PHYSICS

BOOKS - GR BATHLA & SONS PHYSICS (HINGLISH)

FRICTION AND CIRCULAR MOTION

Problem

1. A man of mass $40kg$ is at rest between the walls as shown in the If ' $\bullet$ ' between the man and the walls is 0.8 find the normal reactions exerted by the walls on the man .

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2. A $2kg$ block is in contact with a vertical wall having coefficient of friction 0.5 between the surfaces. A horizontal force of $40N$ is applied on the block at right angles to the wall. Another force of $15N$ is applied on the plane of the wall and at right angles to $40N$ force. Find the acclecration of the block .

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3. A block of mass $4kg$ is placed on a rough horizontal plane A time dependent horizontal force $F = kt$ acts on the block $(k = 2N/s)$. Find the frictional force between the block and the plane at $t = 2$ seconds and $t = 5$ seconds $(\mu = 0.2)$.

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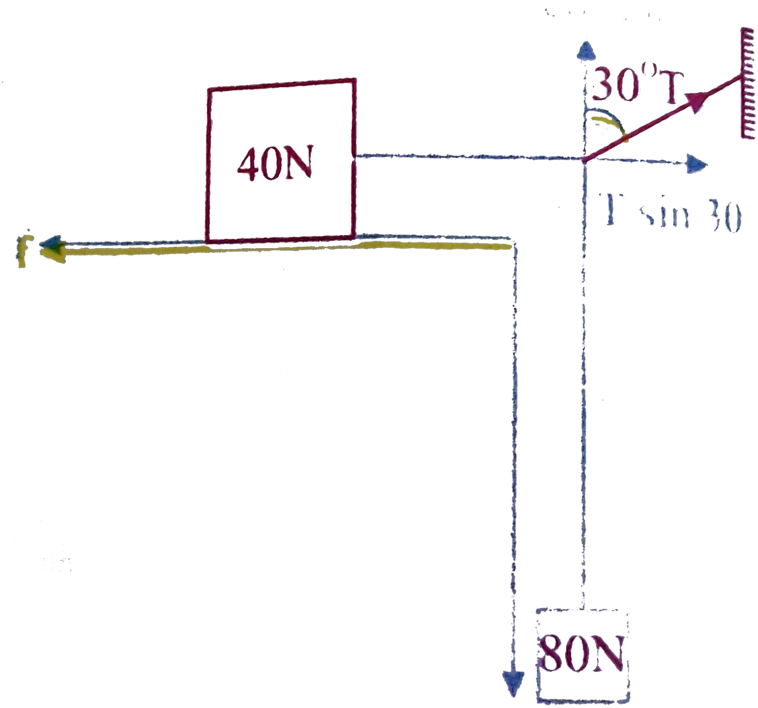
4. A block on table shown in is just on the edge of slipping Find the coefficient of static friction between the blocks and table



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5. When a car of mass $1000kg$ is moving with a veocity of $20ms^{-1}$ on a rough horizontal road its engine is switched off. How far does the car move before it comes to rest if the coefficient of kintic friction between the road and tyres of the car is 0.75 ? .

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6. A horizontal conveyor belt moves with a constant velocity $V. A$ small block is projected with a velocity of $6m/s$ on it in a direction opposite to the direction of motion of the belt The block comes to rest relative to the belt in a time $4s. \mu = 0.3, g = 10. m/s^2$ Find V .

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7. The rear side of a truck is open and a box of 40 kg mass is placed 5 m from the open end 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 $2m/s^2$ At what distance from the starting point does the box fall off the truck ? Ignore the size of the box .

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8. A block of mass $10kg$ is pushed by a force F on a horizontal rough plane is moving with acceleration $5ms^{-2}$ When force is doubled its acceleration becomes $18ms^{-2}$ Find the coefficient of friction between the block and rough horizontal plane $(g = 10ms^{-2})$.

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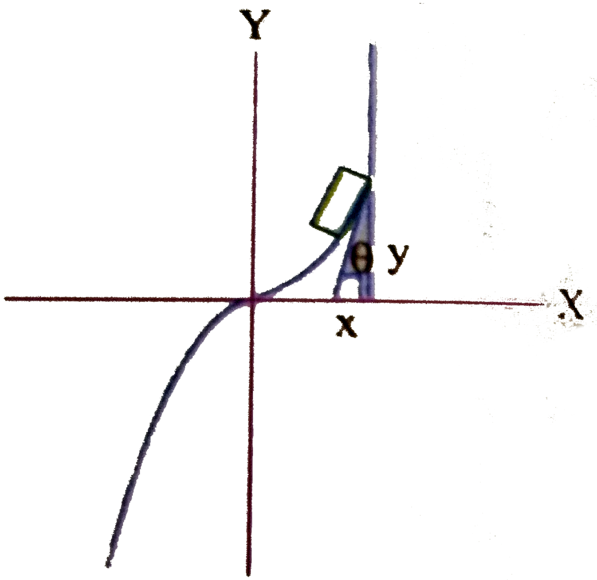
9. A block of mass $'m'$ is placed on a rough surface with a vertical cross section of $y = \frac{x^3}{6}$. If the coefficient of friction is 0.5, the maximum height above the ground at which the block can be placed without slipping is .



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10. A body is moving down a long inclined plane of angle of inclination $'\theta'$ for which the coefficient of friction varies with distance x as μ(x) = kx , where k is a constant . Here x is the distance moved by the body down the plane . The net force on the body will be zero at a distance x_0 is given by ....

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11. A body of mass 'm' slides down a smooth inclined plane having an inclination of 45° with the horizontal . It takes 2 s to reach the bottom . If the body is placed on a similar plane having coefficient of friction 0.5 , then what is the time taken for it to reach the bottom ?

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12. Two blocks of masses 4 kg and 2 kg are in contact with each other on an inclined plane of inclination 30° as shown in the figure . The coefficient of friction between 4 kg mass and the inclined plane is 0.3 , whereas between 2 kg mass and the plane is 0.2 . find the contact force between the blocks .

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13. A $30kg$ box has to move up an inclined plane of slope 30° the horizontal with a unform velocity of $5ms^{-1}$. If the frictional force retarding the motion is $150N$, the horizontal force required to move the box up is $\left(g = ms^{-2}\right)$.

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14. A body is sliding down an inclined plane having coefficient of friction 0.5. If the normal reaction is twice that of resultant downward force along the inclined plane, then find the angle between the inclined plane and the horizontal .

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15. In the given the wedge is acted upon by a constant horizontal force 'F'. The wedge is moving on a smooth horizontal surface A ball of mas 'm' is at rest relative to the wedge The ratio of forces exerted on 'm' by the wedge when 'F' is acting and 'F' is withdrawn assuming no friction between the edge and the ball is equal to .

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16. A block of mass m kg is pushed up against a wall by a force P that makes an angle 'θ' with the horizontal as shown in figure . The coefficient of static friction between the block and the wall is μ . Find the minimum value of P that allows the block to remain stationary .

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17. 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 $5m/s^2$, the frictional force acting on the block is............newtons.

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18. Assuming the length of a chain to be L and coefficient of static friction μ. Compute the maximum length of the chain which can be held outside a table without sliding.

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19. If the coefficient of friction between an insect and bowl is μ and the radius of the bowl is r, find the maximum height to which the insect can crawl in the bowl.

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20. A block placed on a horizontal surface is being pushed by a force F making an angle θ with the vertical as shown in Fig. 7.39 . The coefficient of friction between block and surface is μ . (a) Find the force required to slide the block with uniform velocity on the floor . (b) Show that if θ is smaller than a certain

angle θ_0 , the block cannot be made to slide across the floor , no matter how great the force be .

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21. A particle of mass m rests on a horizontal floor with which it has a coefficient of static friction μ. It is desired to make the body move by applying the minimum possible force F. Find the magnitude of F and the direction in which it has to be applied.

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22. A cart weighing 200 N can roll without friction along a horizontal path . The cart carries a block weighing 20 N . The coefficient of friction between the block and the cart is 0.25 and g= $10m/s^2$. Find the force of friction between the block and cart and their acceleration when a force of (a) 2N is applied to the block , (b) 20 N is applied to the block .

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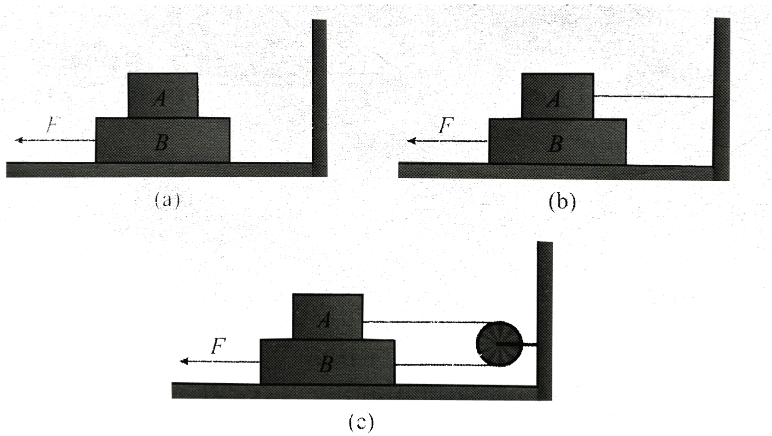
23. Block A weighs $4N$ and block weigh $8N$ The coefficient of kinetic friction is 0.25 for all surface find the force F to slide B at a constant speed when (a)A rest on B and moves with it (b) A is held at rest and (c)A and B are connected by a light cord passing over a smooth putting as shown in fig 7.31 (a - c) restively.



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24. A block of mass 2 kg rests on an inclined plane which makes an angle of 30° with the horizontal. The coefficient of friction between the block and the surfcae is $\sqrt{3/2}$. (i) What force should be applied on the block so that it moves down without any acceleration ? (ii) What force should be applied on the block so that it moves up without any acceleration ? (iii) Calculate the ratio of the powers in the above two cases if the block moves with uniform speed in both the cases.

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25. A body of mass 5×10^{-3} kg is launched upon a rough inclined plane making an angle of 30° with the horizontal. Obtain the coefficient of friction between the body and the plane if the time of ascent is half of the time of descent.

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26. A 60 kg block is pushed up on inclined plane by means of a horizontal push P as shwon in the figure . The coefficients of friction between the incline and block are $\mu_s = 0.6$ and $\mu_k = 0.4$ and the ramp makes an angle of 30° with the horizontal .

(a) What value of P is required to move the block at a constant speed of 0.20 m/s along the incline ?

(b) If the person should stop for rest and let P = 0 , does the block slide back on the incline ?

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27. A block of mass m is sliding on an inclined right angle through as shown in Fig. 7.46(a) and (b) If μ is the coefficient of kinetic friction , find the acceleration of the block .

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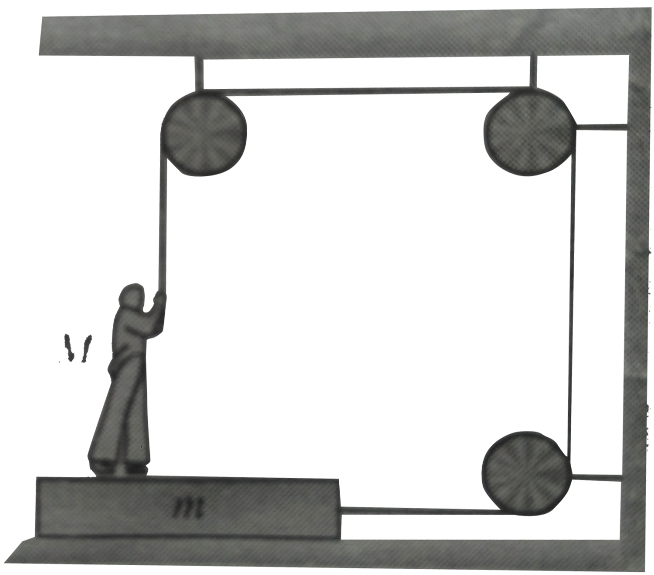
28. The friction coefficient between the board and the floor shown in figure is μ Find the maximum force that the man can exert on the rope so that the board does not slip on the floor



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29. Consider the situation shwon in Fig. 7.49 . The horizontal surface below the bigger block is smooth . The coefficient of friction between the blocks is μ . Find the minimum and maximum accelerations with which the system should move in order to keep the smaller blocks at rest with respect to the bigger block .

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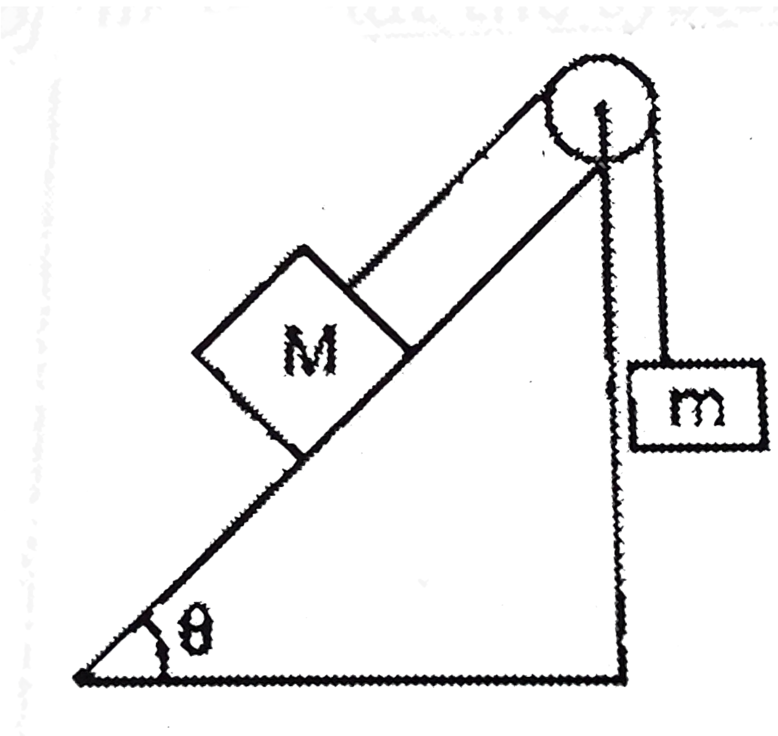
30. Two blocks of mass m and M, are connect to the ends of a string passing over a pulley. M lies on the plane inclined at an angle θ with the horizontal and m is hanging vertically as shown in Fig. The coefficient of static friction between M and the incline is μ_s. Find the minimum and maximum value of m so that the system is at rest.



