PHYSICS

BOOKS - CENGAGE PHYSICS

FRICTION

Worked Examples

1. A book of mass 0.5 kg lies on the surface of a table. The coefficient of friction between the book and the surface of the table is 0.6.

Calculate the force required to just move it. (Take g $= 10ms^{-2}$)

Another identical book is kept on the book on the table.How is the force needed to move it affected?

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2. A block of weight 10 N lies on a rough table. It just moves when a force of 7N is applied on it. Calculate the coefficient of limiting friction between the block and the table.

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3. A block of mass 10 kg rests on a rough inclined plane of inclination 45° with the horizontal. What minimum force is required to just move the block up the inclined plane. Given $\mu_s = 0.5$ and $g = 10ms^{-2}$.

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4. A heavy box of mass 20 kg is pulled on a horizontal force.If the coefficient of kinetic

friction between the box and the horizontal surface is 0.25, find the force of friction exerted by horizontal surface on the box.

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Mandatory Exercise Exercise Set I

1. Arrange the following in ascending order of their magnitude.

Rolling friction, static friction, kinetic friction, limiting friction.

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2. Why do tyres of vehicles have tread?

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3. Example why:

(i) we slip when step on a banana pell.

(ii) lubricants are used in matchines.

(iii) a hover-creft travels much faster then a steamer pushing through water.

(iv) aeroplanes, missiles, and space ships have their front pointed.

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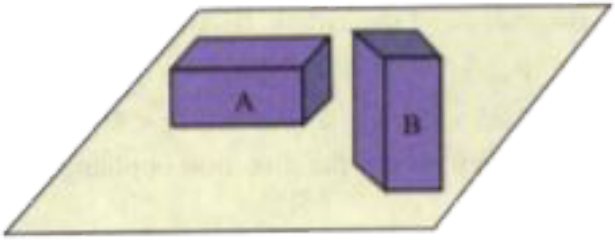
4. Two identical wooden blocks (A and B) are kept as known in the figure. When you push the blocks, which of the blocks would experience less frictional force? State the reason.



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5. If a constant retarding force is applied on an object moving backwards, i.e., $\nu = u - at$ becomes negative after $(at > u)$ .But, even if you hold the brake lever pressed in your bicycle, it does not go backwards after coming to rest. Comment.

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6. You can keep a book pressed against a wall and prevent it from falling down. Can this horizontal force applied cancel the weight which is a vertical force? Explain.

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7. Why is it easier to maintain the motion than to state it?

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8. In order to stop a car in shortest disatance on a horizontal road one should

A. apply the brakes very hard so that the wheels stop rotating

B. apply the brakes hard enough to just prevent slipping

C. pump the brakes (press and release)

D. shut the engine off and not apply brakes

Answer: b

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9. If the normal force is doubled, the coefficient of friction is

A. doubled

B. halved

C. not changed

D. tripled

Answer: c

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10. For a block kept on a table, the maximum force of static friction is F_1 . If the set-up is taken to moon, the force is F_2. Then

A. $F_1 = F_2$

B. $F_1 < F_2$

C. $F_2 < F_1$

D. none of these

Answer: c

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11. A scooter generally slips on an oily road, because

A. friction between tyres and road is large.

B. friction between tures and not sufficient.

C. inertia between tyres and road is large.

D. tyres of a scooter cannot rotate.

Answer: b

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12. A body of mass 100 g is made just to slide on a rough surface by applying a force of 0.8 N. Find the coefficient of friction. Take $g = 10ms^2$.

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13. A weight 'W' rests on a horizontal plane. What will be the least force required to move the body alone the plane,if the angle of friction is 0?

