Exercise-1

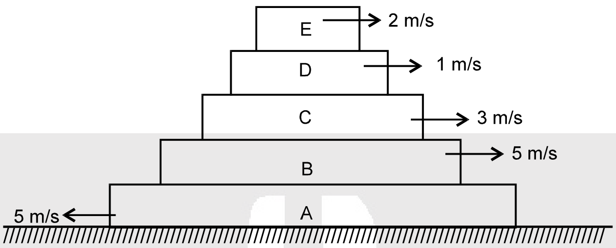
✍ **Marked Questions can be used as Revision Questions.**

PART - I : SUBJECTIVE QUESTIONS

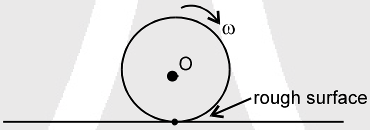
Section (A) : Kinetic Friction

A-1. Suppose you are running fast in a field. When you suddenly find a snake in front of you, you stop quickly. Which force is responsible for your deacceleration ?

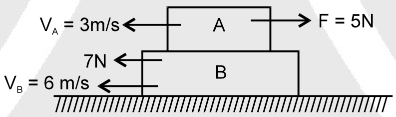
A-2.# In the given diagram find the direction of friction forces on each block and on the ground (Assume all surfaces are rough and all velocities are with respect to ground).



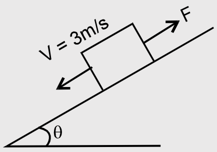
A-3.#✍ The wheel shown in the figure is fixed at 'O' and is in contact with a rough surface as shown. The wheel rotates with an angular velocity ω. What is the direction and nature of friction force on the wheel and on the ground.



A-4.# In the following figure, find the direction of friction on the blocks and ground .



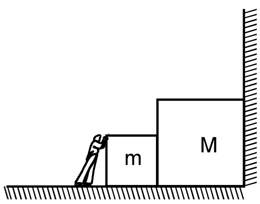
A-5.# In the following figure, find the direction and nature of friction on the block.



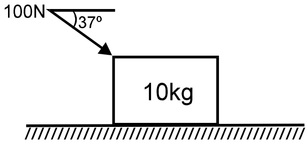
A-6. A block is shot with an initial velocity $5ms^{-1}$ on a rough horizontal plane. Find the distance covered by the block till it comes to rest. The coefficient of kinetic friction between the block and plane is 0.1.

Section (B) : Static Friction

B-1.#✍ The person applies F force horizontally on the smaller block as shown in figure. The coefficient of static friction is μ between the blocks and the surface. Find the force exerted by the vertical wall on mass M. What is the value of action-reaction forces between m and M?



B-2.# In the figure shown calculate the angle of friction. The block is just about to slide. Take g = 10 m/s^2.



B-3. What is the minimum value of force (in following two cases) required to pull a block of mass m on a horizontal surface having coefficient of friction μ? Also find the angle this force makes with the horizontal.

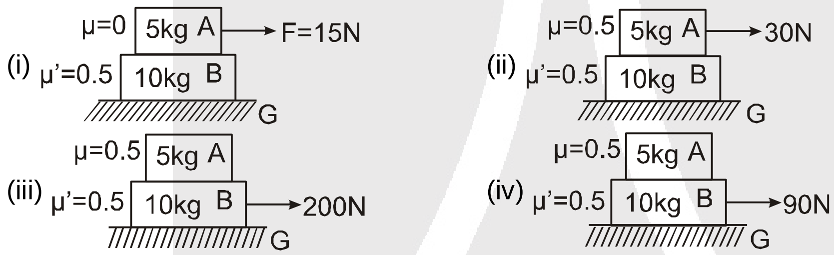
(a) If force is parallel to horizontal surface

(b) If force is in any direction (Also find the angle this force makes with the horizontal.)

Section (C) : Miscellaneous Questions

C-1. A body of mass 5 kg is kept on a rough horizontal surface. It is found that the body does not slide if a horizontal force less than 30 N is applied to it. Also it is found that it takes 5 seconds to slide throughout the first 10 m if a horizontal force of 30 N is applied and the body is gently pushed to start the motion. Taking g= 10 m/s^2, calculate the coefficients of static and kinetic friction between the block and the surface.