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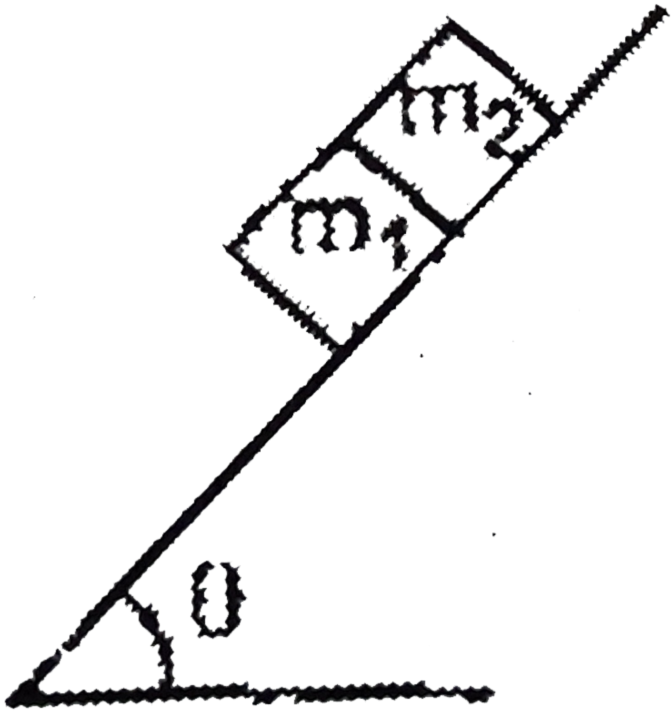
31. Two blocks are kept an incline in contact with each other. Masses of blocks are m_1 and m_2 and coefficients of friction are μ_1 and μ_2 respectively. The angle of inclination is θ. Determine

(a) acceleration of blocks, and

(b) force F with which the blocks press against each other



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32. In the figure , masses m_1, m_2 and M are 20 kg , 5 kg and 50 kg respectively . The coefficient of friction between M and ground is zero . The coefficient of friction between m_1 and M and that between m_2 and ground is0.4 . 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 horizonal force F is applied to the mass M . (Take g = $10m/s^2$)

(a) Draw a free body diagram for mass M , clearly showing all the forces .

(b) 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 $f_1 = 2f_2$. Find f_1 and f_2 . Write down equation of motion of all the masses . Find F , tension in the string and acceleration of the masses .

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33. Two blocks of masses m_1 = 3 kg and $m_2 = \frac{1}{\sqrt{3}}$ kg are connected by a light inextensible string which passes over a smooth peg . The blocks rest on the inclined smooth planes of a wedge and the peg is fixed to the top of the wedge . The planes of the wedge supporting m_1 and m_2 are inclined at

30° and 60° respectively , with the horizontal. Calculate the acceleration of masses and the tension in the string .

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34. A rod of length l and mass M is fixed to one end of a string . The string passes over a massless , frictionless pulley . A small ball of mass m $(< M)$ is attached to the other side of the string . The ball has an opening through which the string passes and the ball can slide along the string with some friction . Initially , the ball is held at level with the lower end of the rod . When set free , both the force of friction , if the ball rises to the level of the upper end of the rod in time t ?

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35. (a) Find the maximum speed at which a car turn round a curve of 30 m radius on a level road if the coefficient of friction between the tyres and the road is 0.4 [acc. Due to gravity = $10m / s^2$]

(b) For traffic moving at 60 km/hr , if the radius of the curve is 0.1 km , what is the correct angle of banking of the road ? (g = $10m/s^2$)

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36. A car is moving along a banked road laid out as a circle of radius r . (a) What should be the banking angle θ so that the car travelling at speed v needs no frictional force from tyres to negotiate the turn ? (b) The coefficient of friction between tyres and road are $\mu_s = 0.9$ and $\mu_k = 0.8$. At what maximum speed can a car enter the curve without sliding toward the top edge of the banked turn ?

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37. A car of mass m travelling at speed v moves on a horizontal track so that the centre of mass describes a circle of radius r . Show that the limiting speed beyond which the car will overturn is given by

$$v^2 = \frac{\text{gra}}{h}$$

where 2a is the separation of the inner and outer wheels and h is the height of the centre of mass above the ground .

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38. A tube of length L is filled completely with an incompressible liquid of mass M and closed at both ends . The tube is then rotated in a horizontal plane about one of its end with a uniform angular velocity ω . Find the force exerted by the liquid at the other end .

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39. A string of length 1m is fixed at one end and carries a mass of 1 kg at the other end. The string makes $2/\pi$ revolutions per second around a vertical axis passing through the fixed end. Calculate (i) angle of inclination of the string with the vertical, (ii) the tension in the strong and (iii) the linear velocity of the mass.

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40. Water of density p flows with a linear speed v through a horizontal rubber tube having the form of a ring of radius R. If the diameter of the tube is $d(< < R)$, find the tension in the rubber tube.

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41. A hemispherical bowl of radius R=0.1 m is rotating about its own axis (which is vertical) with an angular velocity ω A particle of mass 0.01 kg on the friction less inner surface of the bowl is also rotating with same ω The particle is at a height h from the bottom of the bowl.

(a) Obtain the relation between h and ω What is the minimum value of ω needed in order to have a non zero value of h ?

(b) It is desired to measure g using this set up, by measuring h accurately. Assuming that r and ω are known precisely, and that the least count in the measurement of h is 10^{-4} m. What is the minimum possible error Δg in the measured value of g ? $g = 9.8m/s^2$

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42. Three particles, each of the mass m are situated at the vertices of an equilateral triangle of side a. The only forces acting on the particles are their mutual gravitational forces. It is desired that each particle moves in a circle while maintaining the original mutual separation a. Find the initial velocity that should be given to each particle and also the time period of the circular motion. $\left(F = \frac{Gm_1m_2}{r^2}\right)$

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43. A liquid is kept in a cylindrical vessel which is rotated along its axis. The liquid rises at the sides, if the radius of vessel is $0.05m$ and the speed of rotation is $2rev/s$, find difference in the height of the liquid at the centre of the vessel and its sides.

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44. A small block starts sliding down an inclined plane subtending an angle θ with the horizontal . The coefficient of friction between the block and plane depends on the distance covered from rest along the plane as $\mu = \mu_0 x$ where μ_0 is a constant . Find (a) the distance covered by the block down the plane till it stops sliding and (b) its maximum velocity during this journey .

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45. A uniform cylinder of height h and radius r is placed with its circular face on a rough inclined plane and the inclination of the plane to the horizontal is gradually increased. If μ is the coefficient of friction, then under what condition the cylinder will (a) slide before toppling (b) topple before sliding.

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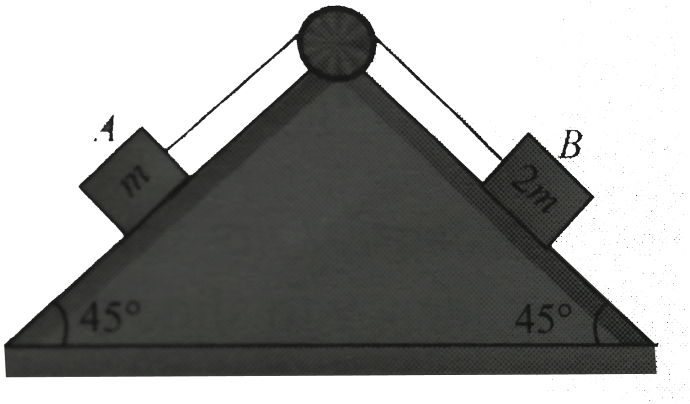
46. Block A of mass m and block B of mass $2m$ are placed on a fixed triangular wedge by means of a light and inextensible string and a frictionless pulley as shown in fig . The wedge is inclined at 45° to the horizontal on both sides . The coefficient of friction between the block $A$and the wedge is $2/3$ and that between the block B and the wedge is $1/3$ .If the system of A and B is released from rest then find .

a. the acceleration of A

b. tension in the string

c.the magnitude and direction of the frictional force acting on A



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47. A particle is at rest on a rough horizontal plane . The plane is slowly titled until the particle starts to move and is then kept fixed . If the static and kinetic coefficients of friction are μ_s and $\mu_k(< \mu_s)$ respectively , show that the velocity of the particle after it has travelled distance d is given by :

$$v = \sqrt{\frac{2(\mu_s - \mu_k)gd}{\left(1 + \mu_s^2\right)^{1/2}}}$$

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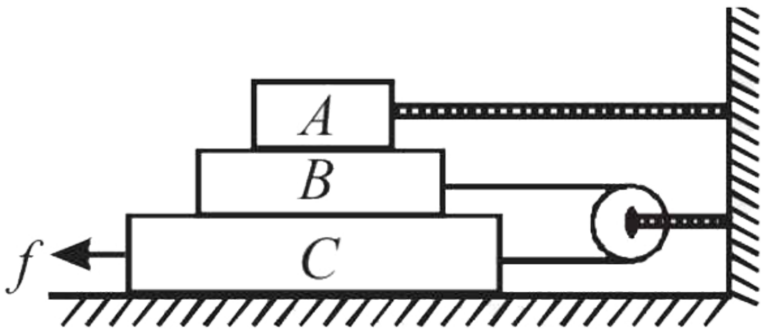
Problem For Practice

1. In the diagram shown, the blocks A, B and C weight, 3kg, 4kg and 5kg respectively. The coefficient of sliding friction between any two surface is 0.25. A is held at rest by a massless rigid rod fixed to the wall while B and C are connected by a light flexible cord passing around a frictionless pulley. Find the force F necessary to drag C along the horizontal surface to the left at constant speed. Assume that the arrangement shown in the diagram, B on C and A on B, is maintained all through. $(g = 9.8 m/s^2)$



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2. A 40 kg slab rests on a frictionless floor . A 10 kg block rests on the top of the slab . [Fig. 7.81 (a)] . The coefficients of static and dynamic friction are 0.60 and 0.40 respectively . The 10 kg block is pulled by a horizontal force of 100 N . what are the resulting accelerations of (a) the block (b) the slab ? (g = $10m/s^2$)

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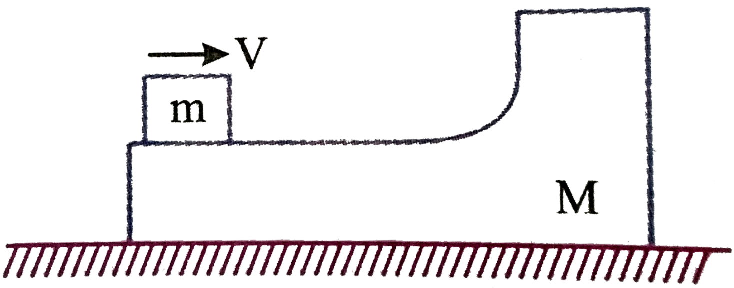
3. A body of mass M with a small block m placed on it rests on a smooth horizontal surface. The block is set in motion in the horizontal direction with a velocity v. To what height relative to the initial level will the block rise after breaking off from the body M. Friction can be assumed to be absent.



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4. A rock-climber (49 kg) is managing to be at rest between two vertical rocks pressing one rock A by his feet and the other B by his back . If the coefficient of friction between his shoes and wall is A 1.2 while between his back and wall B is 0.8 and limiting friction acts at all the contacts , then : (a) What is his push against the rock ? (b) What percent of the weight is supported by the frictional force an legs ?

5. The three flat blocks in the figure are positioned on the 30° incline and a force parallel to the inclined plane is applied to the middle block . The upper block is prevented from moving by a wire which attaches it to the fixed support . The coefficient of static friction for each of the three pairs of contact surfaces is shwon in the figure . Determine the maximum value which P may have before any slipping takes place .

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6. In the Fig. 7.85 shown a constant force is applied on the lower block , just large sliding out from between the upper block and the table . Determine the acceleration of each block .

