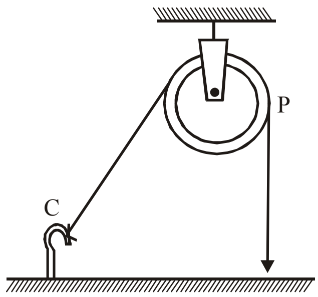
SECTION-I

Single Correct Answer Type **6 Q. [3 M (–1)]**

1. 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]**

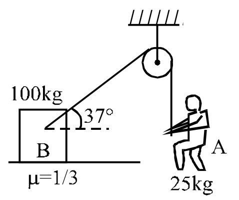


(A) 16 (B) 6 (C) 4 (D) 8

2. 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]**

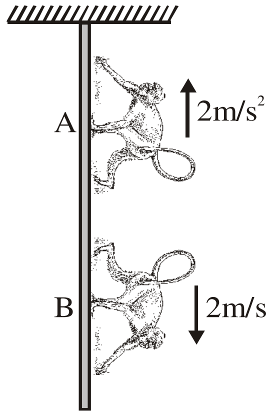
(A) $\mu_k = 1 - \frac{1}{n^2}$ (B) $\mu_k = \sqrt{1-\frac{1}{n^2}}$ (C) $\mu_s = 1 - \frac{1}{n^2}$ (D) $\mu_s = \sqrt{1-\frac{1}{n^2}}$

3. Block *B* of mass 100 kg rests on a rough surface of friction coefficient $\mu = 1/3$. A rope is tied to block *B* as shown in figure. The maximum acceleration with which boy *A* of 25 kg can climbs on rope without making block move is :



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

4. Two monkeys of masses 10 kg and 8 kg are moving along a vertical light rope, the former climbing up with an acceleration of $2\ m/s^2$, while the latter coming down with a uniform velocity of 2 m/s. Find tension in the rope at the fixed support.



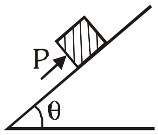
(A) 180 N (B) 200 N (C) 80 N (D) 216 N

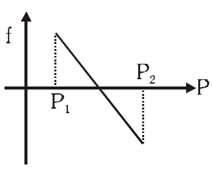
5. A block of mass m is placed on a surface with a vertical cross section given by $y=\frac{x^3}{6}$. If the coefficient of friction is 0.5, the maximum height above the ground at which the block can be placed without slipping is :-

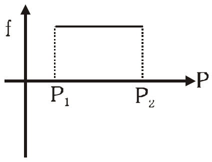
[JEE-Main-2014]

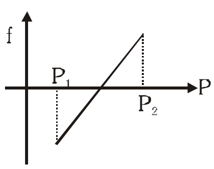
(A) $\frac{1}{3}$m (B) $\frac{1}{2}$m (C) $\frac{1}{6}$m (D) $\frac{2}{3}$m

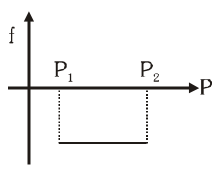
6. A block of mass m is on an inclined plane of angle θ. The coefficient of friction between the block and the plane is μ and tanθ >μ. The block is held stationary by applying a force P parallel to the plane. The direction of force pointing up the plane is taken to be positive. As P is varied from P_1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



(A)


(B)


(C)


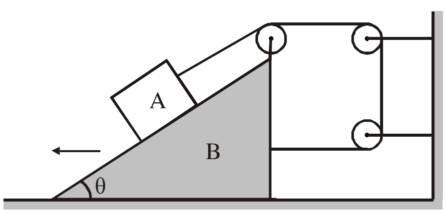
(D)


Multiple Correct Answer Type 4 Q. [4 M (–1)]

7. 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)

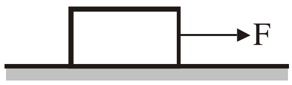
(A) the reading of weighing machine is 15 kg
(B) the man applies a force of 350 N on the string
(C) net force on the man is 150 N
(D) Net force on the weighing machine is 150 N

8. 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.

9. 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



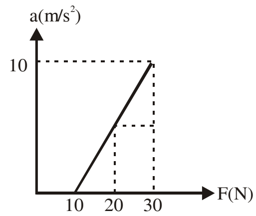
(A) When F is less than the limiting friction, angle made by net force on the block by the surface is less than 30° with vertical.

(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.

10. 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.

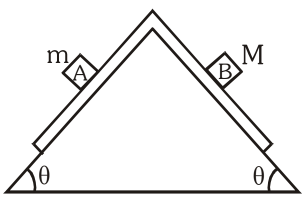
(C) Limiting friction between block and surface is 10 N.

(D) When $F = 8$ N, friction between block and surface is 10 N.