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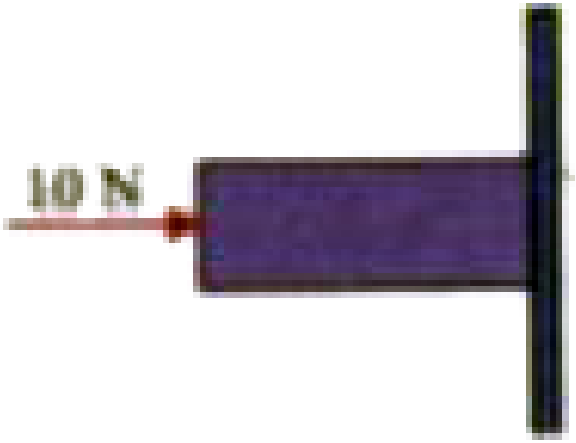
14. A horizontal force of 10 N is necessary to just hold a block stationary against a wall. The coefficient of friction between the block and wall is 0.2. What is the weight of the block?



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15. A mass of 4 kg rests on a horizontal plane. When the plane is gradually inclined to an angle 0 -15° with the horizontal, the mass just begins to slide. What is the coefficient of static friction between the block and the surface? [Given, tan 15° = 0.2679)

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16. The ratio of μ_k (kinetic friction) and μ_s (state friction) is

A. greater than 1

B. less than 1

C. equal to 1

D. depends on condition

Answer: b

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17. What is the relation between the normal reaction acting on a surface and the limiting friction on the surface?

A. $\mu = F_r - N$

B. $\mu = F_r \times N$

C. $\mu = F_r / N$

D. none of these

Answer:

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18. A block of mass 0.1 kg is held against a wall by applying a horizontal force of 5 N on the block. If the coefficient of friction between the

block and the wall is 0.5, then the magnitude of the frictional force acting on the block is

A. 2.5 N

B. 0.98 N

C. 4.9 N

D. 0.49 N

Answer:

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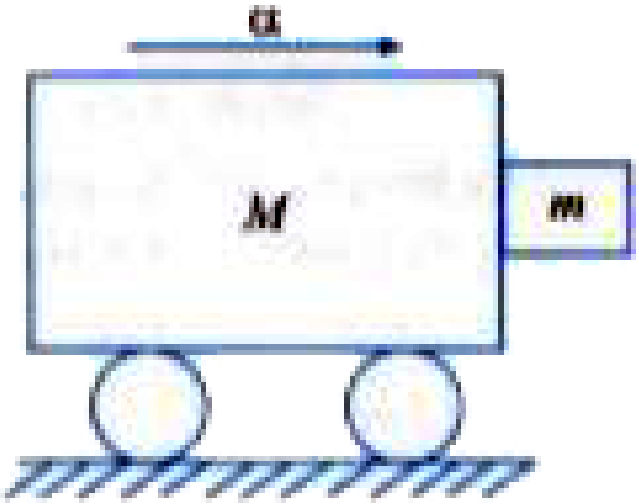
19. The block of mass m is in contact with a moving cart as shown in the figure.The coefficient of friction between the block and the cart is . The acceleration a of the cart that will prevent the block from falling is



A. $\alpha \geq \frac{g}{\mu}$

B. $\alpha < \frac{g}{\mu}$

C. $\alpha > \frac{mg}{\mu}$

D. $\alpha > \frac{g}{\mu m}$

Answer:

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20. A block is placed on an inclined plane. The angle of inclination of the plane is such that the block slides down the plane at a constant speed. The coefficient of kinetic friction is

A. $\sin\theta$

B. $\cos\theta$

C. $\cot\theta$

D. $\tan\theta$

Answer:

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21. Find the maximum value of force F such that the block shown in the figure does not

move

A. 20 N

B. 10 N

C. 12 N

D. 15 N

Answer:

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22. If F denotes the contact force, f denotes the frictional force exerted by one surface on the other, F_N denotes the normal reaction force between the two respectively and none of them are zero, then

A. $F < f$

B. $F_N < F$

C. $F_N > F$

D. $F_N - f < F < F_N + f$

Answer:

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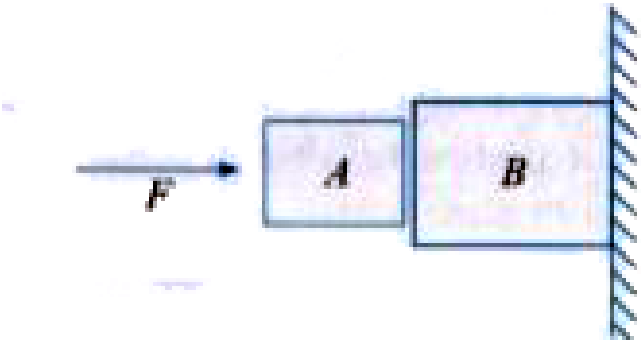
23. In the figure, blocks A and B weigh 20 N and 100 N respectively. The blocks are being pressed by an unknown force F. If the coefficient of friction between the blocks is 0.1, find the force of friction between the block and the wall if the blocks are in equilibrium



A. 80 N

B. 120 N

C. 150 N

D. 100 N

Answer:

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24. A rocket is fired vertically from the earth with an acceleration of 2g, where g is the gravitational acceleration. On an inclined

plane inside the rocket, making an angle o with the horizontal, a point object of mass m is kept. The maximum coefficient of friction between the mass and the inclined surface such that the mass does not move is

A. $\tan 2\theta$

B. $\tan \theta$

C. $3 \tan \theta$

D. $2 \tan \theta$

Answer:

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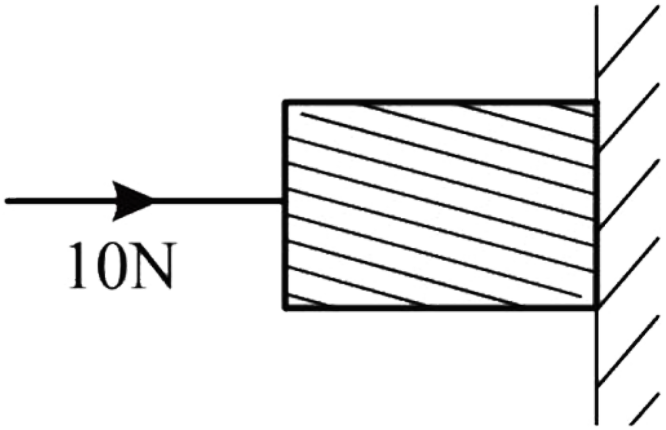
25. A horizontal force of 10N is necessary to just hold a block stationary against as well. The coefficient of friction between the block and the wall is 0.2. The weight of the block is



A. 20 N

B. 50 N

C. 100 N

D. 2 N

Answer:

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26. The acceleration of a moving body down a rough inclined plane is

A. $g(\sin\theta + \mu\cos\theta)$

B. $g(\sin\theta - \mu\cos\theta)$

C. $g\sin\theta$

D. $g\cos\theta$

Answer:

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27. A body of mass Mis kept on a rough horizontal surface with friction coefficient $= \mu$. A person is trying to pull the body by

applying a horizontal force but the body is not moving. The force by the surface on A is F where

A. $F = mg$

B. $F = \mu mg$

C. $mg \leq F \leq mg\sqrt{1+\mu^2}$

D. $mg \geq F \geq mg\sqrt{1-\mu^2}$

Answer:

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28. A block of mass m is placed at rest on a horizontal rough surface with angle of friction ϕ. The block is pulled with a force F at an angle θ with the horizontal. The minimum value of F required to move the block is

A. $\dfrac{mg\sin\phi}{\cos(0-\phi)}$

B. $\dfrac{mg\cos\phi}{\cos(0-\phi)}$

C. $mg\tan\phi$

D. $mg\sin\phi$

Answer:

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29. A block rests on a rough inclined plane making an angle of 30° with the horizontal. The coefficient of static friction between the block and inclined plane is 0.8. If the frictional force on the block is 10 N, the mass of the block is

A. 2 kg

B. 4 kg

C. 1.6 kg

D. 2.5 kg

Answer:

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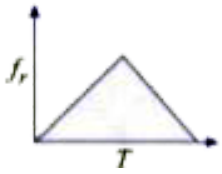
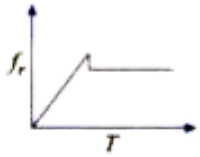
30. A force is linearly increasing with time, on a block of mass m placed on the horizontal surface. The friction coefficient from the block and the ground is u. The graph of friction force and time is drawn. Which of the following graph is correct.