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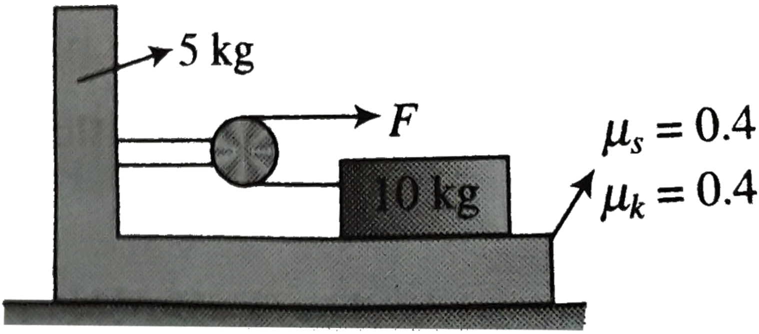
7. A $10kg$ block rests on a $5kg$ bracket as shown in figureThe $5kg$ breaket rests on a horizontal surface The coefficient of frictionbetween the $10kg$ block and the braket on wich it rests are $\mu_s = 0.40$ and $\mu_k = 0.30$



If the $10kg$ block is not to slide on the braket , the corresponding acceleration of the $5kg$ braacket is

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8. A block of mass 0.5 kg rests on a wedge of mass 2 kg as in Fig. 7.87 . The wedge is acted on by a horizontal force F and slides on a frictionless surface . If the coefficient of static friction between the wedge and the block is $\mu_s = 0.8$, and the angle of inclination is 30° , find the maximum and minimum values of F for which the block does not slip . Take (g = $10m / s^2$)

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9. A solide homogeneous cylinder of height h and base radius r is kept vertically on a conveyer belt moving horizontally with an increasing velocity $v = a + bt^2$. If the cylinder is not allowed to slip then the time whem the cylinder is about to topple , will be equal to

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10. In the Fig 7.89 shown , $m_2 = 2.5$ kg , h = 1.5 m , the system is released from rest at t = 0 and the mass m_2 strikes ground at t = 0.82s . The system is placed in its initial position and a 1.2 kg mass is placed on top of the block of mass m_1 . Released from rest , the mass m_2 now strikes the ground 1.3 s later . Determine the mass m_1 and the coefficient of kinetic friction between m_1 and the shelf .

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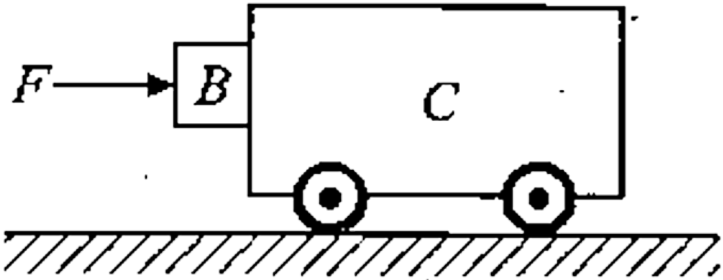
11. Figure-2.85 shows a block B of mass m, cart C of mass M, and the coefficient of static between the block and the cart is μ. Neglect frictional between wheels and axles and the rotational effects of the wheels. Determine the minimum value of F which must be applied on B such that it will not slide.



$$\left[\frac{mg}{\mu}\left(1+\frac{m}{M}\right)\right]$$

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12. A block of mass 2.20 kg is accelerated across a rough surface by a rope passing over a pulley as shown in Fig. 7.91 . The tension in the rope is 10.0 N , and the pulley is 10.0 cm above the block . The coefficient of friction is 0.4 .

(a) Determine the acceleration of block when x =

0.4 m .

(b) Find the value of x at which the acceleration becomes zero .

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13. 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 surfaces of groove in contact is $\mu = 2/5$. The disc has an acceleration of $25m/s^2$. find the acceleration of the block with respect to disc .

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14. A block rests on a rough inclined plane as shown in Fig. 7.93 . A horizontal force is applied to it . (a) Find out the force of reaction .

(b) Can the force of friction be zero ? If yes , when ?

(c) Assuming that , friction is not zero , find it magnitude and the direction of its limiting value .

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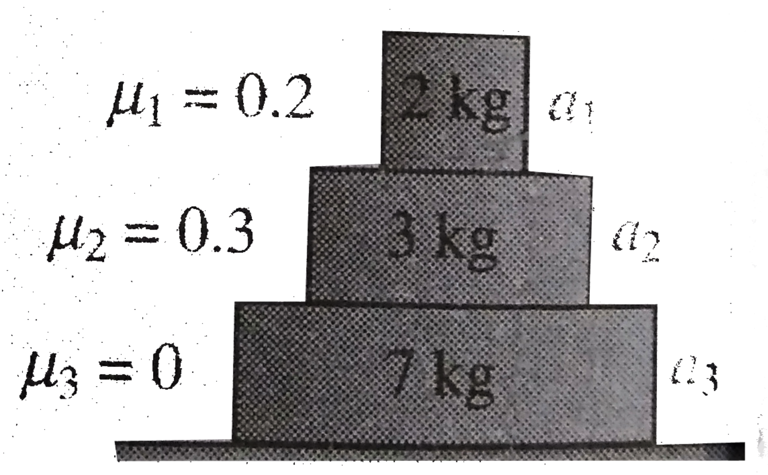
15. Find the acceleration a_1, a_2 and a_3 of the three blocks shown in Fig if a horizontal force of $10N$ is applied on



(a) $2kg$ blocks, (b) $3kg$ blocks and (c) $7kg$ blocks (Take $g = 10ms^{-2}$)

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16. A thin uniform copper rod of length l and mass m rotates uniformly with an angular velocity ω in a horizontal plane about a vertical axis passing through one of its ends. Determine the tension in the rod as a function of the distance r from the rotation axis. Find the elongation of the rod.

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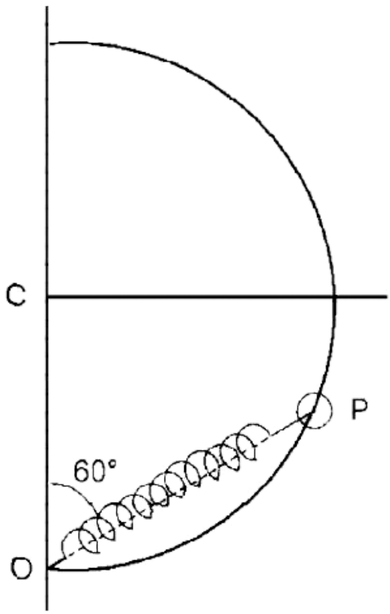
17. A smooth semicircular wire-track of radius R is fixed in a vertical plane. One end of a massless spring of natural length $3R/4$ is attached to the lowest point O of the wire-track. A small ring of mass m, which can slide on the track, is attached to the other end of the spring. The ring is held staionary at point P such that the spring makes an angle of 60° with the vertical. The spring constant $K = mg/R$. Consider the instant when the ring is released, and (i) draw the free body diagram of the ring, (ii) determine the tangential acceleration of the ring and the normal reaction.



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18. A circular table with smooth horizontal surface is rotating at an angular speed ω about its axis. A groove is made on the surface along a radius and a small particle is gently placed inside the groove at a distance l from the centre. Find the speed of the particle with respect to the table as its distance from the centre becomes L.

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19. A metal ring of mass m and radius R is placed on a smooth horizontal table and is set rotating about its own axis in such a way that each part of the ring moves with a speed v. Find the tension in the ring.

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20. A particle describes a horizontal circle on the smooth inner surface of a conical funnel as shown in Fig. If the height of the plane of the circle above the vertex is $9.8cm$, find the speed of the particle.

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21. Two blocks of mass $m_1 = 10kg$ and $m_2 = 5kg$ connected to each other by a massless inextensible string of length $0.3m$ are placed along a diameter of the turntable. The coefficient of friction between the table and m_1 is 0.5 while there is no friction between m_2 and the table. the table is rotating with an angular velocity of $10rad/s$. about a vertical axis passing through its center O. the masses are placed along the diameter of the table on either side of the center O such that the mass m_1 is at a distance of $0.124m$ from O. the masses are observed to be at a rest with respect to an observed on the tuntable $(g = 9.8m/s^2)$.

(a) Calculate the friction on m_1

(b) What should be the minimum angular speed of the turntable so that the masses will slip from this position?

(c) How should the masses be placed with the string remaining taut so that there is no friction on m_1.

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22. A piece of ics slides down a 45° incline in twice the time it takes to slide down a frictionless 45° incline . What is the coefficient of friction between the ice and the incline ? .

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23. A block slides down a rough inclined plane of slope angle θ with a constnat velocity. It is then projected up the same plane with an intial velocity v the distance travelled by the block up the plane coming to rest is .

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Objective Questions Only One Choice Is Correct

1. A block of mass 2 kg is placed on the floor . The coefficient of static friction is 0.4 . If a force of 2.8

N is applied on the block parallel to floor , the force of friction between the block and floor is : (Taking g = $10m / s^2$)

A. 2.8 N

B. 8 N

C. 2 N

D. zero

Answer: A

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

A. $9.8N$

B. $0.7 \times 9.8 \times \sqrt{3}N$

C. $9.8 \times \sqrt{3}N$

D. $0.7 \times 9.8N$

Answer: A

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3. A block has been placed on an inclined plane . The slope angle of θ of the plane is such that the block slides down the plane at a constant speed . The coefficient of kinetic friction is equal to :

A. sin θ

B. cos θ

C. g

D. tan θ

Answer: D

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4. A body of mass 60 kg is dragged with just enough force to start moving on a rough surface with coefficient of static and kinetic frictions 0.5 and 0.4 respectively . On applying the same force , what is the acceleration ?

A. $0.98m/s^2$

B. $9.8m/s^2$

C. $0.54m/s^2$

D. $5.292m/s^2$

Answer: A

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5. Pushing force making an angle θ to the horizontal is applied on a block of weight W placed on a horizontal table . If the angle of friction is ϕ , magnitude of force required to move the body is equal to :

A. $W\cos\phi / \cos(\theta - \phi)$

B. $W\sin\phi / \cos(\theta + \phi)$

C. $W\tan\phi / \sin(\theta - \phi)$

D. $W \sin\theta / g \tan(\theta - \phi)$

Answer: B

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6. A block A of mass 2 kg rests on another block B of mass 8 kg which rests on a horizontal floor. The coefficient of friction between A and B is 0.2 while that between B and floor is 0.5. when a horizontal force of 25 N is applied on the block B. the force of friction between A and B is

A. zero

B. 3.9 N

C. 5.0 N

D. 49 N

Answer: A

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7. A 40 kg slab rests on a frictionless floor . A 10 kg block rests on top of the slab (Fig . 7. 121). The static coefficient of friction between the block and the slab is 0.60 while the kinetic coefficient is 0.40 . The 10 kg block is acted upon by a horizontal force of 100 N . if g = $9.8m / s^2$ the resulting acceleration

of the slab will be :

A. $0.\ 98m / s^2$

B. $1.47m / s^2$

C. $1.52m / s^2$

D. $6.1m / s^2$

Answer: A

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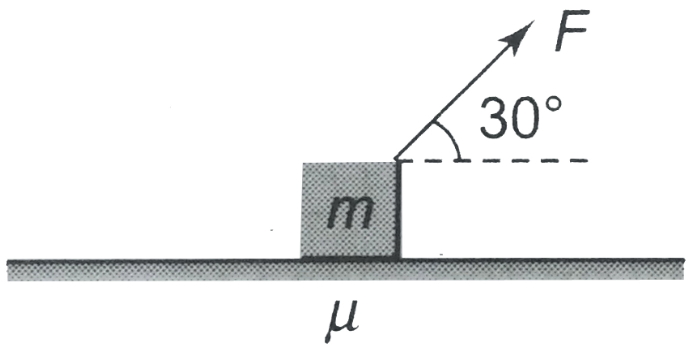
8. A block of mass m lying on a rough horizontal surface of friction coefficient μ is pulled by a force F as shown , the limiting friction between the block and surface will be



A. μ mg

B. $\mu\left[\mathrm{mg}-\left(\sqrt{3}/2\right)F\right]$

C. $\mu[\mathrm{mg}-(F/2)]$

D. $\mu[\mathrm{mg}+(F/2)]$

Answer: C

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

A. 2.5 N

B. 0.98 N

C. 4.9 N

D. 0.49 N

Answer: A

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10. A lineman of mass 60 kg is holding a vertical pole . The coefficient of the static friction between his hands and the pole is 0.5 . If he is able to climb up the pole , what is the minimum force with which he should press the pole with his hands ? (g = $10m / s^2$)

A. 1200 N

B. 600 N

C. 300 N

D. 150 N

Answer: A

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11. A ball weighing $10g$ hits a hard surface vertically with a speed of $5m/s$ and rebounds with the same speed The ball remains in contact with the surface speed The ball remains in contact with the surface for $0.01s$ The average force exerted by the surface on the ball is .

A. 100 N

B. 10 N

C. 1N

D. 0.1 N

Answer: B

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12. A heavy box of mass 20 kg is pulled on a horizontal surface by applying 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 the horizontal surface on the box.

A. 5 N

B. 10 N

C. 50 N

D. 200 N

Answer: C

Watch Video Solution

13. A block takes a twice as much time to slide down a 45° rough inclined plane as it takes to slide down a similar smooth , plane . The coefficient of friction is :

A. $\frac{3}{4}$

B. $\frac{\sqrt{3}}{2}$

C. $\frac{1}{4}$

D. $\frac{1}{3}$

Answer: A

Watch Video Solution

14. A block of mass 2 kg rests on a rough horizontal plank , the coefficient of friction between the plank and block is 0.3. If the plank is pulled horizontally with a constant acceleration of $4m/s^2$, the distance moved by the block on the plank in 5 second starting from rest (in m) is : (Take g = $10m/s^2$)

A. 5

B. 10

C. 25

D. 50

Answer: C

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15. A block released from rest from the top of a smooth inclined plane of inclination 45° takes time 't' to reach the bottom . The same block released from rest , from top of a rough inclined plane of same inclination , takes time '2t' to reach the bottom , coefficient of friction is :

A. 0.75

B. 0.5

C. 0.25

D. 0.4

Answer: A

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16. A block of mass 10 kg is sliding on a surface inclined at 30° with horizontal . If coefficient of friction between the block and the surface is 0.5 , find acceleration produced in the block . Take $g = 9.8m/^2$.

