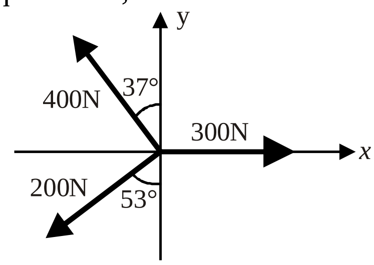
EXERCISE

EXERCISE (S-1)

HCV worked out Example(Chapter No.5 - 1 to 5)

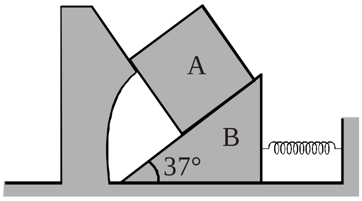
1. A block is placed on a rough horizontal plane. Three horizontal forcesare applied on the block as shown in the figure. If the block is in equilibrium, find the friction force acting on the block.



2. A force F applied to an object of mass m_1 produces an acceleration of 3.00 m/s^2. The same force applied to a second object of mass m_2 produces an acceleration of 1.00 m/s^2.
(i) What is the value of the ratio m_1 / m_2 ?
(ii) If m_1 and m_2 are combined, find their acceleration under the action of the force F.

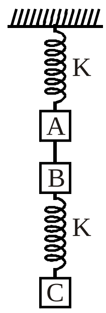
3. A 40 kg boy climbs a rope that passes over an ideal pulley. The other end of the rope is attached to a 60 kg weight placed on the ground. What is the maximum upward acceleration the boy can have without lifting the weight? If he climbs the rope with upward acceleration 2 g, with what acceleration the weight will rise up?

4. In the figure shown, all surfaces are smooth and block A and wedge B have mass 10 kg and 20 kg respectively, and the system is in equilibrium. Find normal reaction between block A & B, spring force and normal reaction of ground on block B. (g= 10 m/s^2).

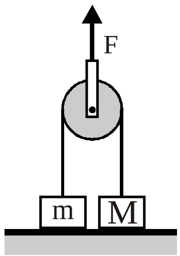


5. A train of mass 1000 ton is moving with an acceleration of 0.5 m/s^2 and the resistance to the motion is 200 N per ton. If the last bogie of 200 ton is suddenly detached from the train, what will be the new acceleration of the train?

6. The system shown adjacent 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)
(i) The spring between ceiling & A is cut.
(ii) The string (inextensible) between A & B is cut.
(iii) 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.



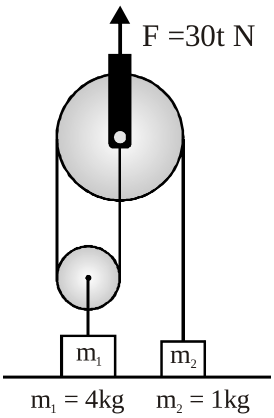
7. In the system shown, pulley and strings are ideal. The vertically upward pull F is being increased gradually, find magnitude of F and acceleration of the 5 kg block at the moment the 10 kg block leaves the floor.



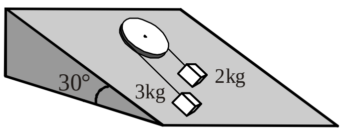
HCV Exercise(Chapter No. 5 - 1 to 20)

HCV work out Example (Chapter No. 5 - 6 to 11)

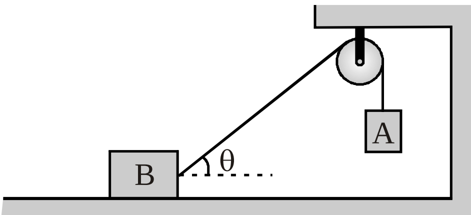
8. Force F is applied on upper pulley. If F = 30t N where t is time in second. Find the time when m_1 loses contact with floor.



9. Two blocks of masses 2.0 kg and 3.0 kg are connected by light inextensible string. The string passes over an ideal pulley pivoted to a fixed axel on a smooth incline plane as shown in the figure. When the blocks are released, find magnitude of their accelerations.

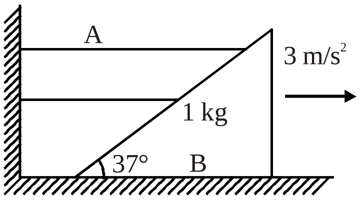


10. The block A is moving downward with constant velocity v_0. Find the velocity of the block B, when the string makes an angle θ with the horizontal

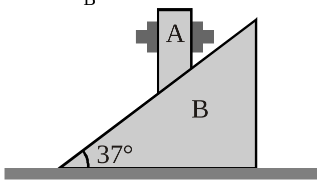


HCV Exercise(Chapter No. 5 - 22 to 42)

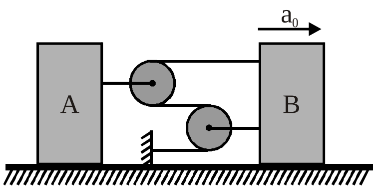
11. Find force in newton which mass A exerts on mass B if B is moving towards right with 3 m/s^2. Also find mass of A.(All surfaces are smooth)



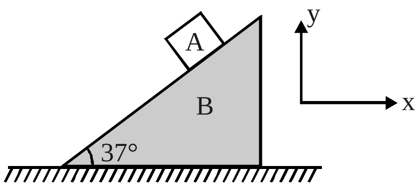
12. Rod A can slide in vertical direction pushing the triangular wedge B towards left. The wedge is moving toward right with uniform acceleration a_B. Find acceleration of the rod A.



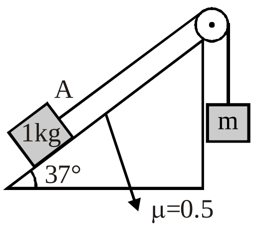
13. Calculate the relative acceleration of A w.r.t. B if B is moving with acceleration a_0 towards right.



