT-JEE-2010]



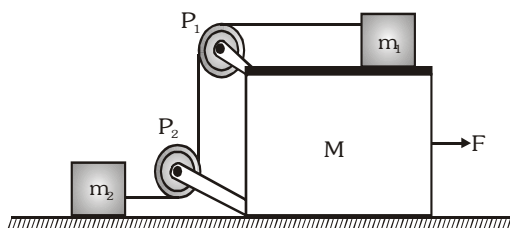
ASSERTION - REASON

This question contains, statement I (assertion) and statement II (reason).

11. **Statement-I** : A cloth covers a table. Some dishes are kept on it. The cloth can be pulled out without dislodging the dishes from the table. [IIT-JEE 2007]
Because :
Statement-II : For every action there is an equal and opposite reaction.
 (A) statement-I is true, statement-II is true; statement-II is a correct explanation for statement-I
 (B) statement-I is true, statement-II is true, statement-II is NOT a correct explanation for statement-I
 (C) statement-I is true, statement-II is false
 (D) statement-I is false, statement-II is true
12. **Statement -I** : It is easier to pull a heavy object than to push it on a level ground. [IIT-JEE 2008]
and
Statement-II: The magnitude of frictional force depends on the nature of the two surface in contact.
 (A) statement-I is true, statement-II is true; statement-II is a correct explanation for statement-I
 (B) statement-I is true, statement-II is true, statement-II is NOT a correct explanation for statement-I
 (C) statement-I is true, statement-II is false
 (D) statement-I is false, statement-II is true

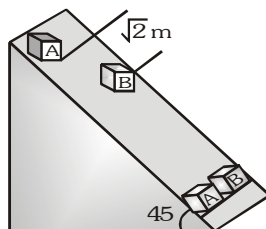
SUBJECTIVE QUESTIONS

13. In the figure masses m_1 , m_2 and M are 20 kg, 5 kg and 50 kg respectively. The coefficient of friction between M and ground is zero. The coefficient of friction between m_1 and M and that between m_2 and ground is 0.3. The pulleys and the strings are massless. The string is perfectly horizontal between P_1 and m_1 and also between P_2 and m_2 . The string is perfectly vertical between P_1 and P_2 . An external horizontal force F is applied to the mass M . Take $g = 10 \text{ m/s}^2$. [IIT-JEE 2000]

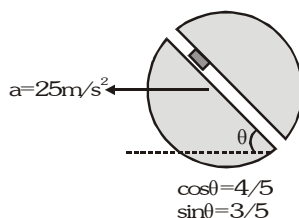


- (i) Draw a free body diagram of mass M , clearly showing all the forces.
 (ii) Let the magnitude of the force of friction between m_1 and M be f_1 and that between m_2 and ground be f_2 . For a particular force F it is found that $f_1 = 2f_2$. Find f_1 and f_2 . Write equations of motion of all the masses. Find F , tension in the string and acceleration of the masses.

14. Two blocks A and B of equal masses are released from an inclined plane of inclination 45° at $t = 0$. Both the blocks are initially at rest. The coefficient of kinetic friction between the block A and the inclined plane is 0.2 while it is 0.3 for block B. Initially the block A is $\sqrt{2}$ m behind the block B. When and where their front faces will come in a line. (Take $g = 10 \text{ m/s}^2$) [IIT-JEE 2004]



15. A circular disc with a groove along its diameter is placed horizontally. A block of mass 1 kg is placed as shown. The coefficient of friction between the block and all surface of groove in contact is $\mu = \frac{2}{5}$. The disc has an acceleration of 25 m/s^2 . Find the acceleration of the block with respect to disc. [IIT-JEE 2006]



INTEGER TYPE QUESTIONS

16. A block is moving on an inclined plane making an angle 45° with the horizontal and the coefficient of friction is μ . The force required to just push it up the inclined plane is 3 times the force required to just prevent it from sliding down. If we define $N = 10\mu$, then N is [IIT-JEE-2011]

JEE-[ADVANCED] : PREVIOUS YEAR QUESTIONS

ANSWER KEY

EXERCISE -5 [B]

MCQ's One correct answers

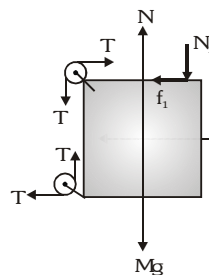
1. A 2. A 3. D 4. C 5. A 6. A 7. A 8. B 9. B
10. A

Assertion - Reason Questions

11. B 12. B

Subjective Questions

13. (i)



- (ii) 60N, 18N, $\frac{3}{5} \text{ ms}^{-2}$

14. (For A) $8\sqrt{2} \text{ m}$, 2s

15. 10 ms^{-2}

16. 5

Integer type questions