Linked Comprehension Type (3 Para × 3Q.) [3 M (-1)]
(Single Correct Answer Type)

Paragraph for Question no. 11 to 13

A light flat ribbon is placed over the top of the triangular prism as shown in figure. Two blocks are placed on the ribbon. The coefficient of static and kinetic friction between the ribbon and the blocks are μ_s and μ_k respectively. There is no friction between the ribon and the prism. Angle θ and the masses of the blocks m & M are given. Assume that M > m and blocks released simultaneously



11. If there is no slipping between ribbon and block then initial acceleration of the block will be

(A) $g\cos\theta\left[\dfrac{(M-m)}{(M+m)}\right]$ (B) $g\left[\dfrac{(M-m)}{(M+m)}\right]$ (C) $g\sin\theta\left[\dfrac{(M+m)}{(M-m)}\right]$ (D) $g\sin\theta\left[\dfrac{(M-m)}{(M+m)}\right]$

12. The tension in the ribbon when there is no slipping will be between ribbon and blocks

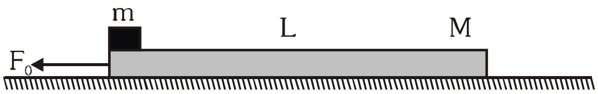
(A) $\mu_s mg\cos\theta$ (B) $\mu_s Mg\cos\theta$ (C) $\dfrac{2g\sin\theta mM}{M+m}$ (D) $\dfrac{g\sin\theta mM}{M+m}$

13. Now if we increase the angle θ then which block starts slipping first on the ribbon

(A) block A (B) block B (C) Simultaneously (D) Can't say anything

Paragraph for Question 14 to 16

A small block of mass m=1 kg is placed to a plank which moves on a horizontal frictionless surface, as shown in the figure. The mass of the plank is M=4 kg, and its length is L=0.8 m. The coefficient of friction between the plank and the block is 0.4. [g = $10 m/s^2$]



14. What is the least constant force F_0 (in N) with which the plank must be pulled in order to make the block slide down from it?

(A) 15 (B) 20 (C) 25 (D) 30

15. How long does it take for the block to slide down if the pulling force is F_1=3 mg?

(A) 0.3 s (B) 0.4 s (C) 0.5 s (D) 0.8 s

16. Till the instant when the block fell off the plank what is the work done by the friction on the upper block (in calorie).

(A) 1.2 (B) 1.5 (C) 4.2 (D) 2.8

Paragraph for Question No. 17 to 19

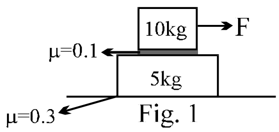


Fig. 1

17. 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

18. The maximum acceleration of 5 kg block is :-

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

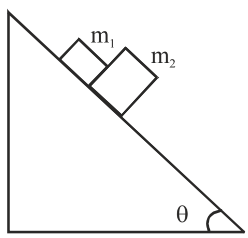
19. The acceleration of 10 kg block when *F* = 30 N is

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

Matching List Type (4 × 4) 1 Q. [3 M (–1)]

20. A block of mass m_1 = 1 kg another mass m_2 = 2kg, are placed together (see figure) on an inclined plane with angle of inclination θ. Various values of θ are given in List I. The coefficient of friction between the block m_1 and the plane is always zero. The coefficient of static and dynamic friction between the block m_2 and the plane are equal to μ = 0.3. In List II expressions for the friction on block m_2 are given. Match the correct expression of the friction in List II with the angles given in List I, and choose the correct option. The acceleration due to gravity is denoted by g. [**useful information :** tan (5.5°) ≈ 0.1 ; tan(11.5°) ≈ 0.2 ; tan (16.5°) ≈ 0.3]

[IIT-JEE-2014]



	List–I		**List–II**
(P)	θ = 5°	(1)	$m_2 g \sin\theta$
(Q)	θ = 10°	(2)	$(m_1 + m_2) g \sin\theta$
(R)	θ = 15°	(3)	$\mu m_2 g \cos\theta$
(S)	θ = 20°	(4)	$\mu (m_1 + m_2) g \cos\theta$

Code :

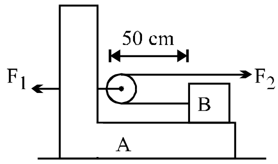
(A) P-1, Q-1, R-1, S-3 (B) P-2. Q-2, R-2, S-3

(C) P-2,. Q-2, R-2, S-4 (D) P-2, Q-2, R-3, S-3

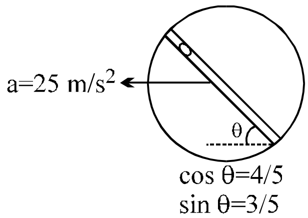
SECTION-II

Numerical Answer Type Question   2 Q. [3(0)]
(upto second decimal place)

1. A 1kg block B rests as shown on a bracket A of same mass. Constant forces $F_1 = 20\text{N}$ and $F_2 = 8\text{N}$ 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 ________.