14. In the figure shown the acceleration of A is, $\vec{a}_A = (15\hat{i}+15\hat{j})$ m/s^2. If A is sliding on B then the acceleration of B is

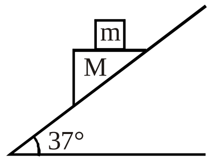


15. In the figure, what should be mass m so that block A slides up with a constant velocity?

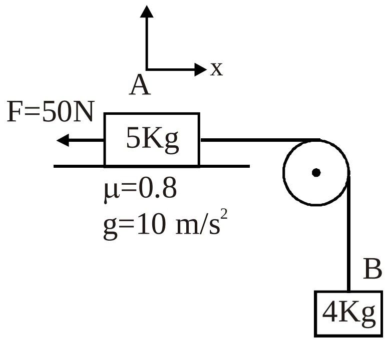


16. A block of mass 1 kg is horizontally thrown with a velocity of 10 m/s on a stationary long plank of mass 2 kg whose surface has $\mu = 0.5$. Plank rests on frictionless surface. Find the time when block comes to rest w.r.t. plank.

17. Block M slides down on frictionless incline as shown. Find the minimum friction coefficient so that m does not slide with respect to M.

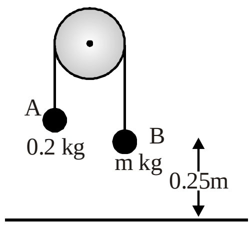


18. Find the acceleration of the blocks and magnitude & direction of frictional force between block A and table, if block A is pulled towards left with a force of 50 N.



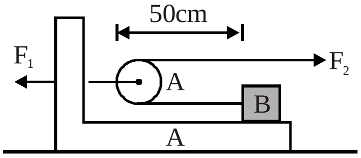
19. Coefficient of friction between 5 kg and 10 kg block is 0.5. If friction between them is 20 N. What is the value of force being applied on 5 kg. The floor is frictionless.

20. The diagram shows particles A and B, of masses 0.2 kg and m kg respectively, connected by a light inextensible string which passes over a fixed smooth peg. The system is released from rest, with B at a height of 0.25 m above the floor. B descends, hitting the floor 0.5 s later. All resistances to motion may be ignored.

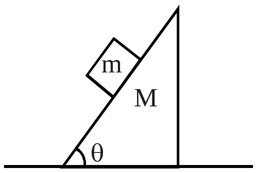


(i) Find the acceleration of B as it descends.
(ii) Find the tension in the string while B is descending and find also the value of m.
(iii) When B hits the floor it comes to rest immediately, and the string becomes slack. Find the length of time for which B remains at rest on the ground before being jerked into motion again.

21. A 1kg block B rests as shown on a bracket A of same mass. Constant forces $F_1 = 20N$ and $F_2 = 8$ N start to act at time t = 0 when the distance of block B from pulley is 50cm. Time when block B reaches the pulley is _________.



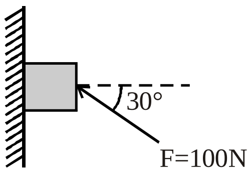
22. A block of mass m lies on wedge of mass M as shown in figure. Answer following parts separately.



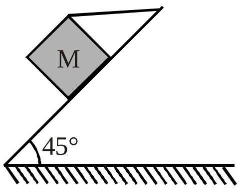
(i) With what minimum acceleration must the wedge be moved towards right horizontally so that block m falls freely.

(ii) Find the minimum friction coefficient required between wedge M and ground so that it does not move while block m slips down on it.

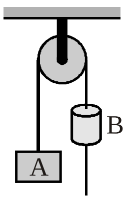
23. A force of 100 N is applied on a block of mass 3 kg as shown in figure. The coefficient of friction between the wall and the surface of the block is 1/4. Calculate frictional force acting on the block.



24. A block of mass 15 kg 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 50 N. Calculate the minimum coefficient of friction between the block and inclined plane.

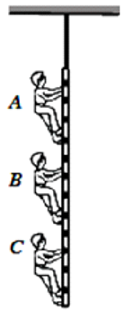


25. A 2 kg block A is attached to one end of a light string that passes over an an ideal pulley and a 1 kg sleeve B slides down the other part of the string with an acceleration of 5 m/s^2 with respect to the string. Find the acceleration of the block, acceleration of sleeve and tension in the string. [g = 10 m/s^2]



EXERCISE (S-2)

1. A ladder is hanging from ceiling as shown in figure. Three men A, B and C of ABC masses 40 kg, 60 kg, and 50 kg are climbing the ladder. Man A is going up withretardation 2 m/s^2, C is going up with an acceleration of 1 m/s^2 and man B isgoing up with a constant speed of 0.5 m/s. Find the tension in the string supportingthe ladder. [g = 9.8 m/s^2]



2. Three identical balls are placed on a frictionless horizontal surface touching each other. They stick to each other because of adhesive. Another ball of same radius and mass m is placed over the void created by the three balls. Find the forces applied by the balls kept on the floor to each other if the system remains in equilibrium.

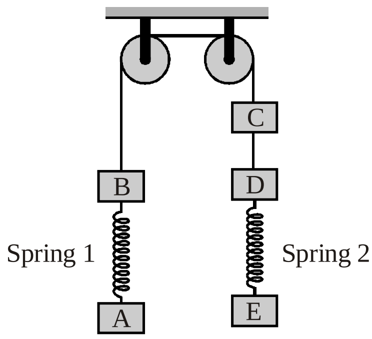
3. The system shown in the figure is initially in equilibrium. A is of mass 2m and B,C, D and E are of mass m. Certain actions are performed on the system. Every action has been taken individually when the system is intact.Find the direction and magnitude of acceleration of the blocks after each action of the following actions has been taken

(i) Spring 1 is cut

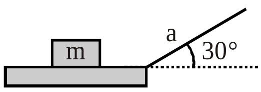
(ii) Spring 2 is cut

(iii) String between C and D is cut.

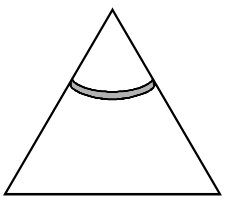
(iv) String between B and C is cut.



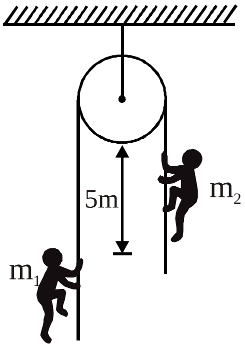
4. A box of mass m is placed on a smooth horizontal platform as shown in the figure. The platform is made to move in direction 30° above the horizontal with acceleration a so that the contact force between the box and the platform becomes 3mg/2. Find the magnitude of the acceleration.