A. 

B. 

C. 

D. 

Answer: d

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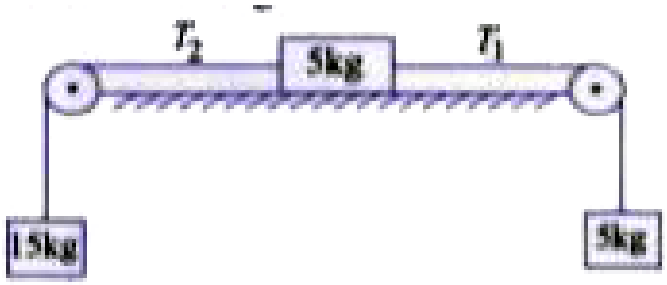
31. In the figure shown, the frictional coefficient between the table and the block is 0.2. Find the ratio of tensions in the right and the left strings.



A. 0.725

B. 34:12

C. 2:3

D. 3:2

Answer:

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Consolidated Exercise

1. Match the following :

A		B	
(1)	Maximum static friction	(a)	wrong
(2)	$\mu_r > \mu_k > \mu_s$	(b)	angle of repose
(3)	Coefficient of friction	(c)	f/R
(4)	$\theta_{max} = \tan^{-1}(\mu_s)$	(d)	viscocity
(5)	Fluid friction	(e)	limiting friction

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Consolidated Exercise Multipal Choice Question With One Or More Than One Correct Answer

1. Mark the correct statements about the friction between two bodies

A. static friction is always greater than the kinetic friction

B. coefficient of static friction is always greater than the coefficient of kinetic friction

C. limiting friction is always greater than the kinetic friction

D. limiting friction is never less than static friction

Answer:

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2. Force of friction on a body kept on the surface of a table depends on

A. nature of the surface

B. weight of the body

C. area of contact

D. material of the body

Answer:

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3. Which statements are not correct?

A. Frictional force always produces retardation while gravitational force may produce acceleration also.

B. Both frictional and gravitational force produce retardation only.

C. Frictional force acts even when two surfaces are not in contact

D. Gravitational force acts even when objects are not in contact.

Answer:

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Challenging Exercise

1. A coin of mass 20 g is pushed on a table. The coin starts moving at a speed of 25 cm s^1 and comes to rest in 5 s. Find the average frictional force exerted by the table on the coin.

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2. For steel surfaces, the coefficient of friction is $\mu = 0.8$ and between teflon surfaces $\mu = 0.04$. A steel block of mass 2 kg kept on a steel surface has a limiting frictional force f. What should be the mass of a teflon block kept on a teflon surface to have the limiting frictional force same as f? Take $g = 10ms^{-1}$.

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3. A body of mass 400 g slides on a rough horizontal surface. If the frictional force is 3.0 N, find

(i) the angle made by the contact force on the body with the vertical and

(ii) the magnitude of the contact force. Take $g = 10ms^{-2}$.

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Olympiad And Ntse Level Exercises

1. A rectangular wooden block $5cm \times 10cm \times 10cm$ in size is kept on a horizontal surface with its face of largest area on the surface. A minimum force of 1.5 N applied parallel to the surface sets the block in sliding motion along the surface. If the block is now kept with its face of smaller area in contact with the surface, the minimum force applied parallel to the surface, to set the block in motion, is

A. greater than 1.5 N

B. less than 1.5 N

C. equal to 1.5 N

D. may be greater or less than 1.5 N

Answer: c

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2. A body of mass 2 kg is placed on a horizontal surface having kinetic friction 0.4 and static friction 0.5. If the force applied on the body is 2.5 N, then the frictional force acting on the body will be