C-2.# In the given figures find the accelerations and the friction forces involved :



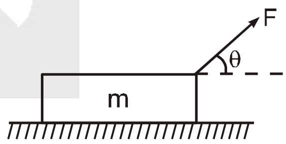
PART - II : ONLY ONE OPTION CORRECT TYPE

Section (A) : Kinetic Friction

A-1. Starting from rest a body slides down a 45º inclined plane in twice the time it takes to slide down the same distance in the absence of friction. The co-efficient of friction between the body and the inclined plane is:

(A) 0.75 (B) 0.33 (C) 0.25 (D) 0.80

A-2.# A wooden block of mass m resting on a rough horizontal table (coefficient of friction = μ) is pulled by a force F as shown in figure. The acceleration of the block moving horizontally is :



(A) $\frac{F\cos\theta}{m}$ (B) $\frac{\mu F\sin\theta}{M}$

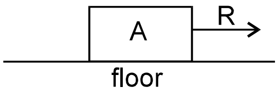
(C) $\frac{F}{m}(\cos\theta + \mu\sin\theta) - \mu g$ (D) none of these

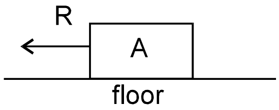
Section (B) : Static Friction

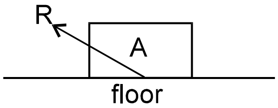
B-1. If the normal force is doubled, the co-efficient of friction is :

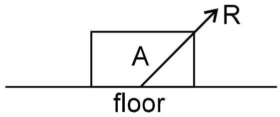
(A) halved (B) doubled (C) tripled (D) not changed

B-2.# A box 'A' is lying on the horizontal floor of the compartment of a train running along horizontal rails from left to right. At time 't', it decelerates. Then the resultant contact force R by the floor on the box is given best by :

(A) 

(B) 

(C) 

(D) 

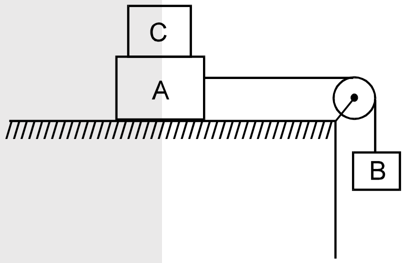
B-3. A block of mass 1 kg lies on a horizontal surface in a truck. The coefficient of static friction between the block and the surface is 0.6 If the acceleration of the truck is 5 m/s^2, the frictional force acting on the block is :

(A) 5 N (B) 6 N (C) 10 N (D) 15 N

B-4. A block of mass 2 kg rests on a rough inclined plane making an angle of 30^0 with the horizontal. The coefficient of static friction between the block and the plane is 0.7. The frictional force on the block is :

(A) 9.8 N (B) $0.7 \times 9.8\sqrt{3}$ N (C) 9.8 × 7 N (D) 0.8 × 9.8 N

B-5. Two masses A and B of 10 kg and 5 kg respectively are connected with a string passing over a frictionless pulley fixed at the corner of a table as shown. The coefficient of static friction of A with table is 0.2. The minimum mass of C that may be placed on A to prevent it from moving is



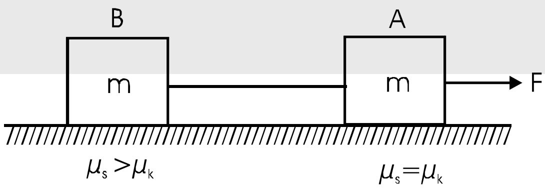
(A) 15 kg (B) 10 kg
(C) 5 kg (D) 12 kg

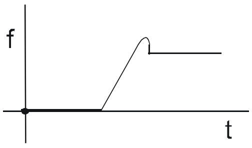
Section (C) : Miscellaneous Questions

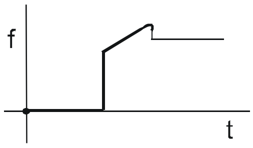
C-1. A 60 kg body is pushed horizontally with just enough force to start it moving across a floor and the same force continues to act afterwards. The coefficient of static friction and sliding friction are 0.5 and 0.4 respectively. The acceleration of the body is :

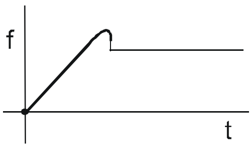
(A) 6 m/s^2 (B) 4.9 m/s^2 (C) 3.92 m/s^2 (D) 1 m/s^2

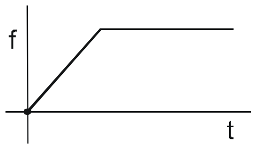
C-2.# A force F = t is applied to block A as shown in figure. The force is applied at t = 0 seconds when the system was at rest and string is just straight without tension. Which of the following graphs gives the friction force between B and horizontal surface as a function of time 't'.