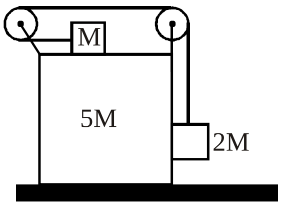
5. A smooth right circular cone of semi vertical angle $\alpha = \tan^{-1}(5/12)$ is at rest on a horizontal plane. A rubber ring of mass 2.5 kg which under a tension of 15N has an extension of 10 cm is placed on the cone as shown. Find the increase in the radius of the ring in equilibrium.



6. Two men of masses m_1 and m_2 hold on the opposite ends of a rope passing over a frictionless pulley. The man m1 climbs up the rope with an acceleration of 1.2 m/s^2 relative to the rope. The mann m_2 climbs up the rope with an acceleration of 2 m/s^2 relative to the rope. Find the tension in the rope if m_1 = 40 kg and m^2 = 60 kg. Also find the time after which they will be at same horizontal level if they start from rest and are initially separated by 5 m.



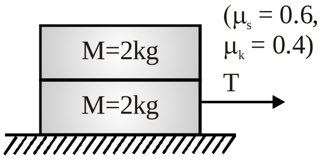
7. In the system shown, find the initial acceleration of the wedge of mass 5 M. The pulleys are ideal and the cords are inextensible. (there is no friction anywhere).



8. A car begins to move at time t = 0 and then accelerates along a straight track with a speed given by $V(t) = 2t^2$ m/s for $0 \le t \le 2$. 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 s and stops slipping at t = 3s. Find the coefficient of static and kinetic friction between the block and the floor.

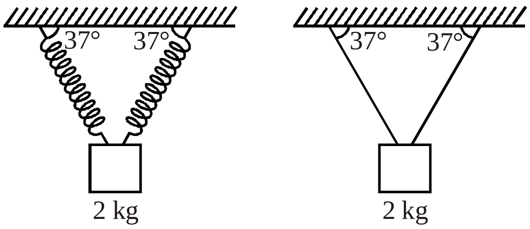
9. A thin rod of length 1 m is fixed in a vertical position inside a train, which is moving horizontally with constant acceleration 4 m/s^2. A bead can slide on the rod, and friction coefficient between them is 1/2. If the bead is released from rest at the top of the rod, find the time when it will reach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

10. The coefficient of static and kinetic friction between the two blocks and also between the lower block and the ground are μ_S=0.6 and μ_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.



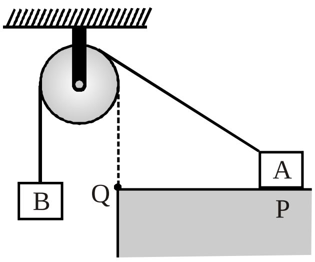
11. The blocks are of mass 2 kg shown is in equilibrium. At t = 0 right spring in figure (i) and right string in figure (ii) breaks.

Find the ratio of instantaneous acceleration of blocks?



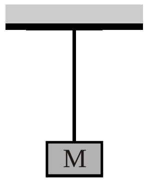
EXERCISE (O)

1. Two small identical blocks are connected to the ends of a string passing over pulley as shown when the system is released from rest.



(A) block A and B do not move
(B) block A accelerates towards pulley along the string.
(C) block A does not leave contact with table till it reaches to the edge Q of the table
(D) Normal reaction of table on block A is less than weight of block A between P and Q and Q it vanishes

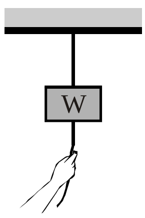
2. Consider a block suspended from a light string as shown in the figure.Which of the following pairs of forces constitute Newton's third law pair?



(A) Force with which string pulls on the ceiling and the force with which string pulls on block
(B) Force with which string pulls on the block and weight of the block
(C) Force acting on block due to the earth and force the block exerts on the earth
(D) Force with which block pulls on string and force with which the string pulls on the block

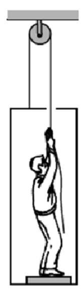
3. If a horizontal support exerts an upward force of 10 N on a block of weight 9.8 N placed on it, which of the following statements is/are correct. Assume acceleration due to gravity to be 9.8 m/s^2.
(A) The block exerts a force of 10 N on the support.
(B) The block exerts a force of 9.8 N on the support.
(C) The block has an upward acceleration.
(D) The block has a downward acceleration.

4. A block of mass m is suspended from a fixed support with the help of a cord. Another identical cord is attached to the bottom of the block. Which of the following statement is /are true?



(A) If the lower cord is pulled suddenly, only the upper cord will break.
(B) If the lower cord is pulled suddenly, only the lower cord will break.
(C) If pull on the lower cord is increased gradually, only the lower cord will break.
(D) If pull on the lower cord is increased gradually, only the upper cord will break.

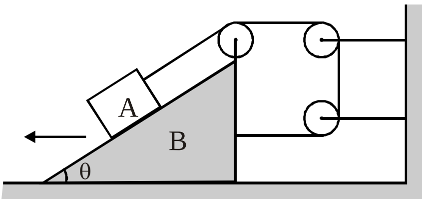
5. A carpenter of mass 50 kg is standing on a weighing machine placed in a lift of mass 20 kg. A light string is attached to the lift. The string passes over a smooth pulley and the other end is held by the carpenter as shown. When carpenter keeps the lift moving upward with constant velocity (g = 10 m/s^2)



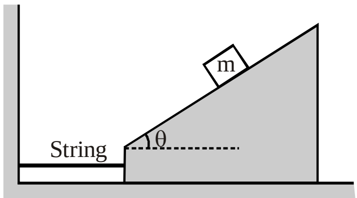
(A) the reading of weighing machine is 15 kg
(B) the man applies a force of 350 N on the string
(C) net force on the man is 150 N
(D) Net force on the weighing machine is 150 N

6. A block A and wedge B connected through a string as shown. The wedge B is moving away from the wall with acceleration 2 m/s^2 horizontally and acceleration of block A is vertical upwards. Then