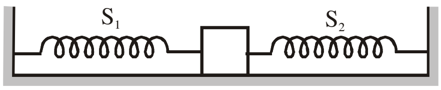
2. A circular disc with a groove along its diameter is placed horizontally. A block of mass 1 kg is placed as shown. The co-efficient of friction between the block and all surfaces of groove in contact is $\mu = 2/5$. The disc has an acceleration of 25 m/s^2. Find the acceleration of the block with respect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



SECTION-IV

Matrix Match Type (4 × 5)   1 Q. [8 M (for each entry +2(0)]

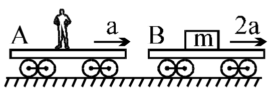
1. The figure shows a block B of mass 2 kg kept on a smooth horizontal floor in equilibrium with two identical springs of S_1 & S_2 force constant k = 100 N/m attached to it and to fixed supports as shown. The block is then displaced horizontally from this position by amount x and released. Match the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



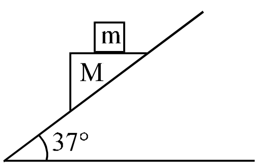
	Column-I		**Column-II**
(A)	S_1 and S_2 are relaxed and x = 2 cm.	(P)	6 m/s^2
(B)	S_1 and S_2 are stretched by 1 cm and x = 2 cm	(Q)	4 m/s^2
(C)	S_1 and S_2 are compressed by 2 cm and x = 4 cm	(R)	3 m/s^2
(D)	S_1 and S_2 are compressed by 4 cm and x = 1 cm	(S)	2 m/s^2
		(T)	1 m/s^2

Subjective Type   7 Q. [4 M (0)]

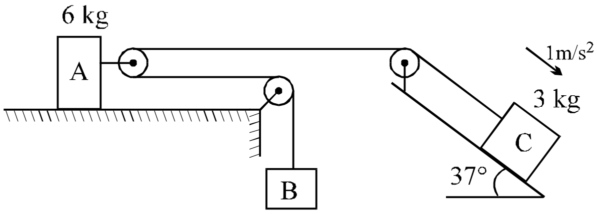
1. Two trolley A and B are moving with accelerations a and 2a respectively in the same direction. To an observer in trolley A, the magnitude of pseudo force acting on a block of mass m on the trolley B is



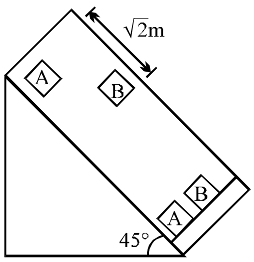
2. Block M slides down on frictionless incline as shown. Find the minimum friction coefficient so that m does not slide with respect to M.



3. Three blocks A, B & C are arranged as shown. Pulleys and strings are ideal. All surfaces are frictionless. If block C is observed moving down along the incline at 1 m/s^2. Find mass of block B, tension in string and accelerations of A, B as the system is released from rest.

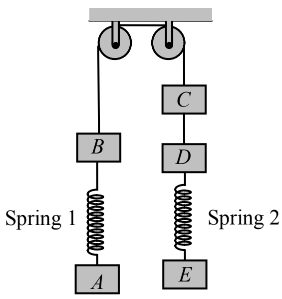


4. Two blocks A and B of equal masses are released from an inclined plane of inclination 45° at t = 0. Both the blocks are initially at rest. The coefficient of kinetic friction between the block A and the inclined plane is 0.2 while it is 0.3 for block B. Initially, the block A is $\sqrt{2}$ m behind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

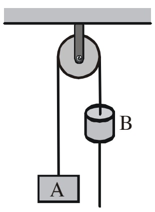


5. The system shown in the figure is initially in equilibrium. A is of mass $2m$ and B, C, D and E are of mass m. Certain actions are performed on the system. Every action has been taken individually when the system is intact. Find the direction and magnitude of acceleration of the blocks after each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

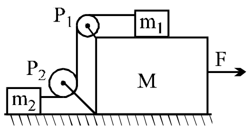
(i) Spring 1 is cut
(ii) Spring 2 is cut
(iii) String between C and D is cut.
(iv) String between B and C is cut.



6. 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]



7. In the figure masses m_1, m_2 and M are 20 kg, 5 kg and 50 kg respectively. The co-efficient of friction between M and ground is zero. The co-efficient of friction between m_1 and M and that between m_2 and ground is 0.3. The pulleys and the string 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 m/s^2. **[IIT-JEE 2000]**



(i) Draw a free-body diagram for 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 F it is found that $f_1 = 2\ f_2$. Find f_1 and f_2 . Write down equations of motion of all the masses. Find F, tension in the string and accelerations of the masses.