(A) 

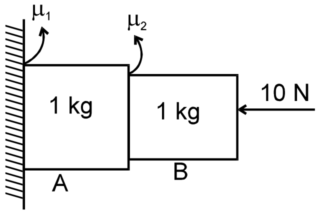
(B) 

(C) 

(D) 

PART - III : MATCH THE COLUMN

1.# In the given figure find the accelerations of blocks A and B for the following cases ($g = 10\ m/s^2$)



Column – I	**Column – II**
(A) $\mu_1 = 0$ and $\mu_2 = 0.1$	(p) $a_A = a_B = 9.5\ m/s^2$
(B) $\mu_2 = 0$ and $\mu_1 = 0.1$	(q) $a_A = 9\ m/s^2$, $a_B = 10\ m/s^2$
(C) $\mu_1 = 0.1$ and $\mu_2 = 1.0$	(r) $a_A = a_B = g = 10\ m/s^2$
(D) $\mu_1 = 1.0$ and $\mu_2 = 0.1$	(s) $a_A = 1$, $a_B = 9\ m/s^2$

2.# Column II gives certain situations involving two blocks of mass 2 kg and 4 kg. The 4 kg block lies on a smooth horizontal table. There is sufficient friction between both the blocks and there is no relative motion between the blocks in all situation. Horizontal forces act on one or both blocks as shown. Column I gives certain statement related to figures given in column II. Match the statements in column I with the figure in column II.

Column I

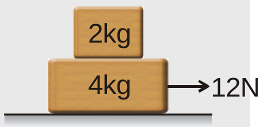
(A) Magnitude of frictional force is maximum.

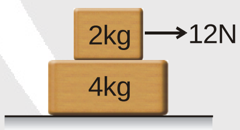
(B) Magnitude of friction force is least.

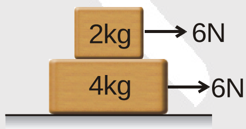
(C) Friction force on 2 kg block is towards right.

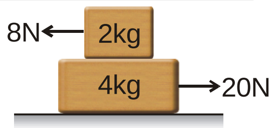
(D) Friction force on 2 kg block is towards left.

Column II

(p) 

(q) 

(r) 

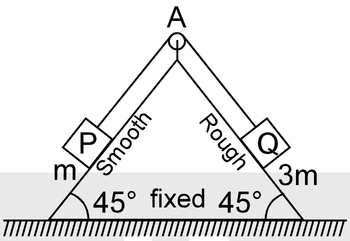
(s) 

Exercise-2

✍ **Marked Questions may have for Revision Questions.**

PART - I : ONLY ONE OPTION CORRECT TYPE

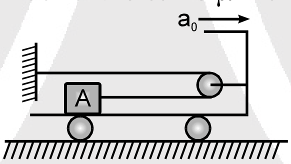
1.✍ A fixed wedge with both surface inclined at 45° to the horizontal as shown in the figure. A particle P of mass m is held on the smooth plane by a light string which passes over a smooth pulley A and attached to a particle Q of mass 3m which rests on the rough plane. The system is released from rest. Given that the acceleration of each particle is of magnitude $\frac{g}{5\sqrt{2}}$ then



the tension in the string is :

(A) mg (B) $\frac{6mg}{5\sqrt{2}}$ (C) $\frac{mg}{2}$ (D) $\frac{mg}{4}$

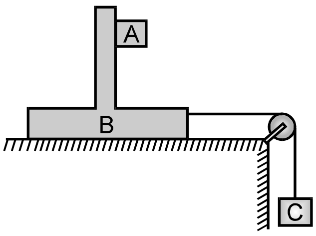
2.#✍ Starting from rest, A flat car is given a constant acceleration a_0 = 2 m/s^2. A cable is connected to a crate A of mass 50 kg as shown. Neglect the friction between floor and car wheels and mass of pulley. The cofficient of friction between crate & floor of the car is μ = 0.3. The tension in cable is -



(A) 700 N (B) 350 N (C) 175 N (D) 0

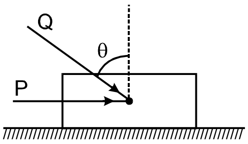
3. A uniform rope lies on a table with some portion hanging. The rope begins to slide when the length of hanging part is 25 % of entire length. The co-efficient of friction between rope and table is:
(A) 0.33 (B) 0.25 (C) 0.5 (D) 0.2

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



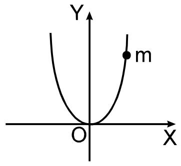
(A) $\frac{m}{\mu}$ (B) $\frac{2m}{\mu+1}$ (C) $\frac{10\ m}{1-\mu}$ (D) $\frac{10m}{\mu-1}$

5.# A block of mass m lying on a rough horizontal plane is acted upon by a horizontal force P and another force Q inclined at an angle θ to the vertical. The minimum value of coefficient of friction between the block and the surface for which the block will remain in equilibrium is:



(A) $\frac{P+Q\sin\theta}{mg+Q\cos\theta}$ (B) $\frac{P\cos\theta+Q}{mg-Q\sin\theta}$ (C) $\frac{P+Q\cos\theta}{mg+Q\sin\theta}$ (D) $\frac{P\sin\theta-Q}{mg-Q\cos\theta}$

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



(A) μa (B) $\mu^2 a$

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

7. A 1.5 kg box is initially at rest on a horizontal surface when at t = 0 a horizontal force $\vec{F} = (1.8t)\hat{i}N$ (with t in seconds) is applied to the box. The acceleration of the box as a function of time t is given by : (g = 10m/s^2)