A. 0.68 mg

B. 0.50 mg

C. 0.74 mg

D. 0.40 mg

Answer: B

Watch Video Solution

17. A block of mass 6 kg is being pulled by force 24 N as shown . If coefficient of friction between the block and the surface is 0.6 , frictional force acting on the block is :

A. 36 N

B. 32 N

C. 12 N

D. none of these

Answer: D

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18. Coefficient of static friction between the two blocks in Fig. 7.124 is μ and the table is frictionless . Maximum horizontal force which can be applied on the lower such that the blocks move together , is :

A. $\mu m_1 g$

B. $\mu m_2 g$

C. $\mu(m_1 - m_2)g$

D. $\mu(m_1 + m_2)g$

Answer: D

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19. In Fig.7.125, coefficient of friction between m_1 and m_2 is μ and that between m_1 and the wall is zero. A force F is pressing the system against the wall. Minimum value of force required to hold the system in equilibrium is :

A. $\mu_1 g$

B. $\mu_1 g$

C. $\mu(m_1 + m_2)g$

D. system cannot be held in equilibrium

Answer: D

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20. If, in Q.19, coefficient of friction between m_1 and the wall is μ,and f_1 and f_2 are respectively, the force of friction on m_1 and m_2, then :

A. f_1 and f_2 both are downward.

B. f_1 and f_2 both are downward.

C. f_1 is upward and f_2 upward.

D. f_1 is downward and f_2 upward.

Answer: B

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21. The rear side of a truck is open and a box of 40 kg mass is placed 5 m from the open end 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 $2m/s^2$ At what distance from the starting point does the box fall off the truck ? Ignore the size of the box .

A. $20m$

B. $10m$

C. $\sqrt{20}m$

D. $5m$

Answer: A

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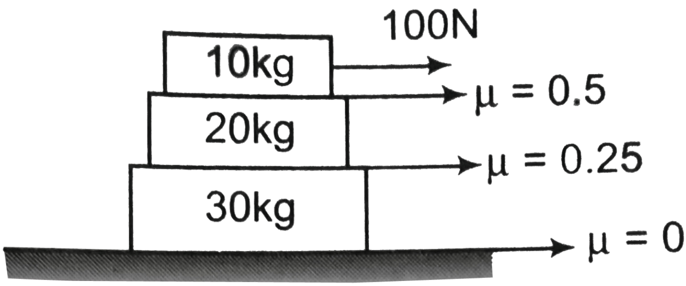
22. Three blocks are kept as shown in figure Acceleration of $20kg$ block with respect to ground is



A. $5ms^{-2}$

B. $2ms^{-2}$

C. $1ms^{-2}$

D. 0

Answer: C

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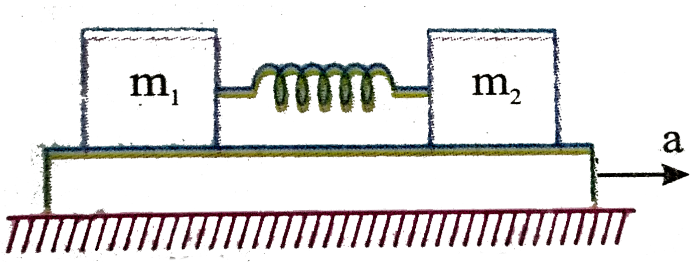
23. Two block of masses $m1$ and $m2$ are connected with a massless unstretched spring and placed over a plank moving with an acceleration $'a'$ as shown in figure. The coefficient of friction between the blocks and platform is μ



A. spring will be stretched if $a > \mu g$.

B. spring will be compressed if $a \leq \mu g$

C. spring will neither be compressed nor be stretched for $a \leq \mu g$ only

D. spring will be in its natural length under all conditions

Answer: D

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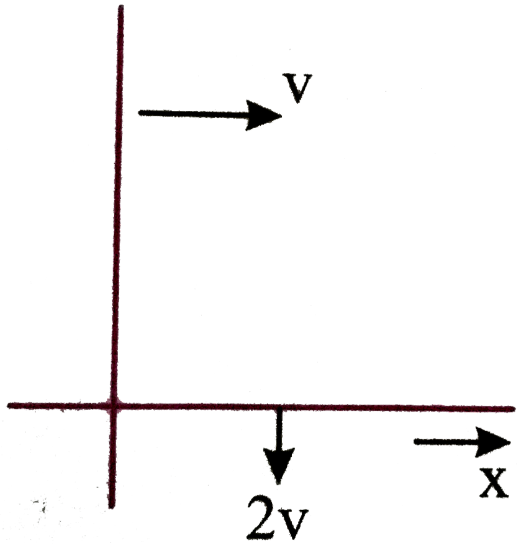
24. Two thin roads are moving perpendicularly as shown in the figure. If the friction acting between them is F_R then the unit vector in the direction of friction force acting on the rod lying along x-axis is



A. $\frac{\left(-\hat{i}-2\hat{j}\right)}{\sqrt{5}}$

B. $\frac{\left(\hat{i}+2\hat{j}\right)}{\sqrt{5}}$

C. $\frac{\left(3\hat{i}+2\hat{j}\right)}{\sqrt{13}}$

D. none of these

Answer: B

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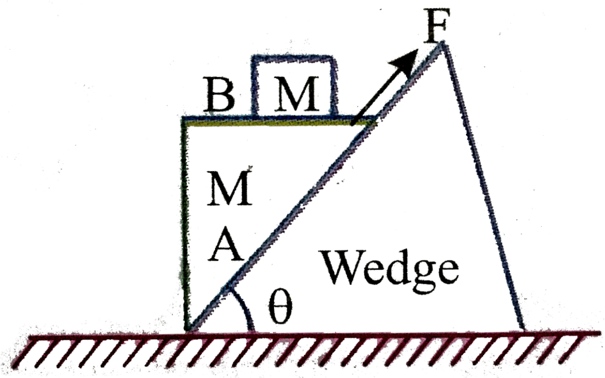
25. Wedge is fixed on horizontal surface. Block A is pulled upward by applying a force F as shown in figure and there is no friction between the wedge and the block A while coefficient of friction between A and B is μ. If there is no relative motion between the block A and B then frictional force developed between A and B is



A. $\left[\frac{F+(m+M)g\sin\theta}{(m+M)}\right]m\cos\theta$

B. μ mg

C. $\left[\frac{F-(m+M)g\sin\theta}{(m+M)}\right]m\cos\theta$

D. μ mg / 2

Answer: C

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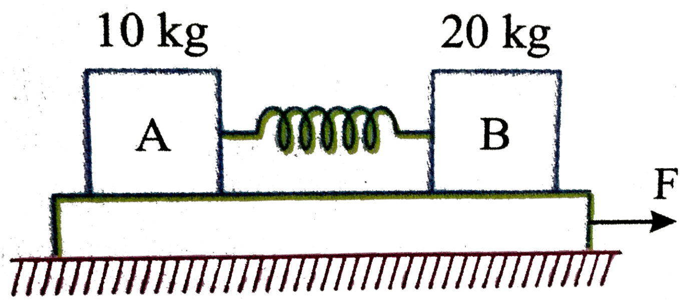
26. Two blocks $A \& B$ attached to each other by a mass-less spring, are kept on a rough horizontal surface $\mu = 0.1$. A constant force $F = 200N$ is applied on blcok B horizon tally as shown below. If a some instant the acceleration of $10kg$ mass is $12m/s^2$, then the acceleration of $20kg$ mass is



A. $2.5m/s^2$ or $15.5m/s^2$

B. $4m/s^2$ or $10m/s^2$

C. $3.6m/s^2$ or $4.1m/s^2$

D. $1.2m/s^2$ or $1.3m/s^2$

Answer: A

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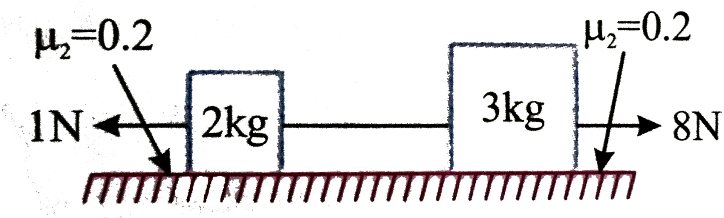
27. In the shown arrangement if f_1, f_2 and T be the frictional forces on $2kg$ block, $3kg$ block & tension in the string respectively, then their values are:



A. 2 N , 6 N , 3.2 N

B. 2 N , 6 N , 0N

C. 1N , 6N , 2 N

D. data insufficient to calculate the required values

Answer: C

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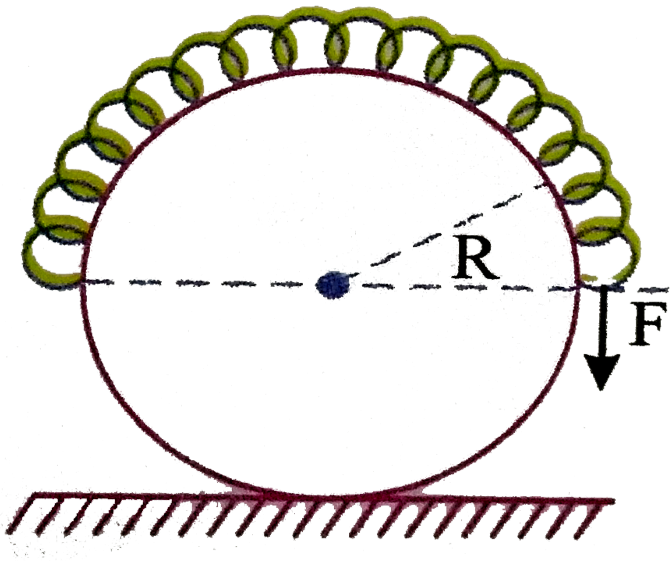
28. Chain of mass M length L kept on rough sphere. μ is coefficient of friction between sphere and chain F is minimum force required to slide chain



A. $\frac{2\mu Mg}{\pi}$

B. μ Mg

C. $> \frac{2\mu Mg}{\pi}$

D. $2\mu Mg$

Answer: C

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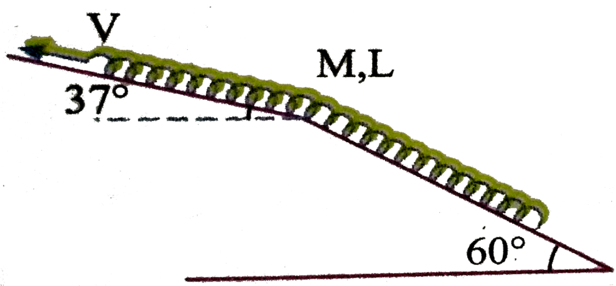
29. A long chain of mass of mass M length L is being pulled with constant velocity on a rough incline with coefficient of friction μ. What rate frictional force on chain is increasing



A. $\frac{3}{10}\mu\frac{M}{L}gv$

B. $\frac{5}{6}\mu\frac{M}{L}gv$

C. Zero

D. $\mu\frac{M}{L}gv$

Answer: A

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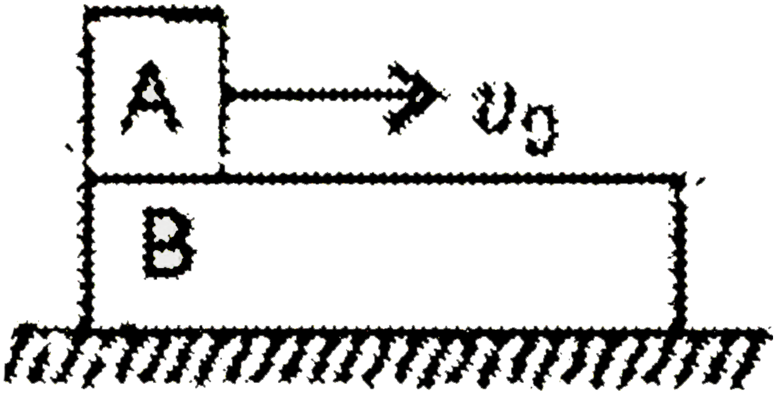
30. A block A is placed over a long rough plank B same mass as shown below. The plank is placed over a smooth horizontal surface. At time $t = 0$, block A is given a velocity v_0 in horizontal direction. Let v_1 and v_2 be the velocity of A & B at time 't'. Then choose the correct graph between v_1

or v_2 and t.



A.

B.

C.

D.