SECTION-I

Single Correct Answer Type **6 Q. [3 M (–1)]**

1. Ans. (C) **2. Ans. (A)** **3. Ans. (B)** **4. Ans. (B)**

5. Ans. (C) **6. Ans. (A)**

Multiple Correct Answer Type **4 Q. [4 M (–1)]**

7. Ans. (A,B) **8. Ans. (A,C,D)** **9. Ans. (A,B,C)** **10. Ans. (A,B,C)**

Linked Comprehension Type **(3 Para × 3Q.) [3 M (-1)]**
(Single Correct Answer Type)

11. Ans. (D) **12. Ans. (C)** **13. Ans. (A)** **14. Ans. (B)**

15. Ans. (D) **16. Ans. (A)** **17. Ans. (A)** **18. Ans. (C)**

19. Ans. (A)

Matching List Type (4 × 4) **1 Q. [3 M (–1)]**

20. Ans. (D)

SECTION-II

Numerical Answer Type Question **2 Q. [3(0)]**
(upto second decimal place)

1. Ans. 0.5 s **2. Ans.** 10 m/s^2

SECTION-IV

Matrix Match Type (4 × 5) **1 Q. [8 M (for each entry +2(0)]**

1. Ans. (A) - (S) ; (B) - (S) ; (C) - (Q) ; (D) - (T)

Subjective Type **7 Q. [4 M (0)]**

1. Ans. (ma) **2. Ans.** 3/4 **3. Ans.** $M_B = 15$ kg, T = 15 , $a_A = 5$ m/s^2 , $a_B = 9$ m/s^2

4. Ans. 2sec and 11.3 m travelled by A

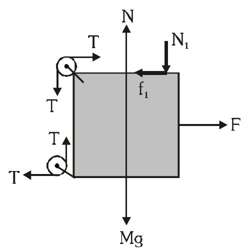
5. Ans. (i) $a_A = g\downarrow,\ a_B = \frac{2g}{3}\uparrow,\ a_c = \frac{2g}{3}\downarrow,\ a_D = \frac{2g}{3}\downarrow,\ a_E = 0$

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

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

7. Ans. (i) 

(ii) a = 3/5 m/s^2 , T = 18 N, F = 60N

SOLUTIONS
SECTION-I

Single Correct Answer Type **6 Q. [3 M (–1)]**

1. Ans. (C)

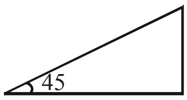
Sol. $840 = 60\,(10 + a)$

$840 = 600 + 60a$

$240 = 60a$

$4 = a$

2. Ans. (A)

Sol. 

$S = \frac{1}{2}\left(g\sin 45\right)T^2$ on smooth plane.

$\sqrt{\frac{2d}{g\sin 45}} = T_1$

on rough plane

$a = g \sin 45 - \mu g \cos 45°$

$= \frac{g}{\sqrt{2}}\left(1-\mu\right)$

$T_2 = \sqrt{\frac{2d}{\frac{g}{\sqrt{2}}\left(1-\mu\right)}}$

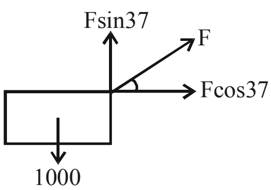
$T_2 = nT_1$

$n^2\frac{2d}{\frac{g}{\sqrt{2}}} = \frac{2d}{\frac{g}{\sqrt{2}}\left(1-\mu\right)}$

$1-\mu = \frac{1}{n^2} \Rightarrow \mu = 1-\frac{1}{n^2}$

3. Ans. (B)

Sol. $F\cos 37 = \mu\left(1000-\frac{3F}{5}\right)$



$\frac{4}{5}F = \frac{1000}{3}-\frac{F}{5}$

$F = \frac{1000}{3}$

$\frac{1000}{3} = 25\left(g+a\right)$

$a = \frac{10}{3}$

4. **Ans. (B)**

Sol. Tension = T – mg = ma

$T = m(g + a)$

$T = 10(10 + 2)$

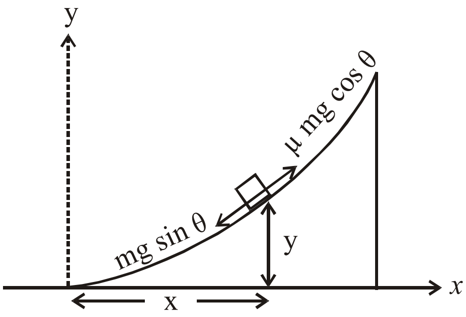
$T = 10 \times 12 = 120$

Upper support 120 + 80 = 200

(80) weight of latter monkey

5. **Ans. (C)**

Sol.