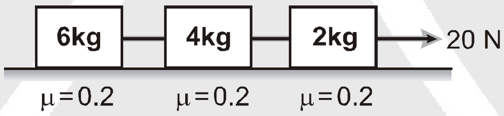
$\vec{a} = 0$ for $0 \le t \le 2.85$

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

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

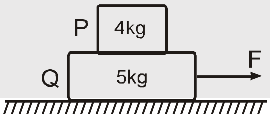
(A) 0.12 (B) 0.24 (C) 0.36 (D) 0.48

8.# In the arrangement shown tension in the string connecting 4kg and 6kg masses is



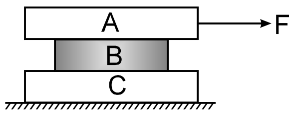
(A) 8N (B) 12N (C) 6N (D) 4N

9.# In the given figure the coefficient of friction between 4kg and 5 kg blocks is 0.2 and between 5 kg block and ground is 0.1. Choose the correct statements



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

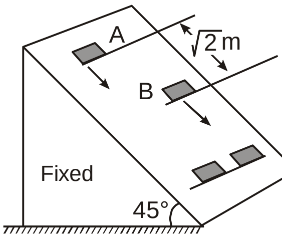
10.# Given m_A = 30 kg, m_B = 10 kg, m_C = 20 kg. Between A and B friction coefficient μ_1 = 0.3, between B and C friction coefficient μ_2 = 0.2 and between C and ground μ_3 = 0.1. The least horizontal force F to start the motion of any part of the system of three blocks resting upon one another as shown in figure is (g = 10 m/s^2)



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

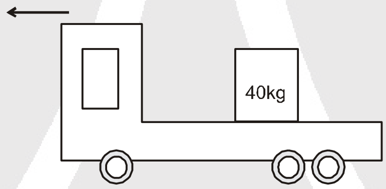
PART - II : SINGLE AND DOUBLE VALUE INTEGER TYPE

1. Two blocks A and B of equal masses are sliding down along straight parallel lines on an inclined plane of 45°. Their coefficients of kinetic friction are $\mu_A = 0.2$ and $\mu_B = 0.3$ respectively. At t = 0, both the blocks are at rest and block A is $\sqrt{2}$ meter behind block B. The time (in second) from the initial position where the front faces of the blocks come in line on the inclined plane as shown in figure. (Use g = 10 ms^{-2}.) **[JEE 2004 (Scr.) 3/84]**

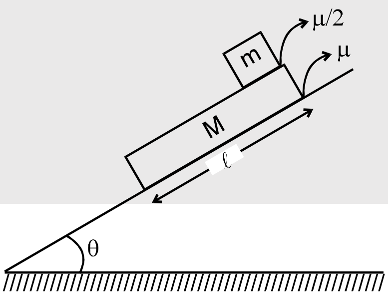


2. A block of mass 2 kg is pushed against a rough vertical wall with a force of 30 N, coefficient of static friction being 0.5. Another horizontal force of 15 N is applied on the block in a direction parallel to the wall. What is the acceleration of block (in m/s^2) ?

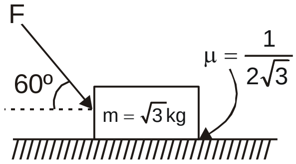
3.# The rear side of a truck is open and a box of 40 kg mass is placed 5 m away from the open end as shown in figure. The coefficient of friction between the box and the surface below it is 0.15. On a straight road, the truck starts from rest and accelerates with 2 ms^{-2}. Find the distance (in m) travelled by the truck by the time box falls from the truck. (Ignore the size of the box).



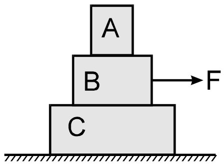
4.# In the given situation it is known that when released the blocks slide. Find the time (in second) when the small block will fall off from the larger block. (The size of m is very –very small then M, see figure). If m = 1 kg, M = 4 kg, ℓ = 4 m, θ = 37°, μ = 0.4.



5.# What is the maximum value of the force F (in newton) such that the block shown in the arrangement, does not move : **[JEE 2003 (Screening); 3/90]**



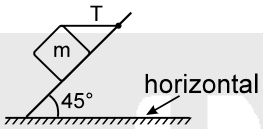
6.# In the figure shown, the coefficient of static friction between C and ground is 0.5, coefficient of static friction between A and B is 0.25, coefficient of static friction between B and C is zero. Find the minimum value of force 'F' (in newton), to cause sliding between A and B. Masses of A, B and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



7. A small body was launched up an inclined plane set at an angle α = 15° against the horizontal. The coefficient of friction is k, if the time of the ascent of the body is η = 2.0 times less than the time of its descent. Find value of 100 k