(A) Acceleration of A with respect to B is 4 m/s^2.
(B) Acceleration of A with respect to B is $2\sqrt{3}$ m/s^2
(C) Angle θ is 60°
(D) Acceleration of A is $2\sqrt{3}$ m/s^2



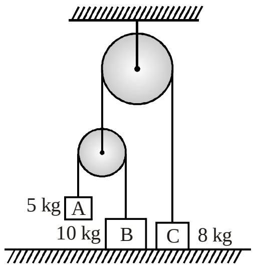
7. Refer the system shown in the figure. Block is sliding down the wedge. All surfaces are frictionless. Find correct statement(s)



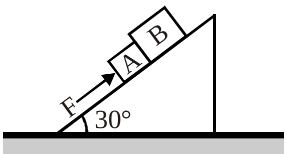
(A) Acceleration of block is $g\sin\theta$
(B) Acceleration block is $g\cos\theta$
(C) Tension in the string is $mg\cos^2\theta$
(D) Tension in the string is $mg\sin\theta\,.\cos\theta$

8. 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 [g = 10 m/s^2]

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



9. Two blocks A and B of mass 2 kg and 4 kg respectively are placed on a smooth inclined plane and 2 kg block is pushed by a force F acting parallel to the plane as shown. If N be the magnitude of contact force applied on B by A, which of the following is/are correct?

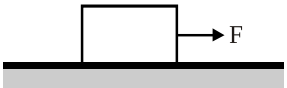


(A) if F = 0 N, N = 10 N
(B) if F=15 N, N=10 N
(C) If F = 30 N, N = 20 N
(D) if F=45 N, N=30 N

10. A block is kept on a rough horizontal surface as shown. Its mass is 2 kg and coefficient of friction between block and surface (μ) = 0.5. A horizontal force F is acting on the block. When

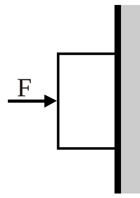
(A) F = 4 N, acceleration is zero.
(B) F = 4 N, friction is 10 N and acceleration is 3 m/s^2.
(C) F = 14 N, acceleration is 2 m/s^2.
(D) F = 14 N, friction is 14 N.

11. A block is kept on a rough surface and applied with a horizontal force as shown which is gradually increasing from zero. The coefficient of static and kinetic friction are $1/\sqrt{3}$ then

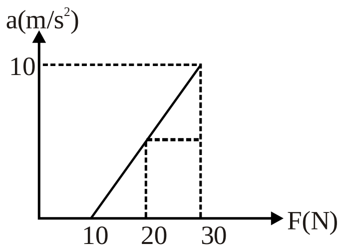


(A) When F is less than the limiting friction, angle made by net force on the block by the surface is less than 30° with vertical.
(B) When the block is just about to move, the angle made by net force by the surface on the block becomes equal to 30° with vertical.
(C) When the block starts to accelerate, the angle made by net force by the surface on the block becomes constant and equal to 30° vertical.
(D) The angle made by net force with vertical on the block by the surface, depends on the mass of the block.

12. A block of mass 1 kg is held at rest against a rough vertical surface by pushing by a force F horizontally. The coefficient of friction is 0.5. When
(A) F = 40 N, friction on the block is 20 N.
(B) F = 30 N, friction on the block is 10 N.
(C) F = 20 N, friction on the block is 10 N.
(D) Minimum value of force F to keep block at rest is 20 N.



13. A block placed on a rough horizontal surface is pushed with a force F acting horizontally on the block.The magnitude of F is increased and acceleration produced is plotted in the graph shown.



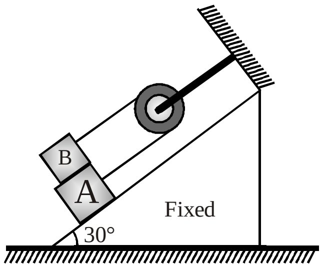
(A) Mass of the block is 2 kg.
(B) Coefficient of friction between block and surface is 0.5.
(C) Limiting friction between block and surface is 10 N.
(D) When F = 8 N, friction between block and surface is 10 N.

14. 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 $a_0 = 4\ m/s^2$. The displacement of the plank in 1s is ($g=10\ m/s^2$)

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

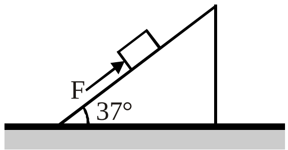
15. A block is released from rest from a point on a rough inclined place of inclination 37°. The coefficient of friction is 0.5.
(A) The time taken to slide down 9 m on the plane is 3 s.
(B) The velocity of block after moving 4 m is 4 m/s.
(C) The block travels equal distances in equal intervals of time.
(D) The velocity of block increases linearly.

16. In the arrangement shown in figure pulley is smooth and massless and string is light. Friction coefficient between A and B is μ. Friction is absent between A and plane. Select the correct alternative(s).



(A) Acceleration of the system is zero if $m_A = m_B$
(B) Force of friction between A and B is zero if $m_A = m_B$
(C) B moves upwards if $m_B < m_A$
(D) Tension in the string in $mg(\sin\theta - \mu\cos\theta)$ if $m_A = m_B = m$

17. A block placed on rough inclined plane is pushed with a force F. The coefficient of friction is $\mu = 0.5$ and mass of block is 10 kg.

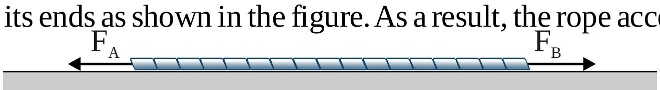


(A) If F = 30 N, acceleration of block is zero and friction acting on block is 30 N.
(B) If F = 60 N, acceleration of block is zero and friction acting on block is 60 N.
(C) If F = 90 N, acceleration of block is zero and friction acting on block is 30 N.
(D) If F = 120 N, acceleration of block is 2 m/s^2 and friction acting on block is 40 N.

18. **Statement 1 :** A cloth covers a table. Some dishes are kept on it. The cloth can be pulled out without dislodging the dishes from the table.
because
Statement-2 : For every action there is an equal and opposite reaction
(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.

Paragraph for Question No. 19 to 22

A uniform rope of mass (m) and length (L) placed on frictionless horizontal ground is being pulled by two forces F_A and F_B at its ends as shown in the figure. As a result, the rope accelerates toward the right.