For equilibrium under limiting friction

$mg \sin\theta = \mu\, mg \cos\theta$

$\Rightarrow \tan\theta = \mu$

From the equation of surface $y = \frac{x^3}{6}$

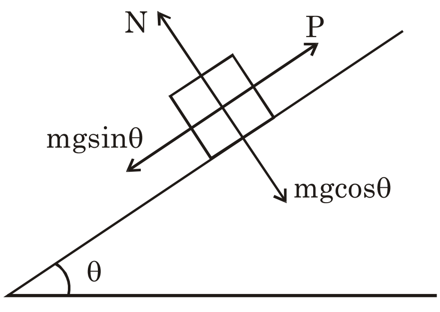
slope = $\frac{dy}{dx} = \frac{3x^2}{6} = \tan\theta$

$\Rightarrow \frac{x^2}{2} = \mu = 0.5 \Rightarrow x = 1$

So $y = \frac{1}{6}$

6. **Ans. (A)**

Sol.



Maximum value of friction

$f_r = \mu N = \mu mg\cos\theta$

Now friction is self adjustable force

So we have to claculate resultant of other forces first then apply friction

When $P = mg\sin\theta - \mu mg\cos\theta$, net force is $\mu mg\cos\theta$ downwards

So $f_r = \mu mg\cos\theta$ is acting up the inclined

When $P = mg\sin\theta + \mu mg\cos\theta$, net force is $\mu mg\cos\theta$ upwards

So $f_r = \mu mg\cos\theta$ is acting down the inclined

For values of P between minimum and maximum, friction adjust it's value according to net force

Like for $P = mg\sin\theta$, net force is zero so $f_r = 0$

Multiple Correct Answer Type 4 Q. [4 M (–1)]

7. Ans. (A,B)

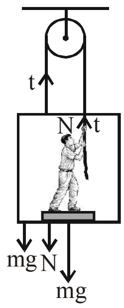
Sol. Man $N + T = mg$

$N + T = 500$ .....(i)

Weghing machine $T = mg + N$

$T - N = mg$

$T - N = 200$ ....(ii)



$N + T = 500$

$T - N = 200$

$2T = 700$

$T = 350$

$N + 350 = 500$

$N = 150$

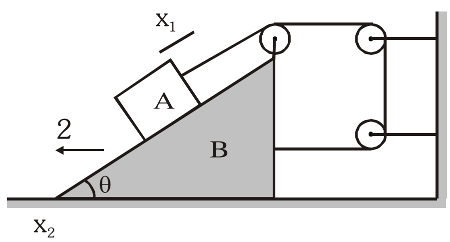
Reading 15 kg

$T = 350$

8. Ans. (A,C,D)

Sol. $4\cos\theta - 2 = 0$

$\cos\theta = \dfrac{1}{2}$ $\theta = 60°$



$a_A = 4\sin 60 = 2\sqrt{3}m/s^2$

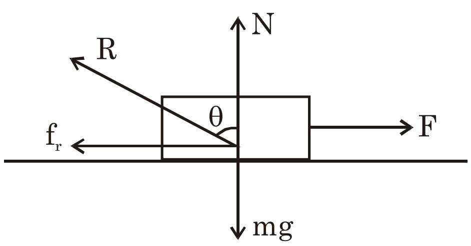
$TX_1 - 2TX_2 = 0 \Rightarrow X_1 = 2X_2$

$a_1 = 2a_2$

$a_1 = 2 \times 2 = 4$

9. Ans. (A,B,C)

Sol.



Net force by surface is resultant (R) of normal and friction

$$\tan\theta = \frac{f_r}{N} = \frac{f_r}{mg}$$

for $F \geq \mu mg$ $f_r = \mu mg = \dfrac{1}{\sqrt{3}}mg$

$$\tan\theta = \frac{\frac{1}{\sqrt{3}}mg}{mg} = \frac{1}{\sqrt{3}} \Rightarrow \theta = 30°$$

For $F < \mu mg$ $f_r = F$ and $\tan\theta = \dfrac{F}{mg} < \dfrac{\mu mg}{mg}$

$\tan\theta < \frac{1}{\sqrt{3}} \Rightarrow \theta < 30°$

(D) For $F < \mu mg$, θ depends on m but for $F \geq \mu mg$ value of θ is fixed (= 30°) and does not depend on m

10. Ans. (A,B,C)

Sol. $F - f = ma$

$30 - 10 = m \times 10$ $\qquad$ $\mu mg = 10$

$20 = 10m$ $\qquad$ $\mu 20 = 10$

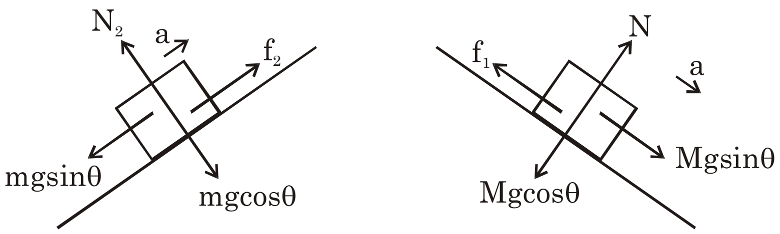
$m = 2kg$ $\qquad$ $\mu = \frac{1}{2}$

block start at force = 10. Limiting friction is 10.