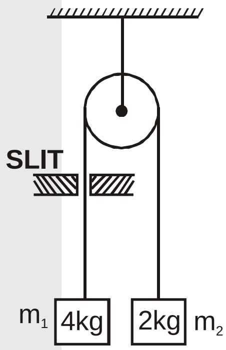
PART - III : ONE OR MORE THAN ONE OPTIONS CORRECT TYPE

1. # 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. The coefficient of friction between the surfaces of contact may be (g = 10 m/s^2)



(A) 1/2 (B) 2/3 (C) 3/4 (D) 1/4

2.# Two masses m_1 = 4 kg and m_2 = 2kg are connected with an inextensible, massless string that passes over a frictionless pulley and through a slit, as shown. The string is vertical on both sides and the string on the left is acted upon by a constant friction force 10 N by the slit as it moves. (Use g = 10 m/s^2)



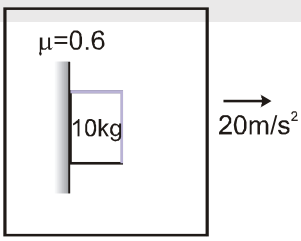
(A) Acceleration of mass m_1 is $\frac{5}{3}$ m/s^2, downwards.

(B) Tension in the string is same throughout.

(C) Force exerted by the string on mass m_2 is $\frac{70}{3}$ N.

(D) If positions of both the masses are interchanged, then 2kg mass moves up with an acceleration $\frac{10}{3}$ m/s^2.

3. # Car is accelerating with acceleration = 20 m/s^2. A box of mass m = 10 kg that is placed inside the car, it is put in contact with the vertical wall of car as shown. The friction coefficient between the box and the wall is μ = 0.6.



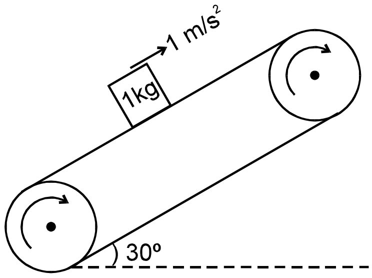
(A) The acceleration of the box will be 20 m/sec^2

(B) The friction force acting on the box will be 100 N

(C) The contact force between the vertical wall and the box will be $100\sqrt{5}$ N

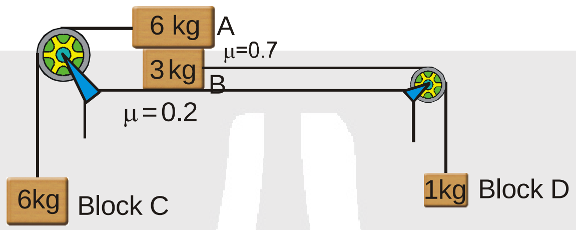
(D) The net contact force between the vertical wall and the box is only of electromagnetic in nature.

4.# A block of mass 1 kg is stationary with respect to a conveyer belt that is accelerating with 1 m/s^2 upwards at an angle of 30º as shown in figure. Which of the following is/are correct?



(A) Force of friction on block is 6 N upwards along the inclined plane.
(B) Force of friction on block is 1.5 N upwards along the inclined plane.
(C) Contact force between the block & belt is 10.5 N.
(D) Contact force between the block & belt is $5\sqrt{3}$ N.

5.# An arrangement of the masses and pulleys is shown in the figure. Strings connecting masses A and B with pulleys are horizontal and all pulleys and strings are light. Friction coefficient between the surface and the block B is 0.2 and between blocks A and B is 0.7. The system is released from rest. (use g = 10 m/s^2)

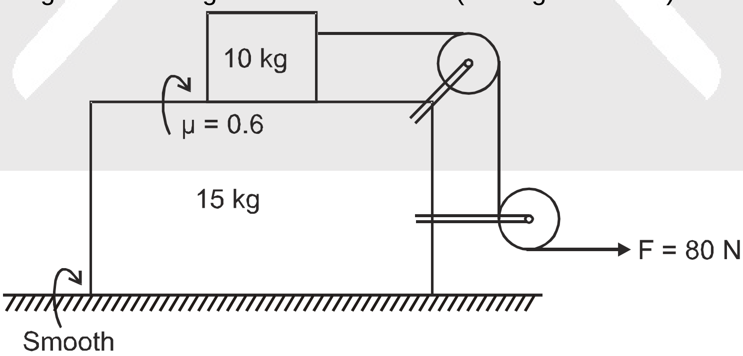


(A) The magnitude of acceleration of the system is 2 m/s^2 and there is no slipping between block A and block B.
(B) The magnitude of friction force between block A and block B is 42 N.
(C) Acceleration of block C is 1 m/s^2 downwards.
(D) Tension in the string connecting block B and block D is 12 N.