19. Acceleration (A) of the rope is

(A) zero (B) $a = \frac{F_A + F_B}{m}$ (C) $a = \frac{F_A - F_B}{m}$ (D) $a = \frac{F_B - F_A}{m}$

20. Tension (T) at the mid point of the rope is

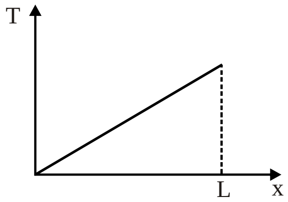
(A) $T = F_B - F_A$ (B) $T = F_A + F_B$ (C) $T = \frac{1}{2}(F_B - F_A)$ (D) $T = \frac{1}{2}(F_A + F_B)$

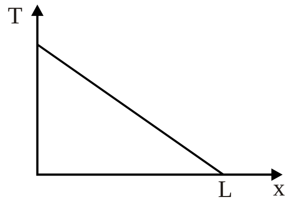
21. Expression (T_x) of tension at a point at distance x from the end A is

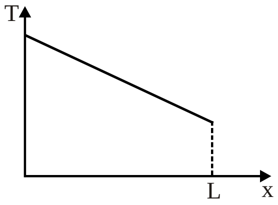
(A) $T_x = \left(\frac{F_B - F_A}{L}\right)x + F_A$ (B) $T_x = \left(\frac{F_B - F_A}{L}\right)x - F_A$

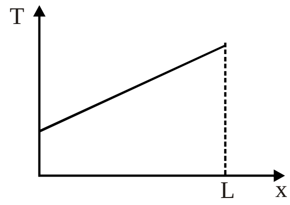
(C) $T_x = \left(\frac{F_B - F_A}{L}\right)x + F_B$ (D) $T_x = \left(\frac{F_B - F_A}{L}\right)x - F_B$

22. Which of the following graph best represents variation in tension at a point on the rope with distance *x* of the point from the end A?

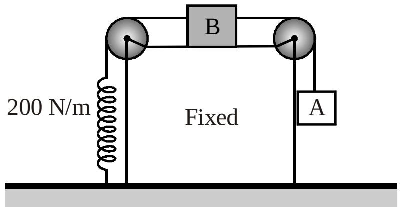
(A) 

(B) 

(C) 

(D) 

Paragraph for Question No. 23 to 25



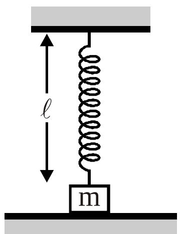
The figure shown blocks A and B are of mass 2 kg and 8 kg and they are connected through strings to a spring connected to ground. The blocks are in equilibrium. ($g = 10 m/s^2$).

23. The elongation of the spring is
(A) 1 cm (B) 10 cm (C) 0.1 cm (D) 1m

24. Now the block A is pulled downwards by a force gradually increasing to 20 N. The new elongation of spring is
(A) 2 cm (B) 4 cm (C) 20 cm (D) 40 cm

25. Now the force on A is suddenly removed. The acceleration of block B becomes
(A) 1.0 m/s (B) 2.0 m/s^2 (C) 3.0 m/s^2 (D) 4.0 m/s^2

Paragraph for Question No. 26 to 28
A block of mass m is placed on a smooth horizontal floor is attached to one end of spring. The other end of the spring is attached to fixed support. When spring is vertical it is relaxed. Now the block is pulled towards right by a force F, which is being increased gradually. When the spring makes angle 53° with the vertical, block leaves the floor.



26. When blocks leaves the table, the normal force on it from table is
(A) mg (B) zero (C) $\frac{4mg}{3}$ (D) $\frac{3mg}{4}$

27. Force constant of the spring is

(A) $\frac{5mg}{2\ell}$ (B) $\frac{15mg}{8\ell}$ (C) $\frac{5mg}{3\ell}$ (D) $\frac{5mg}{4\ell}$

28. When the block leaves the table, the force F is

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

Paragraph for Question No. 29 to 33

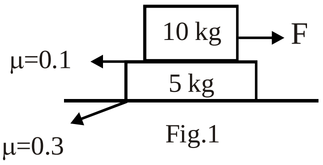


Fig.1

29. When F = 2N, the frictional force between 5 kg block and ground is

(A) 2N (B) 0 (C) 8 N (D) 10 N

30. When F = 2N, the frictional force between 10 kg block and 5 kg block is

(A) 2N (B) 15 N (C) 10 N (D) None

31. The maximum F which will not cause motion of any of the blocks is

(A) 10 N (B) 15 N (C) data insufficient (D) None

32. The maximum acceleration of 5 kg block is

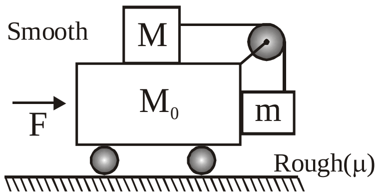
(A) 1 m/s^2 (B) 3 m/s^2 (C) 0 (D) None

33. The acceleration of 10 kg block when F = 30 N is

(A) 2 m/s^2 (B) 3 m/s^2 (C) 1 m/s^2 (D) None

Paragraph for Question No. 34 to 37

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.



34. Identify the wrong statement(s)

(A) If F = 0, the blocks cannot remain stationary.

(B) For one unique value of F, the blocks M and m remain stationary with respect to M_0.

(C) The limiting friction between m and M_0 is independent of F.

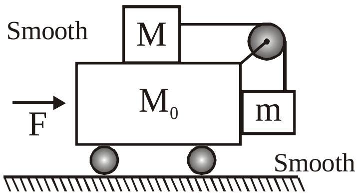
(D) There exists a value of F at which friction force is equal to zero.

35. In above problem, choose the correct value(s) of F which the blocks M and m remain stationary with respect to M_0

(A) $(M_0 + M + m)\dfrac{mg}{M - \mu M} \times 2$ (B) $\dfrac{m(M_0 + M + m)g}{M + \mu M}\dfrac{1}{2}$

(C) $(M_0 + M + m)\dfrac{mg}{M}$ (D) None of these

36. 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).