Linked Comprehension Type (3 Para × 3Q.) [3 M (-1)]
(Single Correct Answer Type)

11. Ans. (D)

Sol. No slipping between ribbon and blocks implies ribbon also moving with blocks and blocks and ribbon have acceleration of same magnitude



As ribbon is massless, net force on it is zero

$\Rightarrow f_1 = f_2 = f$

by F = ma $\qquad$ $Mg\sin\theta - f = Ma$

$\qquad\qquad\qquad$ $f - mg\sin\theta = ma$

$\Rightarrow a = \frac{g\sin\theta(M-m)}{M+m}$

12. Ans. (C)

Sol. Tension = f

$Mg\sin\theta - f = Ma = \frac{Mg\sin\theta(M-m)}{M+m}$

$f = \frac{2Mmg\sin\theta}{(M+m)}$

13. Ans. (A)

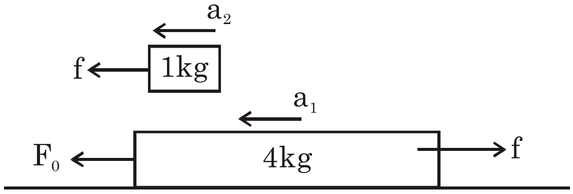
Sol. As θ increases $\Rightarrow$ f increases

as value $f_1)_{max} > f_2)_{max}$

So first m block slip on ribbon

14. Ans. (B)

Sol. Maximum value of friction $f_{max} = (0.4)(1 \times 10) = 4$ N



on verge of slipping $f = f_{max} = 4$ N and $a_1 = a_2 = a$

$F_0 - 4 = 4a$

$4 = 1a$

$\Rightarrow$ $a = 4$ and $F_0 = 20$ N

15. Ans. (D)

Sol. $F_0 = 3 \times 1 \times 10 = 30$ N

$30 - 4 = 4a_1 \Rightarrow a_1 = \frac{13}{2}$

$4 = 1 \cdot a_2 \Rightarrow a_2 = 4$

$a_{rel.} = \frac{13}{2} - 4 = \frac{5}{2} m/s^2$

w.r.t plank $\qquad S = ut + \frac{1}{2}at^2$

$0.8 = 0(t) + \frac{1}{2}\left(\frac{5}{2}\right)t^2$

$\Rightarrow t = \frac{4}{5} = 0.8 \sec.$

16. Ans. (A)

Sol. $a_2 = 4$ m/s^2

$S_2 = \frac{1}{2}a_2t^2 = \frac{1}{2} \times 4 \times \left(\frac{4}{5}\right)^2 = \frac{32}{25}$ m

$W = f\,S\cos 0 = 4 \times \frac{32}{25} = \frac{128}{25}$ J

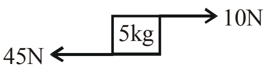
In Calorie $\frac{128}{25 \times 4.2} = 1.22$ Cal.

17. Ans. (A)

Sol. At F = 10N, motion between blocks starts

18. Ans. (C)

Sol.



So the block will never move

19. Ans. (A)

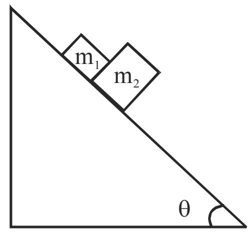
Sol. $30 - 10 = 10$ a

$20 = 10$ a

$a = 2$

Matching List Type (4 × 4) 1 Q. [3 M (–1)]

20. Ans. (D)



Sol. The system slip down if

$(m_1 + m_2)$ g $\sin\theta > \mu m_2 g\cos\theta$

$\tan\theta > \frac{\mu m_2}{m_1 + m_2} > \frac{0.3 \times 2}{3}$

$\tan\theta > 0.2$

$\Rightarrow \theta > 11.5°$

For P and Q system will remain stationary hence friction = $(m_1 + m_2)$ g $\sin\theta$

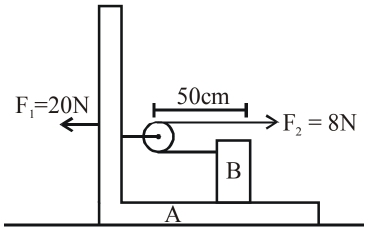
For R and S system will move hence limiting friction acts friction = $\mu m_2 g \cos\theta$