PART - IV : COMPREHENSION

Comprehension - 1

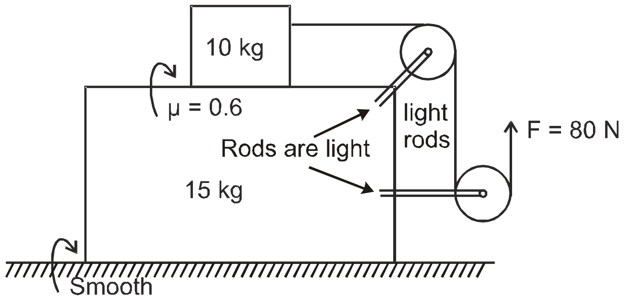
A block of mass 15 kg is placed over a frictionless horizontal surface. Another block of mass 10 kg is placed over it, that is connected with a light string passing over two pulleys fastened to the 15 kg block. A force F = 80 N is applied horizontally to the free end of the string. Friction coefficient between two blocks is 0.6. The portion of the string between 10 kg block and the upper pulley is horizontal as shown in figure Pulley string & connecting rods are massless. (Take g = 10 m/s^2)



1. The magnitude of acceleration of the 10 kg block is :
(A) 3.2 m/s^2 (B) 2.0 m/s^2 (C) 1.6 m/s^2 (D) 0.8 m/s^2

2. If applied force F = 120 N, then magnitude of acceleration of 15 kg block will be :
(A) 8 m/s^2 (B) 4 m/s^2 (C) 3.2 m/s^2 (D) 4.8 m/s^2

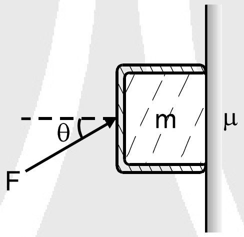
3. Continuing with the situation, if the force F = 80 N is directed vertically as shown, the acceleration of the 10 kg block will be :



(A) 2 m/s^2, towards right
(B) 2 m/s^2, towards left
(C) 6 m/s^2, towards left
(D) 16/5 m/s^2, towards right

Comprehension # 2

Impending state of motion is a critical border line between static and dynamic states of a body. A block of mass m is supported on a rough vertical wall by applying a force F as shown in figure. Coefficient of static friction between block and wall is μ_S. The block under the influence of F sinθ may have a tendency to move upward or it may be assumed that F sinθ just prevents downward fall of the block. Read the above passage carefully and answer the following questions.



4. The minimum value of force F required to keep the block stationary is :

(A) $\frac{mg}{\mu\cos\theta}$ (B) $\frac{mg}{\sin\theta+\mu\cos\theta}$ (C) $\frac{mg}{\sin\theta-\mu\cos\theta}$ (D) $\frac{mg}{\mu\tan\theta}$

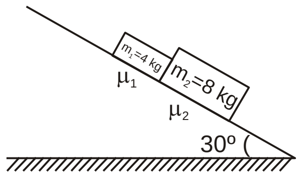
5. The value of F for which friction force between the block and the wall is zero.

(A) mg (B) $\frac{mg}{\sin\theta}$ (C) $\frac{mg}{\cos\theta}$ (D) $\frac{mg}{\tan\theta}$

6. If F is the force applied on the block as shown and F_{min} is the minimum value of force required to keep the block stationary. Then choose the correct alternative.
(A) If F < F_{min} ; the block slides downward
(B) If F = F_{min} ; the block slides upward
(C) In each case (for any value of F) the friction force f < mg
(D) All the above

Comprehension # 3

In the figure shown below the friction between the 4 kg block and the incline as μ_1 and between 8 kg and incline is μ_2. (Take g = 10 m/s^2)



7. If μ_1 = 0.2 and μ_2 = 0.3 then find acceleration of m_1 and m_2 ?
(A) $a_1 = a_2 = 2.7$ m/s^2
(B) $a_1 = 3.2$ m/s^2, $a_2 = 2.4$ m/s^2
(C) $a_1 = a_2 = 3.2$ m/s^2
(D) $a_1 = 2.4$ m/s^2, $a_2 = 3.2$ m/s^2

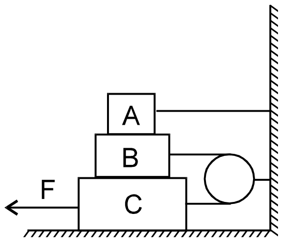
8. If $\mu_1 = 0.3$ and $\mu_2 = 0.2$ then find acceleration of m_1 and m_2 ?