Answer: B

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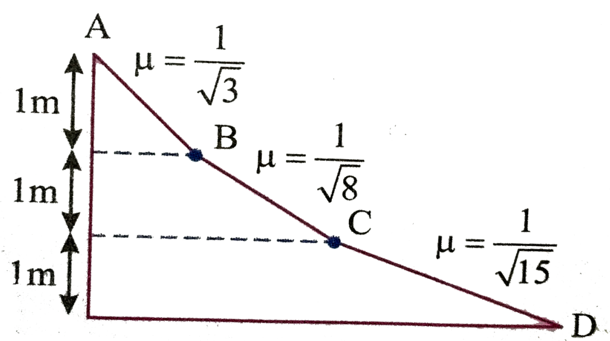
31. A composite inclined plane has three different inclined surfaces AB, BC and CD of heights $1m$ each and coefficients of friction $\frac{1}{\sqrt{3}}, \frac{1}{\sqrt{8}}$ and $\frac{1}{\sqrt{15}}$ respectively. A particle given an initial velocity at A along AB transverses the inclined surfaces with uniform speed, reaches D in $5s$. The initial speed given is $(\text{in} m / s)$



A. 1.6

B. 1.8

C. 2.4

D. 3

Answer: B

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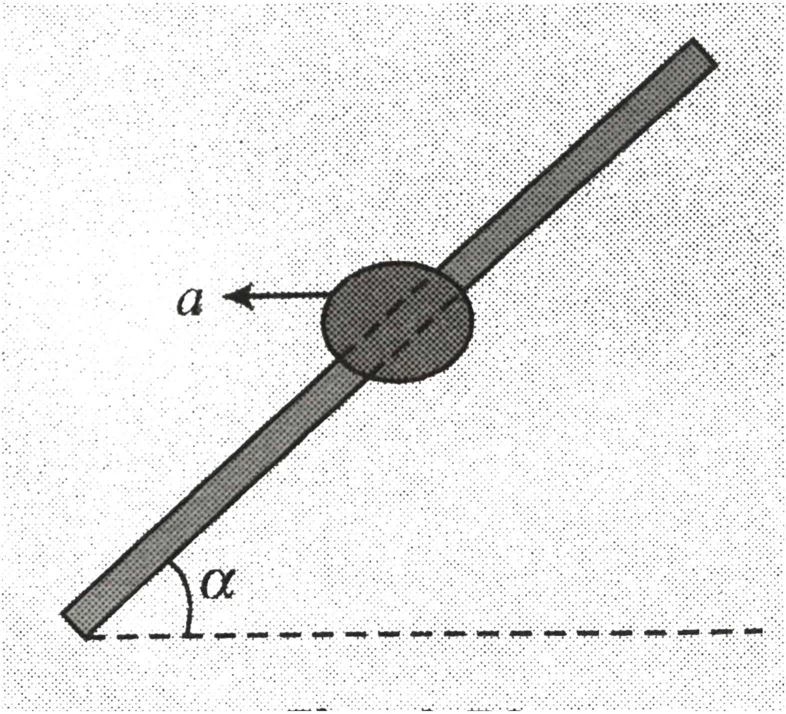
32. A bead of mass m is fitted on to a rod and can move on it without friction. At the initial moment the bead is in the middle of the rod. The rod moves translationally in a horizontal plane with an acceleration a in a direction forming an angle α with the rod. Find the acceleration of the bead relative to the rod.



A. g sin α

B. $(g + a_0)\sin\alpha$

C. $g\sin\alpha + a_0\cos\alpha$

D. $g \sin \alpha - a_0 \cos \alpha$

Answer: D

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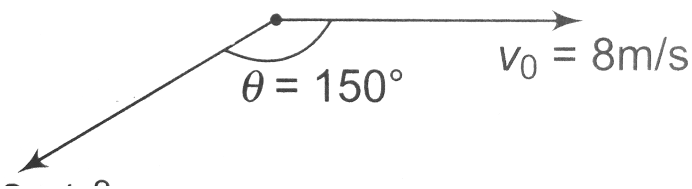
33. The figure shows th velocity and acceleration of a point like body at the initial moment of its motion. The acceleration vector of the body remain constant. The minimum radius of curvature of trajectory of the body is



A. 2 metre

B. 4 metre

C. 8 metre

D. 16 metre

Answer: B

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34. A stone is thrown horizontally with a velocity of $10m/\sec$. Find the radius of curvature of it's trajectory at the end of $3s$ after motion began. $(g = 10m/s^2)$

A. $10\sqrt{10}$ m

B. $100\sqrt{10}$ m

C. $\sqrt{10}$ m

D. 100 m

Answer: B

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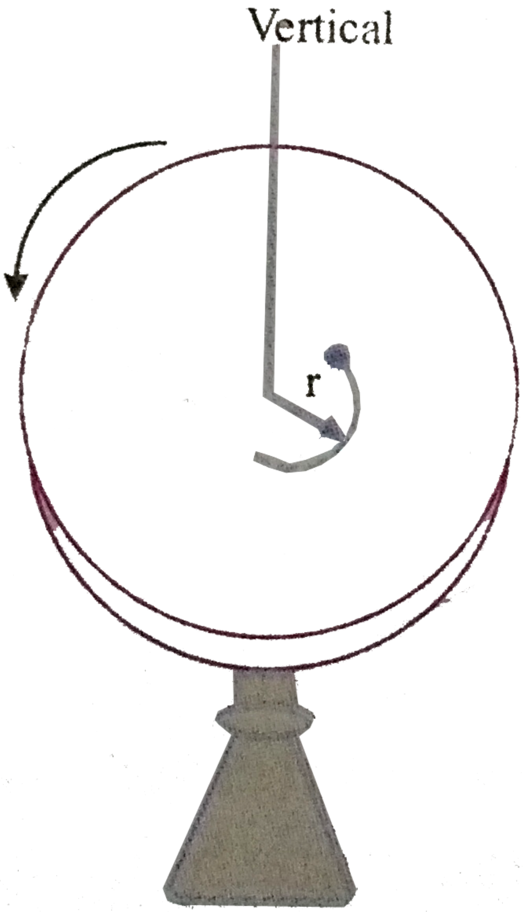
35. A small coin of mass $80g$ is placed on the horizontal surface of a rotating disc. The disc starts from rest and is given a constant angular acceleration $\alpha = 2rad / s^2$. The coefficient of static friction between the coin and the disc is $\mu_s = 3/4$ and cofficient of kinetic friction is $\mu_k = 0.5$. The coin is placed at a distance $r = 1m$ from the centre of the disc. The magnitude of the resultant force on the coin exerted by the disc just before it starts slipping on the disc is



A. $0.2N$

B. 0.3 N

C. 0.4N

D. 1N

Answer: D

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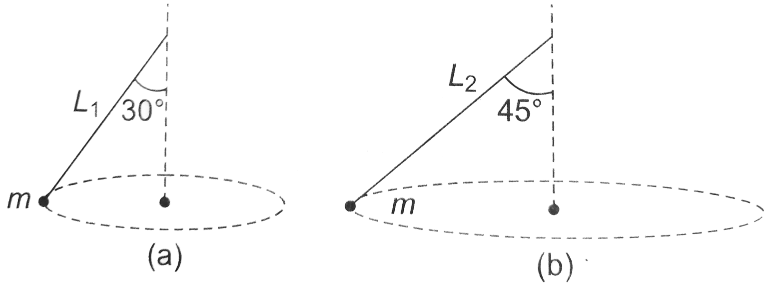
36. Two partical tied to different strings are whirled in a horizontal circle as shown in figure. The ratio of lengths of the string so that they complete their circular path with equal time priod is:



A. $\sqrt{\frac{3}{2}}$

B. $\sqrt{\frac{1}{3}}$

C. 1

D. $\sqrt{3}$

Answer: B

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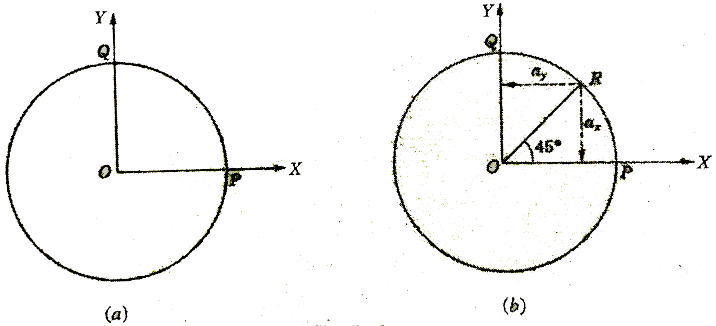
37. A particle moves in a circle of radius 4.0 cm clockwise at constant speed of $2ms^{-1}$. If $\widehat{x}$ and $\hat{y}$ are unit acceleration vectors along X-axis and Y-axis respectively (in cms^{-2}), find the acceleration of the particle at the instant half way between P and Q. Refer to Fig.5.14 (a).



A. $-4(\widehat{x}+\hat{y})$

B. $4(\widehat{x}+\hat{y})$

C. $-(\widehat{x}+\hat{y})\frac{1}{\sqrt{2}}$

D. $(\widehat{x}+\hat{y})4$

Answer: C

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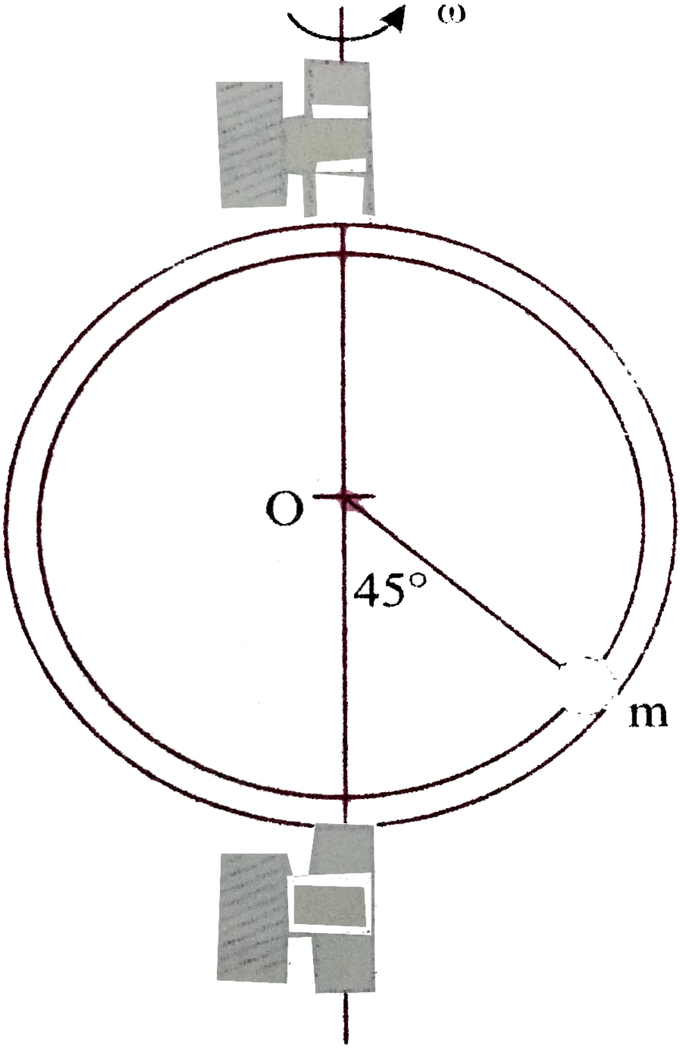
38. A small bead of mass m is carried by a circular hoop having center at O and radius $\sqrt{2}m$ which rotates about a fixed vertical axis. The coefficient of friction between beed and hoop is $\mu = 0.5$. The maximum angular speed of the hoop for which the bead does not have relative motion with respect to hoop. $(g = 10m / s^2)$



A. $\sqrt{5}$

B. $\sqrt{10}$

C. $\sqrt{15}$

D. $\sqrt{30}$

Answer: D

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39. Two identical particle are attached at the ends of a light string which passes through a hole at the centre of a table another particle on the table is made to revolve with angular velocity ω_1 . One of the particles is made to move in a horizontal circle as a conical pendulum with angular velocity ω_2 . If

l_1 and l_2 are the length of the string over and under the table , then in order that particle under the table neither moves down nor moves up the ratio $\frac{l_1}{l_2}$ is :

A. $\frac{\omega_1}{\omega_2}$

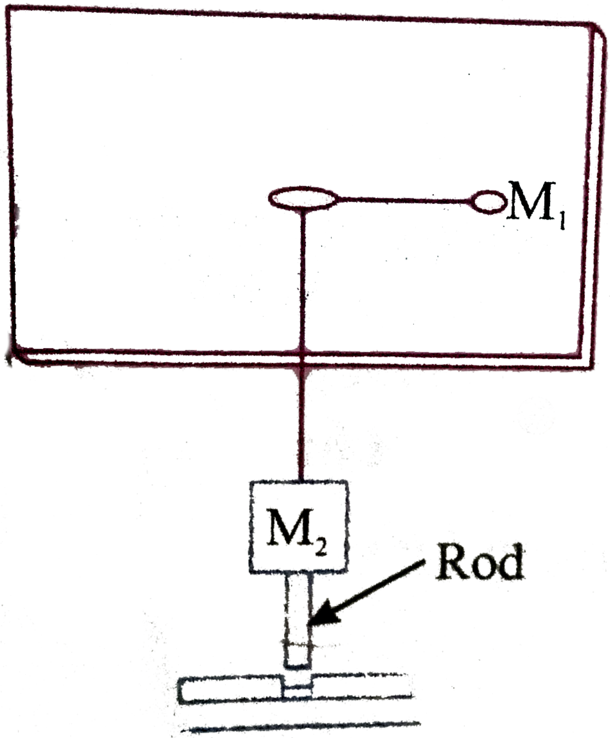
B. $\frac{\omega_2}{\omega_1}$

C. $\frac{\omega_1^2}{\omega_2^2}$

D. $\frac{\omega_2^2}{\omega_1^2}$

Answer: D

40. For the arrangement in the Figure, the particle M_1 attached to one end of string which moves on a horizantal table in a circle of radius $\frac{l}{2}$ (where l is the length of the string) with constant angular speed ω. The other end of the string attached to to mass M_2 which rest on a vertical rod. When the rod collapse, the acceleration of mass M_2 at that instant



A. g

B. $\frac{\omega^2 l}{2}$

C. $\frac{2M_2 g - M_1 l \omega^2}{2(M_1 + M_2)}$

D. $\frac{M_2 g + M_1 l \omega^2}{M_1 + M_2}$

Answer: C

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41. A bead of mass m is located on a parabolic wire with its axis vertical and vertex at the origin as shown in figure and whose equations is $x^2 = 4ay$. The wire frame is fixed and the bead can slide on it without friction . The bead is released from the point y = 4a on the wire frame from rest . The tangential acceleration of the bead when it reaches the position given by y = a is :