A. 8N

B. 10 N

C. 20 N

D. 2.5 N

Answer: d

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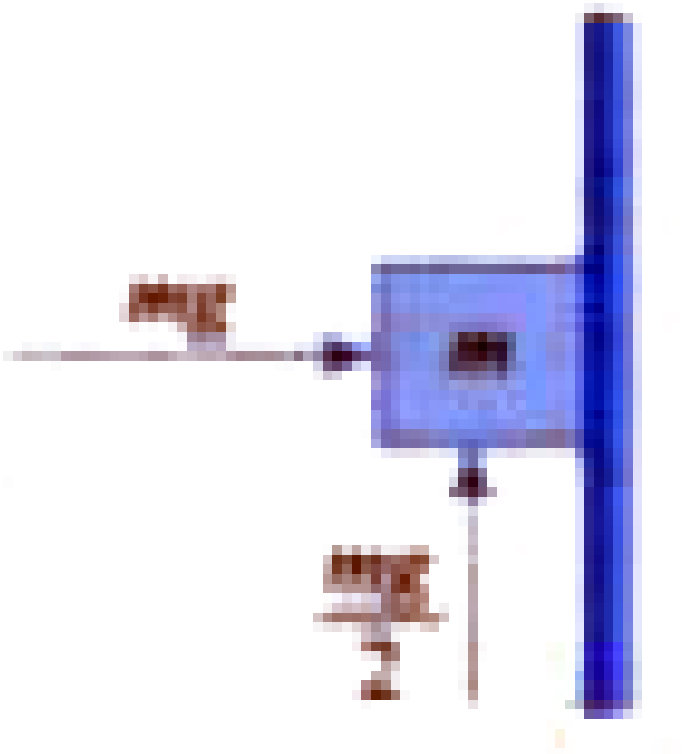
3. A block pressed against the vertical wall is in equilibrium. The minimum coefficient of

friction is:



A. 0.4

B. 0.2

C. 0.5

D. none of these me

Answer:

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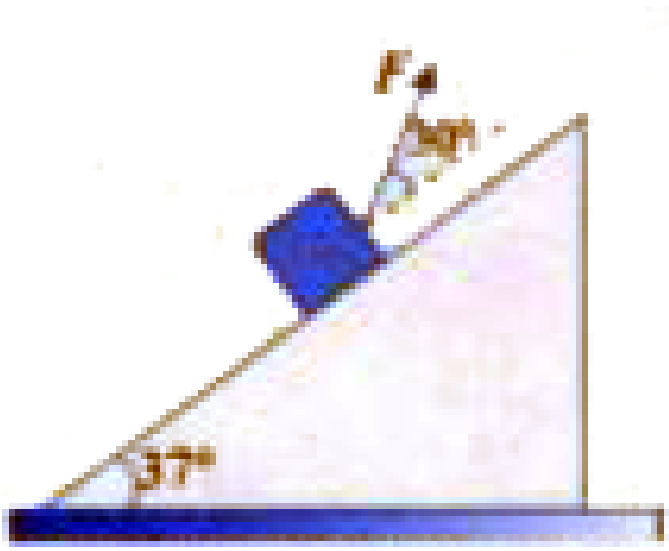
4. A block of mass m = 4 kg is placed over a rough inclined plane as shown in figure. The coefficient of friction between the block and the plane is u=0.5. A force F= 10 N is applied on the block at an angle of 30°. The friction force

between the block and wedge is



A. static in nature in the direction up the plane and have the value 30.2 N

B. static in nature in the direction down the plane and have the value 30.2 N

C. kinetic in nature in the direction up the plane and have the value 13.5 N

D. None of these

Answer: c

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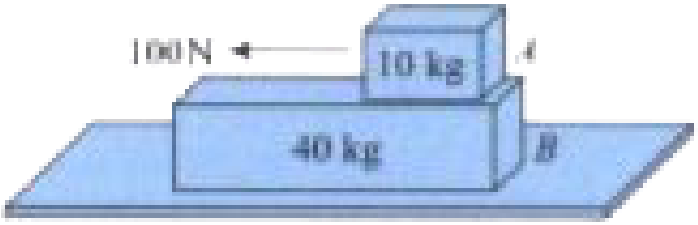
5. A 40 kg slab rests on a frictionless floor as shown in the figure. A 10 kg block rests on the top of the slab. The static coefficient of friction between the block and slab is 0.60 while the

kinetic friction is 0.40. The 10 kg block is acted upon by a horizontal force 100 N. If $g = 9.8\frac{m}{s^2}$, the resulting acceleration of the slab will be