(A) $a_1 = a_2 = 2.7$ m/s^2 (B) $a_1 = 3.2$ m/s^2, $a_2 = 2.4$ m/s^2

(C) $a_1 = a_2 = 3.2$ m/s^2 (D) $a_1 = 2.4$ m/s^2, $a_2 = 3.2$ m/s^2

Comprehension # 4

$M_A = 3$ kg, $M_B = 4$ kg and $M_C = 8$ kg. Friction cofficient between any two surfaces is 0.25. Pulley is frictionless and string is massless. Block, A is connected to the wall through a horizontal massless rigid rod as shown in figure. (g=10m/s^2)



9. Find the value of F to keep C moving with constant speed

(A) 60 N (B) 40 N (C) 80 N (D) 100 N

10. If F is 200 N then find acceleration of B

(A) 5 m/s^2 (B) 10 m/s^2 (C) 4 m/s^2 (D) zero

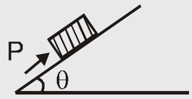
Exercise-3

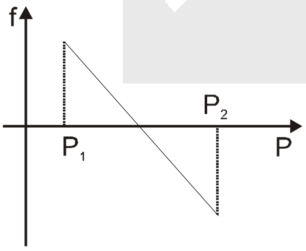
✍ Marked Questions may have for Revision Questions.

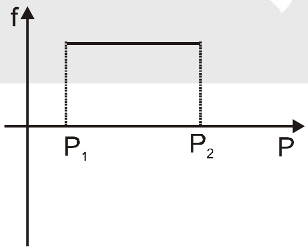
*** Marked Questions may have more than one correct option.**

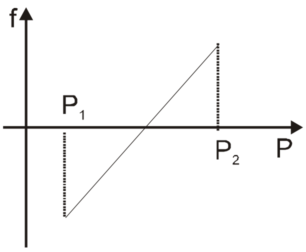
PART - I : JEE (ADVANCED) / IIT-JEE PROBLEMS (PREVIOUS YEARS)

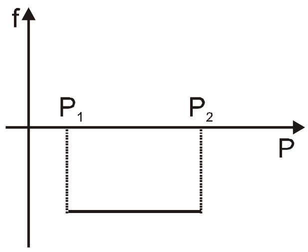
1.#✍ A block of mass m is on inclined plane of angle θ. The coefficient of friction between the block and the plane is μ and tanθ > μ. The block is held stationary by applying a force P parallel to the plane. The direction of force pointing up the plane is taken to be positive. As P is varied from $P_1 = mg(\sin\theta - \mu\cos\theta)$ to $P_2 = mg(\sin\theta + \mu\cos\theta)$, the frictional force f versus P graph will look like : **[JEE 2010, 3/163, –1]**



(A) 

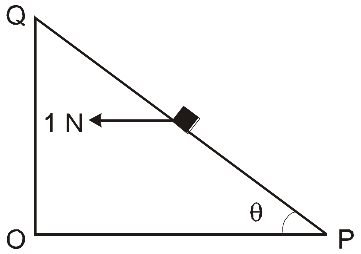
(B) 

(C) 

(D) 

2. 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 $k = 10\ \mu$, then value of k is **[JEE 2011, 4/160]**

3.*#✍ A small block of mass 0.1 kg lies on a fixed inclined plane PQ which makes an angle θ with the horizontal. A horizontal force of 1 N acts on the block through its center of mass as shown in the figure. The block remains stationary if (take $g = 10\ m/s^2$) **[IIT-JEE-2012, Paper-1; 4/70]**



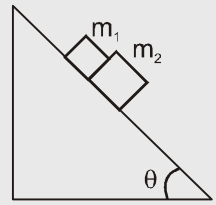
(A) $\theta = 45°$

(B) $\theta > 45°$ and a frictional force acts on the block towards P.

(C) $\theta > 45°$ and a frictional force acts on the block towards Q.

(D) $\theta < 45°$ and a frictional force acts on the block towards Q.

4.# A block of mass $m_1 = 1$ kg and another mass $m_2 = 2$ kg , 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 $\mu = 0.3$. In List II expression for the friction on block m_2 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. **[JEE (Advanced) 2014; 3/60, –1]**
[**Useful information** : tan(5.5°) ≈ 0.1 ; tan (11.5°) ≈ 0.2 ; tan(16.5º ≈ 0.3)]



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

PART - II : JEE (MAIN) / AIEEE PROBLEMS (PREVIOUS YEARS)

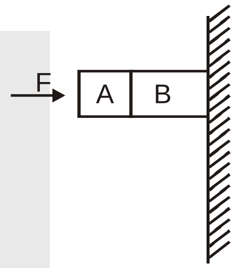
1. The minimum force required to start pushing a body up a rough (friction coefficient μ) inclined plane is F_1 while the minimum force needed to prevent it from sliding down is F_2. If the inclined plane makes an angle θ from the horizontal such that $\tan\theta = 2\mu$ then the ratio F_1/F_2 is :
[AIEEE 2011, 11 May; 4/120, –1]