A. $\frac{g}{2}$

B. $\left(\sqrt{3}g\right)(2)$

C. $\frac{g}{\sqrt{2}}$

D. g

Answer: C

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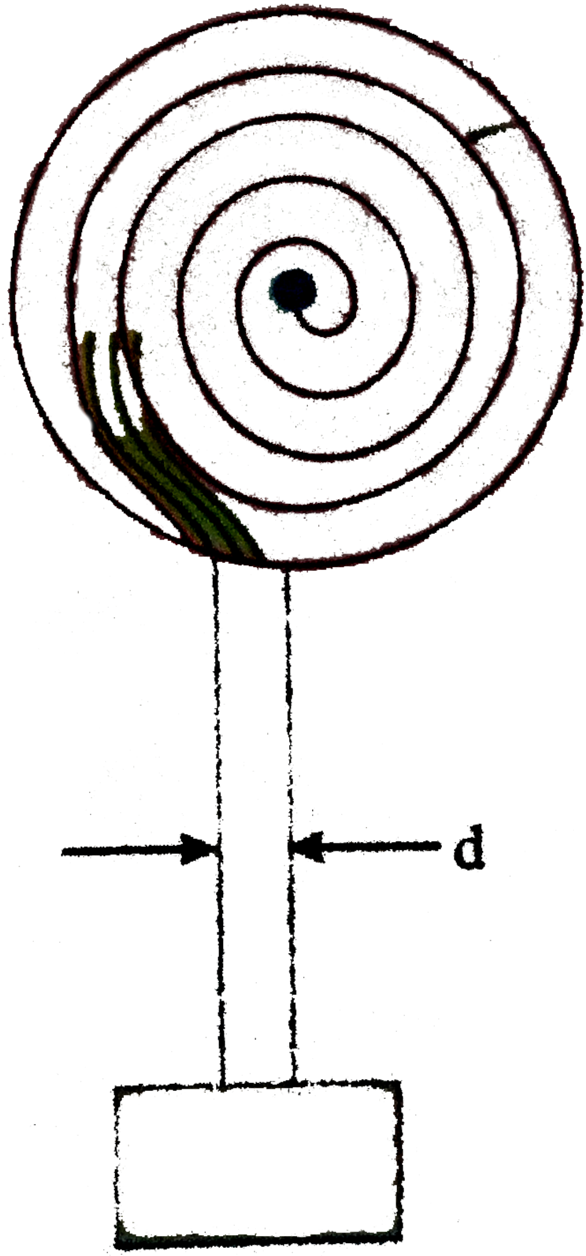
42. A mass 1kg attached to the end of a flexible rope of diameter $d = 0.25m$is raised vertically by winding the rope on a reel as shown. If the reel is turned uniformly at the rate of $2r.p.s.$ What is the tension in rope. The inertia of rope may be neglected.


d

A. 16.28 N

B. 10 N

C. 20 N

D. 1 N

Answer: A

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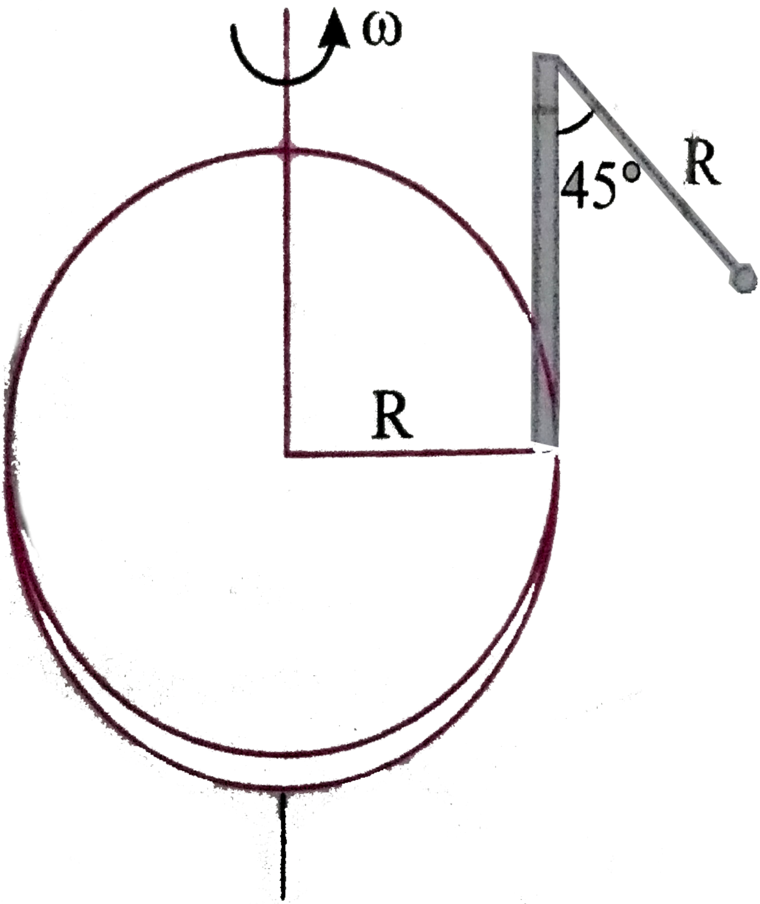
43. A disc of radius R has a light pole fixed perpendicular to the disc at its periphery which in turn has a pendulum of length R attached to its other end as shown in figure. The disc is rotated with a constant angular velocity ω The string is making an angle 45° with the rod. Then the angular velocity ω of disc is



A. $\left(\frac{\sqrt{3}g}{R}\right)^{1/2}$

B. $\left(\frac{\sqrt{3}g}{2R}\right)^{1/2}$

C. $\left(\frac{g}{\sqrt{3}R}\right)^{1/2}$

D. $\left(\frac{\sqrt{2}g}{\left(\sqrt{2}+1\right)R}\right)^{1/2}$

Answer: D

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44. A particle is moving in a circle of radius R in such a way that at any instant the normal and tangential component of the acceleration are equal. If its speed at $t = 0$ is u_0 the time taken to complete the first revolution is

A. R / μ_0

B. $\mu_0 R$

C. $\frac{R}{\mu_0}\left(1 - e^{-2\pi}\right)$

D. $\frac{R}{\mu_0} e^{-2\pi}$

Answer: C

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45. A car is moving in a circular horizontal track of radius 10 m with a constant speed of 10 ms/s A plumb bob is suspended from the roof of the car by a light rigid rod of length 1m. The angle made by the rod with the track is (Take g= 10m/s^2

A. zero

B. 30°

C. 45°

D. 60°

Answer: C

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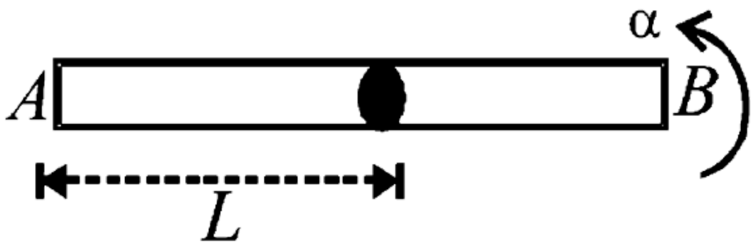
46. A long horizontal rod has a bead which can slide along its length and initially placed at a



distance L from one end A of the rod. The rod is set in angular motion about A with constant angular acceleration α. if the coefficient of friction between the rod and the bead is μ, and gravity is neglected, then the time after which the bead starts slipping is

A. $\sqrt{\frac{\mu}{\alpha}}$

B. $\frac{\mu}{\sqrt{\alpha}}$

C. $\frac{1}{\sqrt{\mu\alpha}}$

D. infinitesimal

Answer: A

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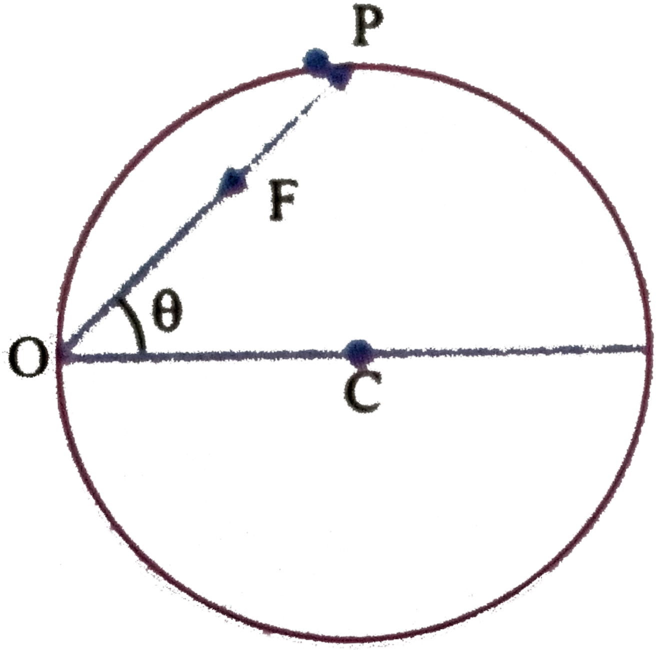
47. A particle $'P'$ is moving on a circular path under the action of only one force action always toward the fixed point $'O'$ on the circumference. Find the ratio of $\frac{d^2\theta}{dt^2}$ & $\left(\frac{d\theta}{dt}\right)^2$



A. 2 tan θ

B. $\tan\theta$

C. $\dfrac{\tan\theta}{2}$

D. $\dfrac{\tan\theta}{3}$

Answer: A

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48. In Fig. 7.149 , coefficient of friction between the block and the floor is μ . Force F that will move the block on the floor with a uniform speed is :

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

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

C. $\frac{\mu \mathrm{mg}}{\cos \theta - \mu \sin \theta}$

D. $\frac{\mu mg}{\sin \theta - \mu \cos \theta}$

Answer: D

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49. In Q.48 , the block can be made to slide on the floor only if θ is more than a minimum value . Otherwise , the block cannot be made to slide by any value of F however large . Minimum value of θ for less than which sliding cannot happen , is :

A. $\sin^{-1}\left(\frac{\mu}{\sqrt{1+\mu^2}}\right)$

B. $\cos^{-1}\left(\frac{\mu}{\sqrt{1+\mu^2}}\right)$

C. $\tan^{-1}\left(\frac{\mu}{\sqrt{1+\mu^2}}\right)$

D. zero

Answer: A

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50. To avoid slipping while walking on ice, one should take smaller steps because of the

A. it results in smaller friction

B. it results in larger friction

C. it does not change friction but makes you more alert about slipping

D. none of the above

Answer: B

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51. A block of mass M slides down a rough inclined surface of inclination θ and reaches the bottom at speed at 'v' . However , if it slides down a smooth inclined surface of same length and same inclination , it reaches the bottom with the speed kv. Coefficient of friction between the block and the rough incline is :

A. $\sin\theta\left(k^2 - 1\right)$

B. $\left(\frac{k^2 - 1}{k^2}\right)\tan\theta$

C. $\left(\frac{k^2 + 1}{k^2}\right)\cos\theta$

D. $\frac{k^2 - 1}{k^2}$

Answer: B

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52. In Fig. 7.150 , coefficient of friction between m_2 and the horizontal surface is μ , minimum value of m so that the system has zero acceleration , is :

A. $\mu(m_1 + m_2)$

B. $\mu(m_1 + m_2)$

C. $m_2 - \frac{m_1}{\mu}$

D. $\frac{m_1}{\mu} - m_2$

Answer: D

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53. In Fig . 7.151 , coefficient of kinetic friction between the 4 kg block and the inclined surface is $\frac{1}{\sqrt{3}}$. Here 'm' is such a mass that the 4 kg block is moving up the plane with a constant speed , then m is :

A. 2 kg

B. 2.8 kg

C. 3.4 kg

D. 4 kg

Answer: D

Watch Video Solution

54. A uniform rope of length l lies on a table . If the coefficient of friction is μ , then the maximum length l_1 of the part of this rope which can overhang from the edge of the table without sliding down is :

A. $\frac{1}{\mu}$

B. $\frac{1}{\mu+1}$

C. $\frac{\mu l}{\mu+1}$

D. $\frac{\mu l}{\mu-1}$

Answer: C

Watch Video Solution

55. Two balls of masses m_1 and m_2 are separated from each other by a powder charge placed between them. The whole system is at rest on the ground. Suddenly the powder charge explodes and masses are pushed apart. The mass m_1 travels a distance s_1 and stops. If the coefficients of friction between the balls and ground are same, the mass m_2 stops after travelling the distance

A. $S_2 = \frac{m_1}{m_2} S_1$

B. $S_2 = \frac{m_2}{m_1} S_1$

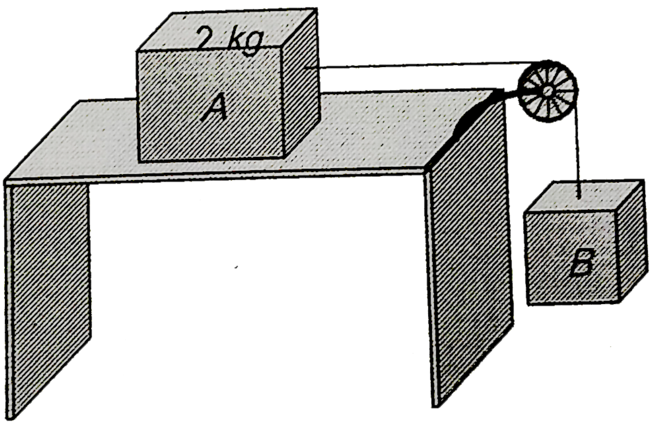
C. $S_2 = \frac{m_1^2}{m_2^2} S_1$

D. $S_2 = \frac{m_2^2}{m_1^2} S_1$

Answer: C

Watch Video Solution

56. The coefficient of static friction, μ_s between block A of mass 2 kg and the table as shown in the figure is 0.2. What would be the maximum mass value of block B so that the two blocks do not move? The string and the pulley are assumed to be smooth and massless. $(g = 10m/s^2)$



A. 2.0 kg

B. 4.0 kg

C. 0.2 kg

D. 0.4 kg

Answer: D

Watch Video Solution

57. The minimum force required to start pushing a body up a rough (frictional coefficient μ) inclined plane is F_1 while the minimum force needed to prevent it from sliding down is F_2. If the inclined plane makes an angle θ with the horizontal such that $\tan\theta = 2\mu$ then the ratio $\frac{F_1}{F_2}$ is .