SECTION-II

Numerical Answer Type Question **2 Q. [3(0)]**

(upto second decimal place)

1. **Ans.** 0.5 s



Sol. $a_A = \frac{20-16}{1} = 4m/s^2$

$a_B = \frac{8}{1} = 8m/s^2$

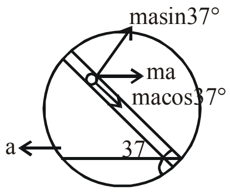
$a_{B/A} = 4m/s^2$

$0.5 = 1/2 \times 4t^2$

$t = \frac{1}{2}\sec = 0.5\sec$

2. **Ans.** 10 m/s^2

Sol.



ma cos 37 – μ ma sin 37 – μmg = ma_0

$25\times\frac{4}{5}-\frac{2}{5}\times 25\times\frac{3}{5}-\frac{2}{5}\times 10 = a_0$

20 – 6 – 4 = 90

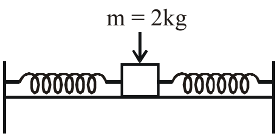
a_0 = 10 m/s^2

SECTION-IV

Matrix Match Type (4 × 5) **1 Q. [8 M (for each entry +2(0)]**

1. **Ans. (A) - (S) ; (B) - (S) ; (C) - (Q) ; (D) - (T)**

Sol.



force = $100\times\frac{2}{100}+100\times\frac{2}{100}$

4 =2a

a = 2

(C) $100 \times \frac{4\times 1}{100} + 100 \times \frac{4}{100}$

8 = 2a

a = 4

(D) $100\times\frac{1}{100}+100\times\frac{1}{100}$

2 = 2a

a = 1

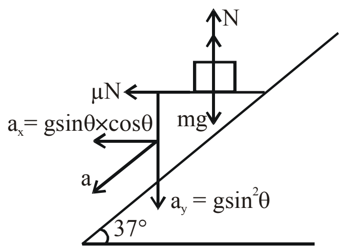
Subjective Type 7 Q. [4 M (0)]

1. Ans. (ma)

Sol. Pseudo force = $m_{objet} \times a_{observer}$

2. Ans. 3/4

Sol. If m notsliding



$a = g \sin\theta$

$mg - N = mg\sin^2\theta$

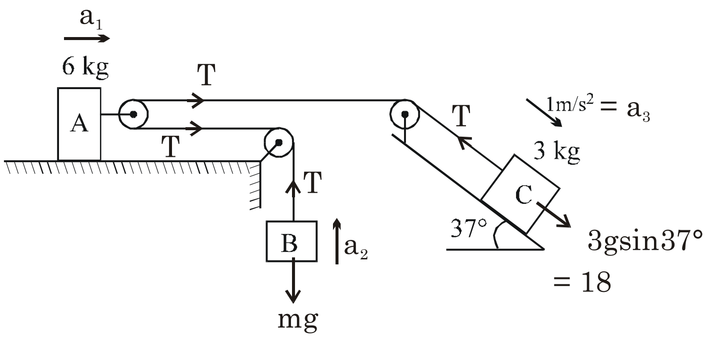
$N = mg(1 - \sin^2\theta) = mg \cos 2\theta$

$\mu N = mg \sin\theta \cos\theta$

$$\mu = \frac{\sin\theta}{\cos 2\theta} = \tan\theta = \frac{3}{4}$$

3. Ans. $M_B = 15$ kg, $T = 15$, $a_A = 5$ m/s², $a_B = 9$ m/s²

Sol.



By string constrain

$2Ta_1 + Ta_2 - Ta_3 = 0$

$2a_1 + a_2 = 1$ .... (i)

by F = ma

$18 - T = 3 \times 1 \Rightarrow T = 15$

$$2T = 6a_1 \Rightarrow a_1 = \frac{2\times 15}{6} = 5\,m/s^2$$

by equation (i) $2(5) + a_2 = 1 \Rightarrow a_2 = -9$

$T - mg = ma_2 \Rightarrow 15 - 10\,m = m\,(-9)$

$\Rightarrow m = 15$ kg

4. Ans. 2sec and 11.3 m travelled by A

Sol. $a_A = g \sin 45 - \mu_A g \cos 45$

$a_B = g \sin 45 - \mu_B g \cos 45$

$$a_{A/B} = -(\mu_A - \mu_B)\, g \cos 45 = 0.1 \times 10 \times \frac{1}{\sqrt{2}} = \frac{1}{\sqrt{2}}$$

$$s = \frac{1}{2}at^2 \Rightarrow \sqrt{2} = \frac{1}{2}\times\frac{1}{\sqrt{2}}t^2$$

t = 2 sec

distance by A

$$s_A = \frac{1}{2}a_A t^2$$

$$= \frac{1}{2}g\left(\sin 45 - 0.2\cos 45\right)t^2 = \frac{1}{2}10\left(\frac{1}{\sqrt{2}} - \frac{0.2}{\sqrt{2}}\right)t^2$$