(1) 1 (2) 2 (3) 3 (4) 4

2. 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 ; 4/120, –1]**

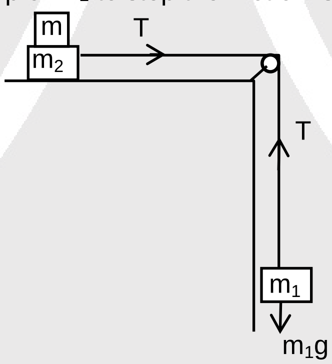
(1) $\frac{1}{6}$ m (2) $\frac{2}{3}$ m (3) $\frac{1}{3}$ m (4) $\frac{1}{2}$ m

3. 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 (Assume system in equilibrium):
[JEE (Main) 2015; 4/120, –1]



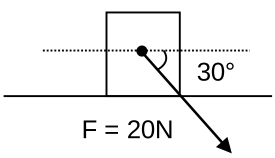
(1) 100N (2) 80N
(3) 120N (4) 150N

4. Two masses m_1 = 5kg and m_2 = 10kg 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; 4/120, –1]**

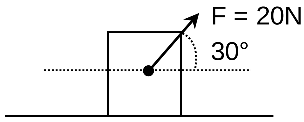


(1) 43.3 kg (2) 10.3 kg (3) 18.3 kg (4) 27.3 kg

5. A block of mass 5kg is (i) pushed in case (A) and (ii) pulled in case (B), by a force F = 20N, making an angle of 30° with the horizontal, as shown in the figures. The coefficient of friction between the block and floor is μ = 0.2. The difference between the accelerations of the block, in case (B) and case (A) will be : (g = $10ms^{-2}$) **[JEE (Main) 2019 April; 4/120, –1]**



(A)



(B)

(1) 0.8 ms^{-2} (2) 0 ms^{-2} (3) 3.2 ms^{-2} (4) 0.4 ms^{-2}

Answers

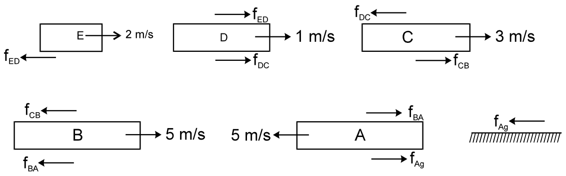
Exercise–1

PART - I

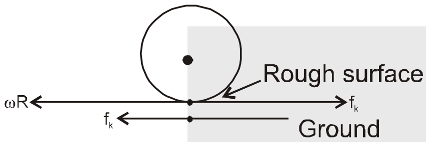
Section (A)

A-1. Frictional force, which is a type of electromagnetic force.

A-2.

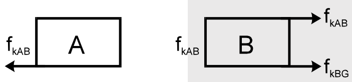


A-3.



Kinetic friction is involved.

A-4.



A-5. Up the incline, kinetic friction.

A-6. 12.5 m

Section (B)

B-1. action-reaction force between M and vertical wall

$N = 0$ for $F\mu \leq (M+m)g$

$N = F - \mu(M+m)g$ for $F > \mu(M+m)g$

Action-reaction force between m and M

$N = F - \mu mg$ for $F > \mu mg$

and $N = 0$ for $F < \mu mg$

B-2. $\theta = \tan^{-1}\frac{1}{2}$

B-3. (a) μmg (b) $\frac{\mu mg}{\sqrt{1+\mu^2}}$, $\tan^{-1}\mu$.

Section (C)

C-1. $\mu_s = 0.60$, $\mu_k = 0.52$

C-2. (i) $a_A = 3\ m/s^2$, $a_B = 0$, $f_{AB} = 0$, $f_{BG} = 0$

(ii) $a_A = 1\ m/s^2$, $a_B = 0$, $f_{AB} = 25N$, $f_{BG} = 25N$

(iii) $a_A = 5\ m/s^2$; $a_B = 10\ m/s^2$; $f_{AB} = 25N$; $f_{BG} = 75N$

(iv) $a_A = 1 m/s^2$; $a_B = 1 m/s^2$; $f_{AB} = 5N$; $f_{BG} = 75N$

PART - II

Section (A)

A-1. (A) **A-2.** (C)

Section (B)

B-1. (D) **B-2.** (C) **B-3.** (A)
B-4. (A) **B-5.** (A)

Section (C)

C-1. (D) **C-2.** (A)

PART - III

1. (A) r, (B) q, (C) p , (D) s
2. (A) s (B) r (C) p, s (D) q, r

Exercise–2

PART - I

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

PART - II

1.	2	**2.**	5	**3.**	20
4.	2	**5.**	20	**6.**	15
7.	16				

PART - III

1. (A) (B) (C) **2.** (A) (C)
3. (A) (B) (C) (D) **4.** (A) (C) **5.** (A) (D)

PART - IV

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

Exercise–3

PART - I

1.	(A)	**2.**	k = 5	**3.**	(A) (C)
4.	(D)				

PART - II

1.	(3)	**2.**	(1)	**3.**	(3)
4.	(4)	**5.**	(1)		