A. $1m/s^2$

B. $1.5m/s^2$

C. $2m/s^2$

D. $6m/s^2$

Answer: a

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6. A truck with mass m has a brake failure while going down an icy mountain road of constant down and slope angle a (see figure). Initially, the truck is moving downhill at speed V. After careening downhill a distance L with negligible friction, the truck driver steers the runaway vehicle onto a runway truck ramp of constant upward slope angle β . The truck ramp has to soft sand surface for which the coefficient of rolling friction is μ_r What is the

distance that the truck moves up the ramp before coming to a halt?

A. $\frac{\left(v_0^2/2g\right) + L\sin\alpha}{\sin\beta - \mu_r\cos\beta}$

B. $\frac{\left(v_0^2/g\right) - L\sin\alpha}{\sin\beta + \mu_r\cos\beta}$

C. $\frac{\left(v_0^2/2g\right) + L\sin\alpha}{\sin\beta - \mu_r\cos\beta}$

D. None of these

Answer: a

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7. A 1 kg mass is projected down a rough circular track (radius=2.0 m) placed in vertical plane as shown. The speed of the mass at point A is 3 m/s and at point B, it is 6.0 m/s. How much work is done on the mass between A and B by the force of friction?

A. $-7.5J$

B. $-8.5J$

C. $-6.5J$

D. $-24J$

Answer: c

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8. A particle moves on a rough horizontal ground with some initial velocity say v_0. If (3/4)th of its kinetic energy is lost in friction in

time t_0, then coefficient of friction between the particle and the ground is:

A. $\frac{\nu_0}{2gt_0}$

B. $\frac{\nu_0}{4gt_0}$

C. $\frac{3\nu_0}{4gt_0}$

D. $\frac{\nu_0}{gt_0}$

Answer: a

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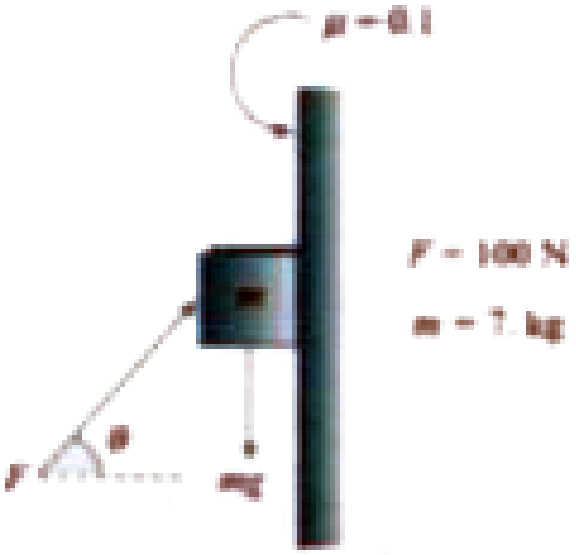
9. Column I gives the angle at which a force F is applied on a block as shown in the figure.



Column II gives the resulting friction on block.

Column I		Column II	
(p)	$\theta = 37°$	(a)	friction by wall on block is upwards
(q)	$\theta = 45°$	(b)	friction by wall on block is downwards
(r)	$\theta = 53°$	(c)	friction by wall on block is static
		(d)	friction by wall on block is kinetic

Now match the given columns and select the

correct option from the codes given below.

Coads:

(a)p-a,b,q-a,c,r-a,c

(b)p-a,d,q-a,c,r-b,c

(c) p-a,b,q-b,c,r-b,c

(d)p-a,q-a,b,c,r-b,c

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Olympiad And Ntse Level Exercises Read The Given Statements And Select The Correct Option

1. Assertion: Friction is a self-adjusting force.

Reason: Friction does not depend upon mass of the body.

A. If both assertion and reason are true and reason is a true explanation of assertion.

B. If both assertion and reason are true but reason is not the correct explanation of assertion

C. If assertion is true but reason is false.

D. If both assertion and reason are false.

Answer: d

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