$= \frac{1}{2} \times 10 \frac{1}{\sqrt{2}} \times 0.8 \times 4 = \frac{16}{\sqrt{2}}$ = 11.3 m

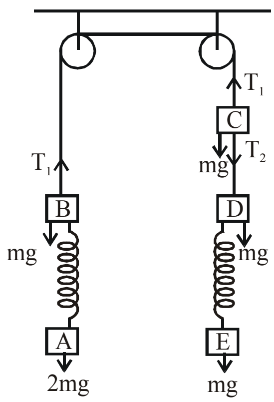
5. **Ans.** (i) $a_A = g \downarrow$, $a_B = \frac{2g}{3} \uparrow$, $a_c = \frac{2g}{3} \downarrow$, $a_D = \frac{2g}{3} \downarrow$, $a_E = 0$

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

Sol. (i) spring 1 is cut



$\vec{a}_A = g \downarrow$

acceleration of B,C,D are a.

$mg - T_1 = ma$

$T_1 - mg - T_2 = ma$

$T_2 - 2mg = ma$

$-2mg = 3ma$

$a = \frac{2g}{3}$

$a_B = \frac{2g}{3} \uparrow$ $a_C = \frac{2g}{3} \downarrow$ $a_D = \frac{2g}{3}$

$a_E = 0$

(ii) spring (2) is cut $a_A = 0$

all of B.C.D. are let a

$3mg - T_1 = ma$ $\vec{a}_B = \frac{g}{3} \downarrow$ $\vec{a}_C = \frac{g}{3} \uparrow$

$T_1 - T_2 - mg = ma$ $\vec{a}_D = g/3 \uparrow$

$T_2 - mg = ma$ $\vec{a}_E = g \downarrow$

$a = \frac{g}{3}$

(iii) String between C & D is cut

$a_A = 0$ $a_E = 0$ $a_D = 2g\downarrow$

let acceleration of B & C

$3mg - T_1 = mg$ $a_B = g\downarrow$ $a_C = g\uparrow$

$T_1 - mg = ma$

(iv) Between B & C is cut

$a_A = 0$ $a_E = 0$

For a_B

$3mg = ma_B$

$a_B = 3g\downarrow$

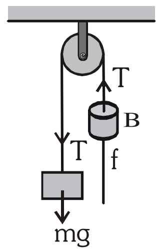
acceleration of C & D are (a) (let)

$2mg - T = ma$

mg + T = ma

$a = \frac{3g}{2}$ $\qquad a_c = \frac{3g}{2}\downarrow$ $\qquad a_D = \frac{3g}{2}\downarrow$

6. **Ans.** 5 m/s^2 downwards, 0 m/s^2, 10 N



Sol. $20 - T = 2a$

for sleeve

$10 - f = 1a_1$

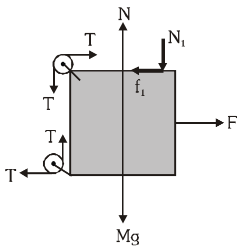
$T = f$

$a_1 + a = 5$

$a_1 = 5 - a$

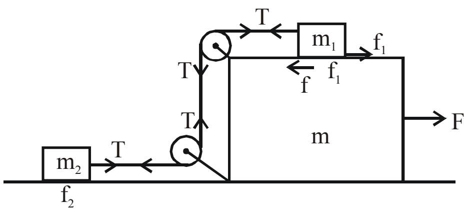
$20 - f = 2a$	acceleration objective
$10 - f = 5 - a$	$a_1 = 5 - 5 = 0$
$10 = 3a - 5$	$20 - T = 2 \times 5$
$a = 5$ m/s^2 downwards	T = 10N

7. Ans. (i)



(ii) a = 3/5 m/s^2 , T = 18 N, F = 60N

Sol.



$f_1 = 2f_2$

for bigger block

$f_1 - T = 20a$

$F - f_1 = 50$ a	$T - f_2 = 5a$
$F - 2f_2 = 50$ a	....(i)
$2f_2 - T = 20a$	...(ii)
$T - f_2 = 5a$	....(iii)

$f_2 = 25$ a $\Rightarrow 15 = 25$ a $\Rightarrow$ a = $a = \frac{3}{5} m/s$

from equation (i)	$F_2 - 50a = 50$ a
$F_2 = 100$ a = 60 N	
$f_2 = \mu\, m_2 g = 0.3 \times 50$	$T - 15 = 3$
= 15 N	T = 18 N