A. 2

B. 3

C. 4

D. 1

Answer: B

Watch Video Solution

58. A bar of mass m_1 is placed on a plank of mass m_2 which rests on a smooth horizontal plane . The coefficient of friction between the surfaces of bar and plank is k . The plank is subjected to a horizontal force F depending on time t as F = at , where a is a constant . The moment of time t_0 at which the plank starts sliding is :

A. $\frac{akg}{m_1 + m_2}$

B. $\frac{(m_1 + m_2)kg}{a}$

C. $\frac{(m_1 + m_2)g}{ka}$

D. $\frac{ka}{(m_1 + m_2)g}$

Answer: B

Watch Video Solution

59. In the given Fig. 7.154 , two masses 2 kg each are attached to a string which passes over a smooth massless pulley P . The surface PQ is smooth and $\angle PQR = 45^{\circ}$. The surface PR is rough , with coefficient of kinetic friction $\frac{1}{\sqrt{3}}$ and $\angle PRQ = 30^{\circ}$ .The acceleration of the system is :

A. $\frac{g\left(\sqrt{2}-1\right)}{2\sqrt{2}}$ along PR

B. zero because the masses are equal

C. $\frac{g}{2}$ along PR

D. $\frac{g\left(\sqrt{2}-1\right)}{2\sqrt{2}}$ along PQ

Answer: A

View Text Solution

60. A block lying on a long horizontal conveyer belt moving at a constant velocity receives a velocity $v_0 = 5m/s$ relative to the ground in the direction opposite to the direction of motion of the conveyer. After $t = 4s$, the velocity of the block becomes equal to the velocity of the belt. The coefficient of friction between the block and the belt is $\mu = 0.2$. Determine the velocity v of the conveyer belt.

A. 3 m/s

B. 5 m/s

C. 4 m/s

D. 7 m/s

Answer: A

Watch Video Solution

61. A particle of weight W rests on a rough inclined plane which makes an angle α with the horizontal . If the coefficient of static friction $\mu = 2\tan\alpha$, find the horizontal force H acting transverse to the slope of the plane when the particle is about to slip :

A. W $\sqrt{3}\cos\alpha$

B. $W\sqrt{3}\sin\alpha$

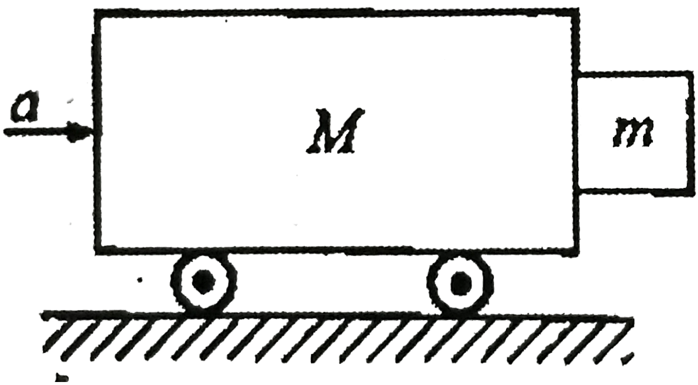
C. $\frac{W\sin\alpha}{\sqrt{3}}$

D. $\frac{W\cos\alpha}{\sqrt{3}}$

Answer: B

View Text Solution

62. A cart of mass M has a block of mass m in contact with it as shown in the figure-2.133. The coefficient of friction between the block and the cart is μ. What is the minimum acceleration of the cart so that the block m does not fall ?



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

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

C. μg

D. $\frac{M\mu g}{m}$

Answer: A

Watch Video Solution

63. A block is placed on a rough floor and a horizontal force F is applied on it.The force of friction f by the floor on the block is measured for different values of F and a graph is plotted between them.

A. straight line parallel to F-axis

B. straight line inclined at 45°

C. straight line inclined at 45° for small values of F and straight line parallel to F-axis for large F

D. none of the above

Answer: C

Watch Video Solution

64. If the coefficient of friction between an insect and bowl is μ and the radius of the bowl is r, find the maximum height to which the insect can crawl in the bowl.

A. $\dfrac{r}{\sqrt{1+\mu^2}}$

B. $r\left[1-\dfrac{1}{\sqrt{1+\mu^2}}\right]$

C. $r\sqrt{1+\mu^2}$

D. $r\left[\sqrt{1+\mu^2}-1\right]$

Answer: B

Watch Video Solution

65. A block rests on a rough inclined plane making an angle of 30° with horizontal. The coefficient of static friction between the block and inclined plane is 0.8 . If the frictional force on the block is $10N$, the mass of the block in kg is $\left(g = 10m/s^2\right)$

A. 2.5

B. 4.0

C. 1.6

D. 2.0

Answer: D

Watch Video Solution

66. The upper half of an inclined plane with inclination ϕ is perfectly smooth while the lower half is rough. A body starting from rest at the top will again come to rest at the bottom if the coefficient of friction for the lower half is given by

A. 2 tan ϕ

B. tan ϕ

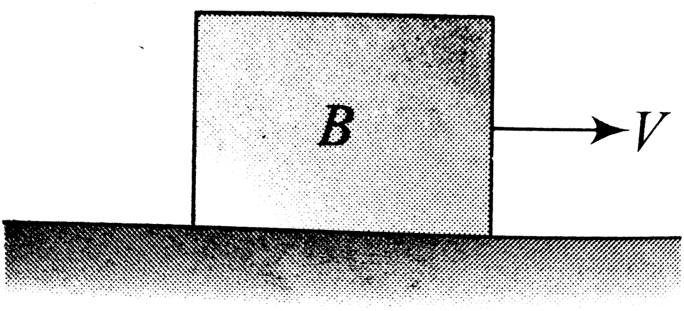
C. 2 sin ϕ

D. 2 cos ϕ

Answer: A

Watch Video Solution

67. A block B is pushed momentarily along a horizontal surface with an initial velocity v. If μ is the coefficient of sliding friction between B and the surface, block B will come to rest after a time:



A. $\frac{v}{g\mu}$

B. $\frac{g\mu}{v}$

C. $\frac{g}{v}$

D. $\frac{v}{g}$

Answer: A

Watch Video Solution

68. A rectangular block of mass 5 kg is kept on a horizontal surface . The coefficient of friction between the block and the surface is 0.2 . If a force of 20 N is applied to the block at angle of 30° with the horizontal plane , what is the force of friction on the block ? (Take g = $10m / s^2$)

A. 5 N

B. 10 N

C. 12 N

D. 20 N

Answer: C

Watch Video Solution

69. In the arrangement shown in figure , there is friction between the blocks of masses m and 2m which are in contact . The ground is smooth . The mass of the suspended block is m . The block of mass m which is kept on mass 2m is stationary with respect to block of mass 2 m . The force of friction between m and 2 m is (pulleys and string are lig frictionless) :

A. $\frac{mg}{2}$

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

C. $\frac{mg}{4}$

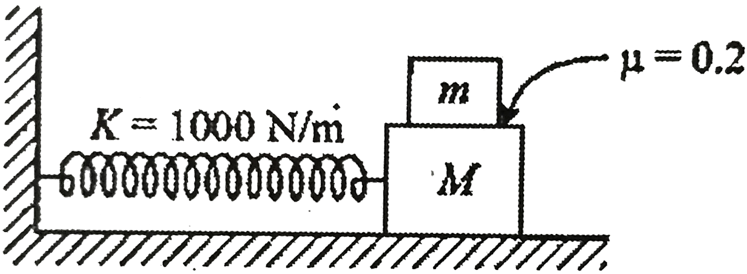
D. $\frac{mg}{3}$

Answer: C

Watch Video Solution

70. A block of mass M = 4 kg is kept on a smooth horizontal plane. A bar of mass m = 1 kg is kept on it. They are connected to a spring as shown & the spring is compressed. Then what is the maximum compression in the spring for which the bar will not slip on the block when released if coefficient of friction between them is 0.2 & spring constant =

1000 N/m : (Take $g = 10m/s^2$)



A. 1 cm

B. 1 m

C. 1.25 cm

D. 10 cm

Answer: A

Watch Video Solution

71. If the mass of block is 1 kg and a force of 10 / $\sqrt{3}$ N is applied horizontally on the block as shown in the figure . The frictional force acting on the block is :

A. zero

B. $\frac{10}{\sqrt{3}}$N

C. $\frac{20}{\sqrt{3}}N$

D. 5 N

Answer: A

72. Two blocks of equal mass 2 kg are placed on a rough horizontally surfaces as shown and a force F is applied on the upper block . The system is initially at rest . Find acceleration of the lower block in m/s^2 .

A. $3m/s^2$

B. $5m/s^2$

C. Zero

D. none of these

Answer: B

View Text Solution

73. A side view of a simplified form of vertical latch B is as shown . The lower member A can be pushed forward in its horizontal channel . The sides of the channels are smooth , but at the interfaces of A and B , which are at 45° with the horizontal , there exists a static coefficient of friction $\mu = 0.4$. what is the minimum force F (in N) that must be applied horizontally to A to start motion of the latch B upwards if it has a mass m = 0.6 kg ?

A. 10 N

B. 0

C. 14 N

D. 22 N

Answer: C

View Text Solution

74. A block of weight 5 N is pushed against a vertical wall by a force 12 N . The coefficient of friction between the wall and block is 0.6 . Find the magnitude of the force exerted by the wall on the block :

A. 12 N

B. 13 N

C. 17 N

D. 16 N

Answer: B

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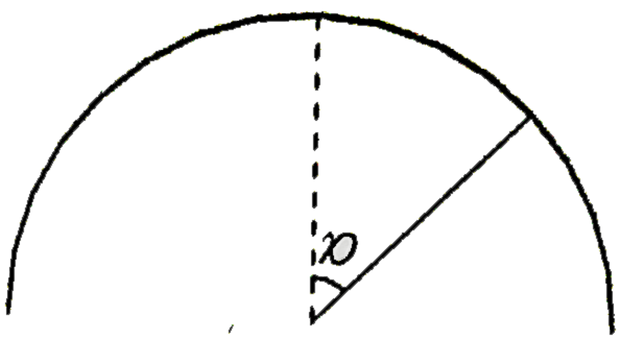
75. An insect crawls up a hemispherical surface very slowly (see the figure). The coefficient of friction between the insect and the surface is 1/3. If the line joining the centre of the hemispherical surface to the insect makes an angle α with the vertical, the maximum possible value of α is given by



A. cot $\alpha = 3$

B. tan $\alpha = 3$

C. sec $\alpha = 3$

D. cosec $\alpha = 3$

Answer: A

Watch Video Solution

76. What is the maximum value of the force F such that the block shown in Fig. 7. 165. does not move ?

A. 20 N

B. 10 N

C. 12 N

D. 15 N

Answer: A

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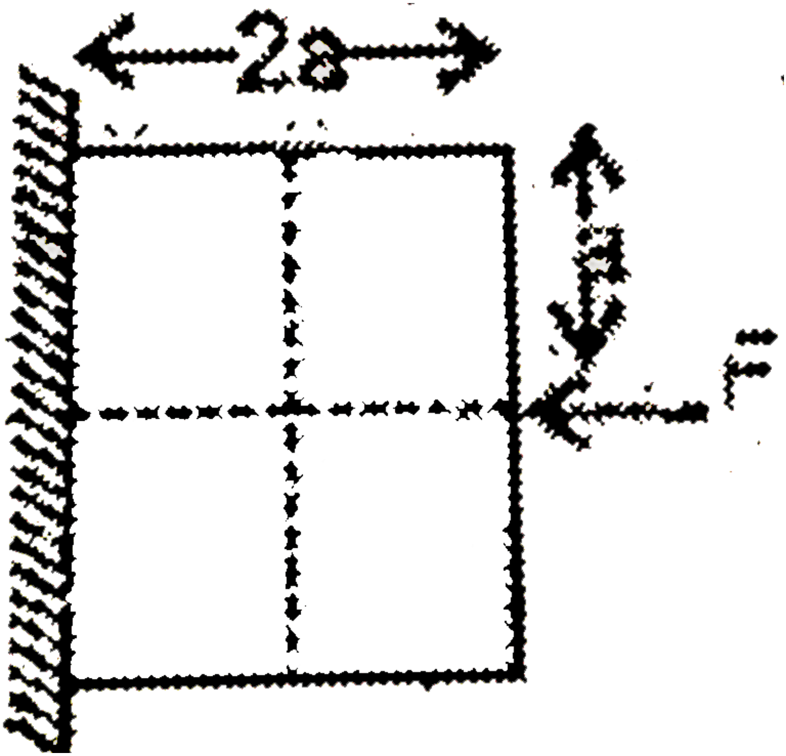
77. A block of mass 'm' is held stationary against a rough wall by applying a force F as shown. Which one of the following statement is incorrect ?



A. frictional force f = mg

B. F = N N^{-} is normal reaction

C. F does not apply any torque

D. N does not apply any torque

Answer: D

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

A.