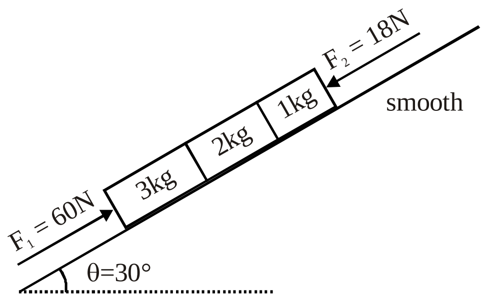


(A) If F = 0, the blocks cannot remain stationary.
(B) For one unique value of F, the blocks M and m remains stationary with respect to block M_0.
(C) There exists a range of F for which blocks M and m remain stationary with respect to block M_0.
(D) Since there is no friction, therefore, blocks M and m cannot be in equilibrium with respect to M_0.

37. In above problem, the value(s) of F for which M and m are stationary with respect to M_0

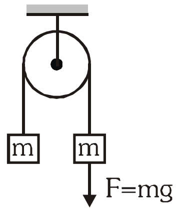
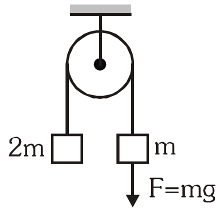
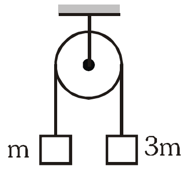
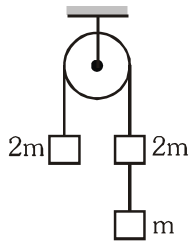
(A) $(M_0 + M + m)g$ (B) $(M_0 + M + m)\dfrac{mg}{M}$ (C) $(M_0 + M + m)\dfrac{Mg}{m}$ (D) None of these

38. In the diagram shown in figure $(g = 10\ m/s^2)$

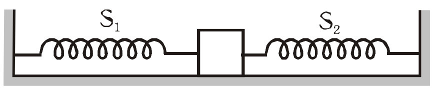


	Column I	Column II	
(A)	Acceleration of 2 kg block in m/s^2	(P)	8
(B)	Net force on 3 kg block in newton	(Q)	25
(C)	Normal reaction between 2 kg and 1 kg in newton	(R)	2
(D)	Normal reaction between 3 kg and 2 kg in newton	(S)	45
		(T)	None

39. Match the situations in column I to the accelerations of blocks in the column II (acceleration due to gravity is g and F is an additional force applied to one of the blocks ?

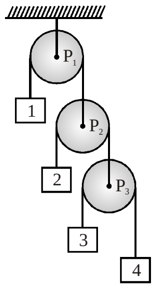
Column I	Column II
(A) 	(P) $\frac{g}{5}$
(B) 	(Q) $\frac{g}{3}$
(C) 	(R) $\frac{g}{2}$
(D) 	(S) $\frac{2g}{3}$
	(T) zero

40. The figure shows a block B of mass 2 kg kept on a smooth horizontal floor in equilibrium with two identical springs of S_1 & S_2 force constant k = 100 N/m attached to it and to fixed supports as shown. The block is then displaced horizontally from this position by amount x and released. Match the initial equilibrium conditions & subsequent values of x in column-I with corresponding acceleration of the block when released in column II.



	Column I	Column II
(A)	S_1 and S_2 are relaxed and x = 2 cm.	(P) 6 m/s^2
(B)	S_1 and S_2 are stretched by 1 cm and x = 2 cm	(Q) 4 m/s^2
(C)	S_1 and S_2 are compressed by 2 cm and x = 4 cm	(R) 3 m/s^2
(D)	S_1 and S_2 are compressed by 4 cm and x = 1 cm	(S) 2 m/s^2
		(T) 1 m/s^2

41. In the figure shown, acceleration of 1 is x (upwards). Acceleration of pulley P_3, w.r.t. pulley



P_2 is y (downwards) and acceleration of 4 w.r.t. to pulley P_3 is z (upwards). Then

	Column I		**Column II**
(A)	Absolute acceleration of 2	(P)	(y–x) downwards
(B)	Absolute acceleration of 3	(Q)	(z–x–y) upwards
(C)	Absolute acceleration of 4	(R)	(x+y+z) downwards
		(S)	None

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

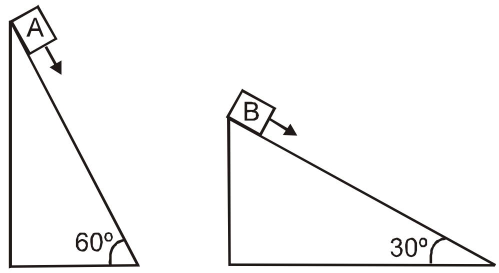
	Column I		**Column II**
(A)	On A as observed by B	(P)	Along positive x–direction
(B)	On B as observed by C	(Q)	Along negative x–direction
(C)	On A as observed by C	(R)	Along positive y–direction
(D)	On C as observed by A	(S)	Along negative y–direction

EXERCISE (JM)

1. A block of mass m is connected to another block of mass M by a string (massless). The blocks are kept on a smooth horizontal plane. Initially the blocks are at rest. 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, 3/120]**

(A) $\frac{mF}{m}$ (B) $\frac{(M+m)F}{m}$ (C) $\frac{mF}{(m+M)}$ (D) $\frac{MF}{(m+M)}$

2. Two fixed frictionless inclined planes making an angle 30º and 60º 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, 4/144, –1]**

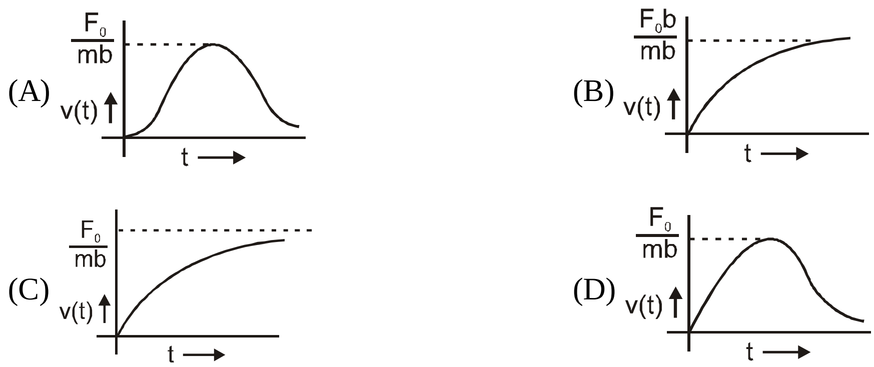


(A) 4.9 ms^{-2} in horizontal direction (B) 9.8 ms^{-2} in vertical direction
(C) Zero (D) 4.9 ms^{-2} in vertical direction

3. If a spring of stiffness 'k' is cut into two parts 'A' and 'B' of length $\ell_A : \ell_B = 2:3$, then the stiffness of spring 'A' is given by : **[AIEEE 2011, 11 May; 4, –1]**

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

4. A particle of mass m is at rest at the origin at time t = 0. It is subjected to a force $F(t) = F_0e^{-bt}$ in the x direction. Its speed v(t) is depicted by which of the following curves ? **[AIEEE 2012 ; 4/120, –1]**



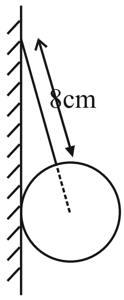
5. A uniform sphere of weight W and radius 5 cm is being held by a string as shown in the figure. The tension in the string will be : **[JEE Main-2013]**

(A) $12\frac{W}{5}$

(B) $5\frac{W}{12}$

(C) $13\frac{W}{5}$

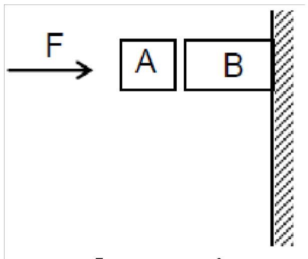
(D) $13\frac{W}{12}$



6. A heavy box is to be dragged along a rough horizontal floor. To do so, person A pushes it at an angle 30° from the horizontal and requires a minimum force F_A, while person B pulls the box at an angle 60° from the horizontal and needs minimum force F_B. If the coefficient of friction between the box and the floor is $\frac{\sqrt{3}}{5}$, the ratio $\frac{F_A}{F_B}$ is : **[JEE Main-2014]**

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

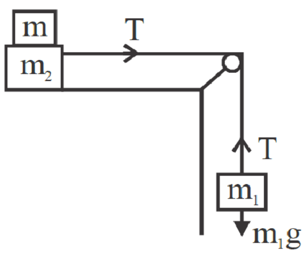
7. Given in the figure are two blocks A and B of weight 20 N and 100 N respectively. These are being pressed against a wall by a force F as shown. If the coefficient of friction between the blocks is 0.1 and between block B and the wall is 0.15, the frictional force applied by the wall on block B is



[JEE Main-2015]

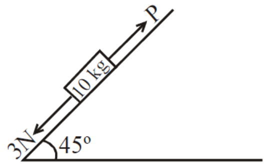
(A) 80 N (B) 120 N
(C) 150 N (D) 100 N

8. Two masses $m_1 = 5$ kg and $m_2 = 10$ kg, connected by an inextensible string over a frictionless pulley, are moving as shown in the figure. The coefficient of friction of horizontal surface is 0.15. The minimum weight m that should be put on top of m_2 to stop the motion is : **[JEE Main-2018]**



(A) 10.3 kg (B) 18.3 kg (C) 27.3 kg (D) 43.3 kg

9. A block of mass 10 kg is kept on a rough inclined plane as shown in the figure. A force of 3 N is applied on the block. The coefficient of static friction between the plane and the block is 0.6. What should be the minimum value of force P, such that the block does not move downward ? **[JEE Main-2019]**



(take g = 10 ms^{-2})

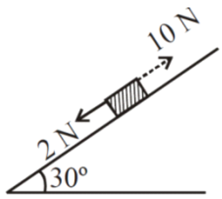
(A) 32N (B) 25 N (C) 23 N (D) 18 N

10. A mass of 10 kg is suspended vertically by a rope from the roof. When a horizontal force is applied on the rope at some point, the rope deviated at an angle of 45° at the roof point. If the suspended mass is at equilibrium, the magnitude of the force applied is (g = 10 ms^{-2}) **[JEE Main-2019]**

(A) 100 N (B) 70 N (C) 140 N (D) 200 N

11. A block kept on a rough inclined plane, as shown in the figure, remains at rest upto a maximum force 2 N down the inclined plane. The maximum external force up the inclined plane that does not move the block is 10 N. The coefficient of static friction between the block and the plane is :

[Take g = 10 m/s^2] **[JEE Main-2019]**



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

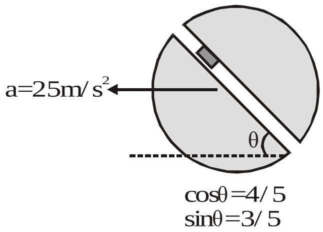
12. A mass of 10 kg is suspended by a rope of length 4 m, from the ceiling. A force F is applied horizontally at the mid-point of the rope such that the top half of the rope makes an angle of 45° with the vertical. Then F equals : (Take g = 10 ms^{-2} and the rope to be massless) **[JEE Main-2020]**

(A) 70 N (B) 75 N (C) 100 N (D) 90 N

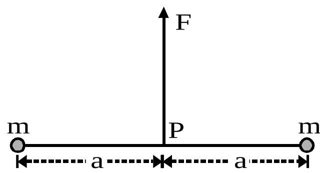
EXERCISE (JA)

1. 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]



2. 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) $\frac{F}{2m}\frac{\sqrt{a^2-x^2}}{x}$

3. **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

4. **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

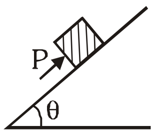
(C) statement–I is true, statement–II is false

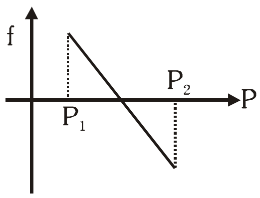
(D) statement–I is false, statement–II is true

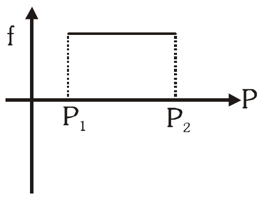
5. A piece of wire is bent in the shape of a parabola $y = kx^2$ (y-axis vertical) with a bead of mass m on it. The bead can slide on the wire without friction. It stays at the lowest point of the parabola when the wire is at rest. The wire is now accelerated parallel to the x-axis with a constant acceleration 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]**

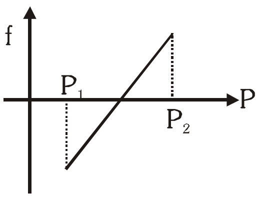
(A) $\frac{a}{gk}$ (B) $\frac{a}{2gk}$ (C) $\frac{2a}{gk}$ (D) $\frac{a}{4gk}$

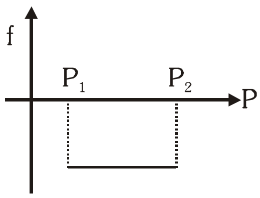
6. A block of mass m is on an inclined plane of angle θ. The coefficient of friction between the block and the plane is μ and tanθ > μ. The block is held stationary by applying a force P parallel to the plane. The direction of force pointing up the plane is taken to be positive. As P is varied from $P_1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



(A)


(B)


(C)


(D)


7. 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 = 10μ, then N is **[IIT-JEE-2011]**

8. A solid horizontal surface is covered with a thin layer of oil. A rectangular block of mass m = 0.4 kg is at rest on this surface. An impulse of 1.0 N is applied to the block at time t = 0 so that it starts moving along the x-axis with a velocity $v(t) = v_0 e^{-t/\tau}$, where v_0 is a constant and $\tau = 4$ s. The displacement of the block, in meters , at $t = \tau$ is __________. Take $e^{-1} = 0.37$ **[IIT-JEE-2018]**

ANSWER KEY

Exercise (S-1)

1. $(100\hat{i}-200\hat{j})$ N

2. (i) $\frac{m_1}{m_2}=\frac{1}{3}$ (ii) $a=\frac{3}{4}$ m/s^2

3. 0.5g, g

4. 80 N, 48 N, 264 N

5. 0.675 m/s^2

6. (i) $a_A=\frac{3g\downarrow}{2}=a_B$; $a_C=0$; $T=\frac{mg}{2}$ (ii) $a_A=2g\uparrow$, $a_B=2g\downarrow$, $a_C=0$, $T=0$;

(iii) $a_A=a_B=g/2\uparrow$, $a_C=g\downarrow$, $T=\frac{3mg}{2}$; $T=2mg$

7. 200 N, 10 m/s^2

8. 2 sec.

9. $\frac{g}{10}$ m/s^2

10. $\frac{v_0}{\cos\theta}$

11. 5N, $\frac{16}{31}$ kg

12. $\frac{3a_B}{4}$

13. $\frac{a_0}{2}$

14. $-5\hat{i}$ m/s^2

15. 1 kg

16. 4/3 s

17. 3/4

18. $0\ m/s^2$, $10\hat{i}$ N

19. 30 N

20. (i) 2 m/s^2, (ii) 2.4 N, 0.3 (iii) 0.2 s

21. 0.5 s

22. (i) $a=g\cot\theta$, (ii) $\mu_{min}=\frac{m\sin\theta\cos\theta}{m\cos^2\theta+M}$

23. 20 N vertically downward

24. 0.5

25. 5 m/s^2 downwards, 0 m/s^2, 10 N

Exercise (S-2)

1. 1440 N

2. $\frac{mg}{\sqrt{54}}$

3. (i) $a_A=g\downarrow$, $a_B=\frac{2g}{3}\uparrow$, $a_c=\frac{2g}{3}\downarrow$, $a_D=\frac{2g}{3}\downarrow$, $a_E=0$

(ii) $a_A=0$, $a_B=\frac{g}{3}\downarrow$, $a_C=\frac{g}{3}\uparrow$, $a_D=\frac{g}{3}\uparrow$, $a_E=g\downarrow$

(iii) $a_A=0$, $a_B=g\downarrow$, $a_C=g\uparrow$, $a_D=2g\downarrow$, $a_E=0$

(iv) $a_A=0$, $a_B=3g\downarrow$, $a_C=\frac{3g}{2}\uparrow$, $a_D=\frac{3g}{2}\downarrow$, $a_E=0$

4. g m/s^2

5. $\Delta r=\frac{mg\cot\alpha}{4\pi^2 k}$, 1 cm

6. 556.8 N, 1.47 s

7. $2g/23$

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

9. 1/2 s

10. 40 N

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

Exercise (O)

1.	CD	**2.**	CD	**3.**	AC	**4.**	BD	**5.**	AB
6.	ACD	**7.**	AD	**8.**	ABCD	**9.**	BCD	**10.**	AC
11.	ABC	**12.**	BCD	**13.**	ABC	**14.**	AB	**15.**	ABD
16.	AB	**17.**	ACD	**18.**	B	**19.**	D	**20.**	D
21.	A	**22.**	D	**23.**	B	**24.**	C	**25.**	B
26.	B	**27.**	A	**28.**	B	**29.**	A	**30.**	A
31.	A	**32.**	C	**33.**	A	**34.**	BC	**35.**	C
36.	AB	**37.**	B						

38. (A)$\rightarrow$R; (B)$\rightarrow$T; (C)$\rightarrow$Q; (D)$\rightarrow$T; **39.** (A)$\rightarrow$R; (B)$\rightarrow$T; (C)$\rightarrow$R; (D)$\rightarrow$P;

40. (A)$\rightarrow$S; (B)$\rightarrow$S; (C)$\rightarrow$Q; (D)$\rightarrow$T; **41.** (A)$\rightarrow$S; (B)$\rightarrow$R; (C)$\rightarrow$Q;

42. (A)$\rightarrow$T; (B)$\rightarrow$R; (C)$\rightarrow$R; (D)$\rightarrow$Q;

Exercise (JM)

1.	C	**2.**	D	**3.**	D	**4.**	C	**5.**	D	**6.**	B	**7.**	B
8.	C	**9.**	A	**10.**	A	**11.**	A	12.	C				

Exercise (JA)

1.	10 m/s^2	**2.**	B	**3.**	B	**4.**	B	**5.**	B	**6.**	A	**7.**	5
8.	6.30												