B.

C.

D.

Answer: A

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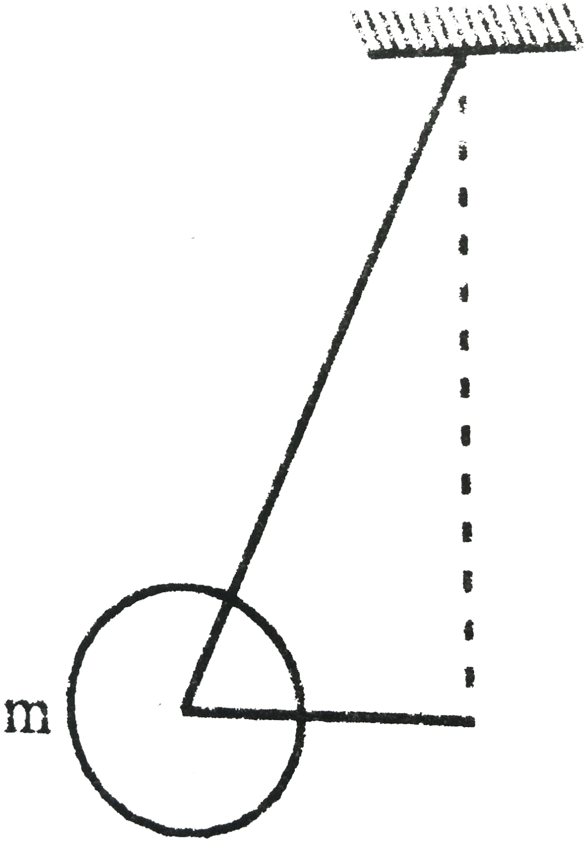
79. A ball of mass $(m)0.5kg$ is attached to the end of a string having length $(L)0.5m$. The ball is rotated on a horizontal circular path about vertical axis. The maximum tension that the string can bear is $324 N$. The maximum possible value of angular velocity of ball (in radian//s) is -



A. 9

B. 18

C. 27

D. 36

Answer: D

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80. 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 expressions for the friction on the 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 option . The acceleration due to gravity is denoted by g .

[Useful information : tan (5.5°) = 0.1 , tan (11.5°) = 0.2 , tan $(16.5^\circ) = 0.3$]

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

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

Answer: D

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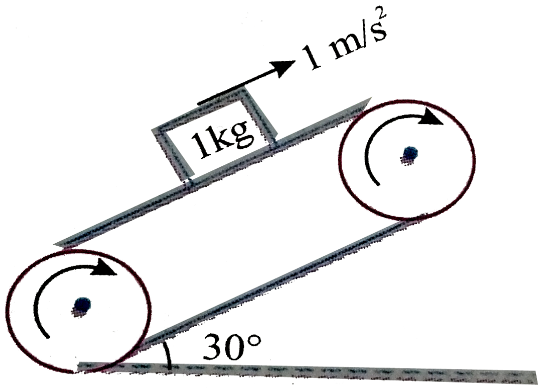
More Than One Correct

1. A block of mass $1kg$ is stationary with respect to a conveyer belt that is accelerating with $1m/s^2$ upwards at an angle of 30° as shown in figure.

Which of the following is / are correct?



A. Force of friction on block is 6 N upwards

B. Force of friction on block is 1.5 N upwards

C. Contact force between the block and belt is

$10.5N$

D. Contact force between the block and the belt

is $5\sqrt{3}N$

Answer: A::C

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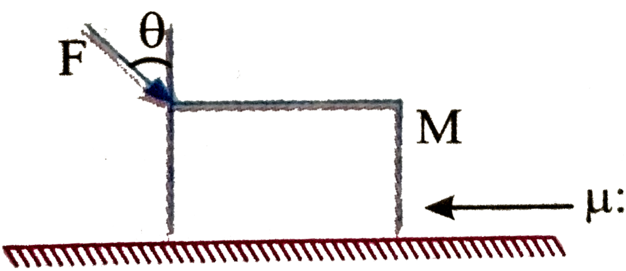
2. In the situration shown in the figure the friction coefficient between M and the horizontal surface is μ. The force F is applied at an angle θ with vertical. The correct statements are



A. If $\theta > \tan^{-1}\mu$ the block cannot be pushed forward for any value of F

B. If $\theta < \tan^{-1}\mu$ the block cannot be pushed forward for any value of F

C. As θ decreases the magnitude of force needed to just push the block M forward increases .

D. none of the above

Answer: A::C

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3. A block resting on a rough horizontal surface. A sharp horizontal impulse is applied on the block at $t = 0$. If at an instant t, its velocity be v and displacement up to this instant be s, then which of the following graphs is / are correct?

A.

B.

C.

D.

Answer: B::C

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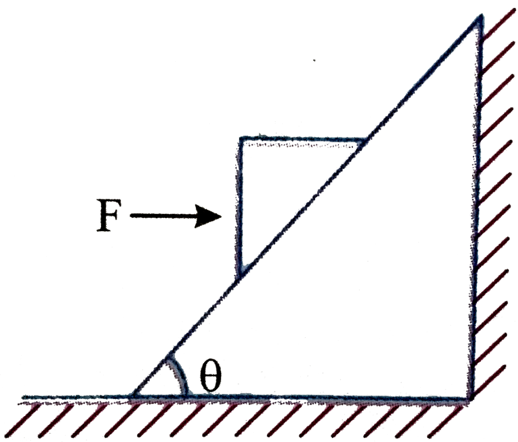
4. A triangular block of mass m rests on a fixed rough inclined plane having friction coefficient μ with the block. A horizontal forces F is applied to it as shown in figure below, then the correct statements is:



A. Friction force is zero when F cos $\theta = mg\sin\theta$

B. The value of limiting friction is $\mu(mg\sin\theta + F\cos\theta)$

C. Normal reaction on the block is $F\sin\theta + mg\cos\theta$

D. The value of limiting friction is $\mu(mg\sin\theta - F\cos\theta)$

Answer: C::D

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5. A small on rough inclined groove on rough inclined plane of inclination θ. Groove makes an angle α as shwon in Fig . 7.173 , μ is the coefficient of friction . Which of the following is correct ?

A. Normal force by inclined plane . N = mg cos θ

B. Normal force by inclined is

$$N = mg\sqrt{\cos^2\theta + \sin^2\theta\sin^2\alpha}$$

C. Maximum frictional force that can develop is

$$f_{\max} = \mu mg\cos\theta$$

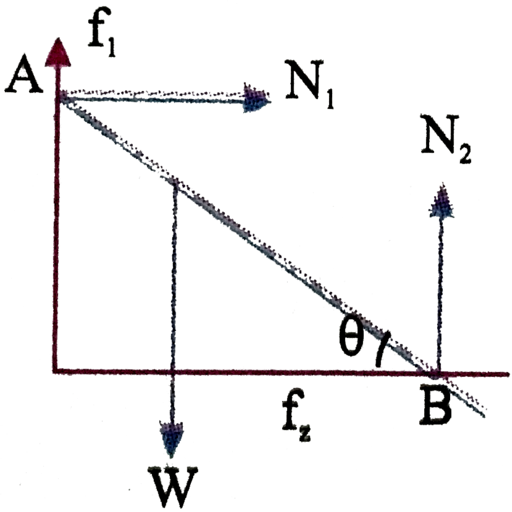
D. If $\mu = 0$ then acceleration of block is g sin

$\theta \cos \alpha$

Answer: B::D

View Text Solution

6. A uniform rod is made to lean between rough vertical wall and the ground. Friction coefficient between rod and walls is $\mu_1 = \frac{1}{2}$ and between the rod and the ground is $\mu_2 = \frac{1}{4}$. The rod is about to slip at contact surfaces. The correct options are:



A. the normal reaction between rod and wall is

$$\frac{\mu_2 W}{1+\mu_1\mu_2}$$

B. normal reaction between rod and ground is

$$\frac{W}{1+\mu_1\mu_2}$$

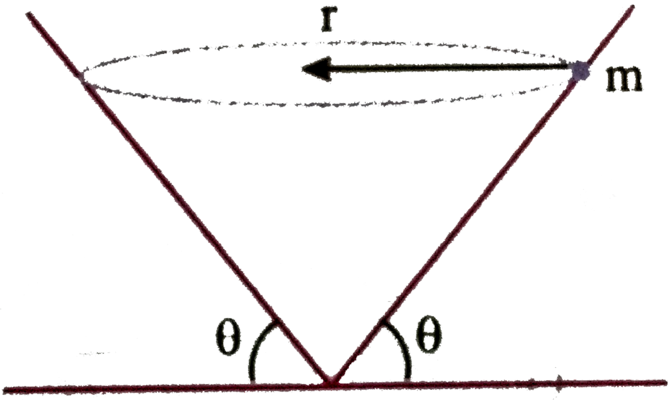
C. $N_2 > N_1$

D. $N_1 > N_2$

Answer: A::B::C

Watch Video Solution

7. A ball of mass m is rotating in a circle of radius r with speed v inside a smooth cone as shown in figure. Let N be the normal reaction on the ball by the cone, then choose the correct option:



A. $N\cos\theta = mg$

B. $g\sin\theta = \frac{v^2}{r}\cos\theta$

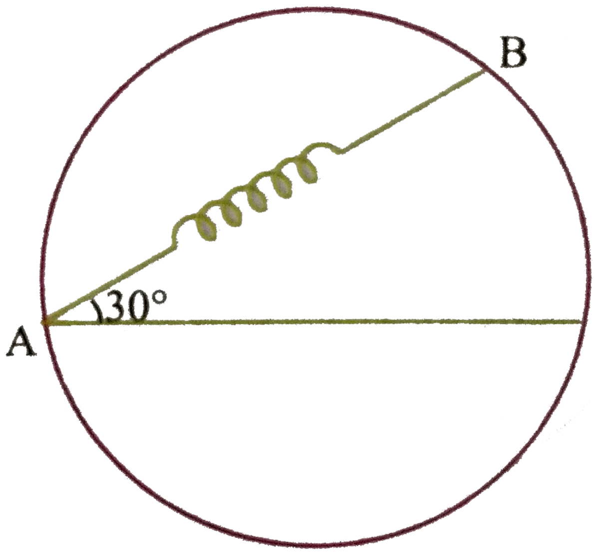
C. $N\sin\theta - \frac{mv^2}{r} = 0$

D. none of these

Answer: A::B::C

Watch Video Solution

8. A Bead of mass m is attached to one end of a spring of natural length $'R'$ and spring cosntant $'k = \frac{(\sqrt{3}+1)mg}{R}'$. The other end of the spring is fixed at point $'A'$ on a smooth vertical ring of radius $'R'$ as shown



A. The normal reaction at 'B' just after the bead is released to move is : $\frac{3\sqrt{3}mg}{3}$

B. The tangential acceleration of the bead just after it is released to move is : g/2

C. The normal reaction at 'B' just after the head is released to move is : $\frac{3mg}{2}$

D. Just after the bead is released to move the normal acceleration and tangential acceleration are numerically equal .

Answer: A::B

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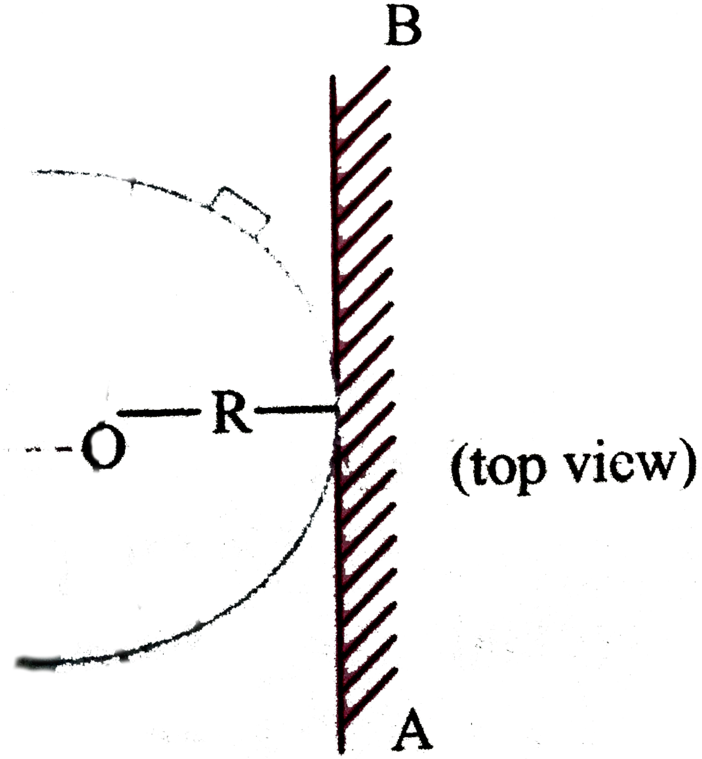
9. As shown in figure AB represents an infinite wall tangential to a horizontal semi circular track. O is a point source of light on the ground at the centre of the circle. A block moves along the circular track with speed v starting from the point where the wall touches the circle. If the velocity and acceleration of shadow along the length of

the wall is respectively $'V'$ and $'a'$ then,



A. $V=v\frac{\cos(vt)}{R}$

B. $V=v\sec^2\left(\frac{vt}{R}\right)$

C. $a=\frac{v^2}{R}\sec^2\left(\frac{vt}{R}\right)\tan\left(\frac{vt}{R}\right)$

D. $a=\frac{2v^2}{R}\sec^2\left(\frac{vt}{R}\right)\tan\left(\frac{vt}{R}\right)$

Answer: B::D

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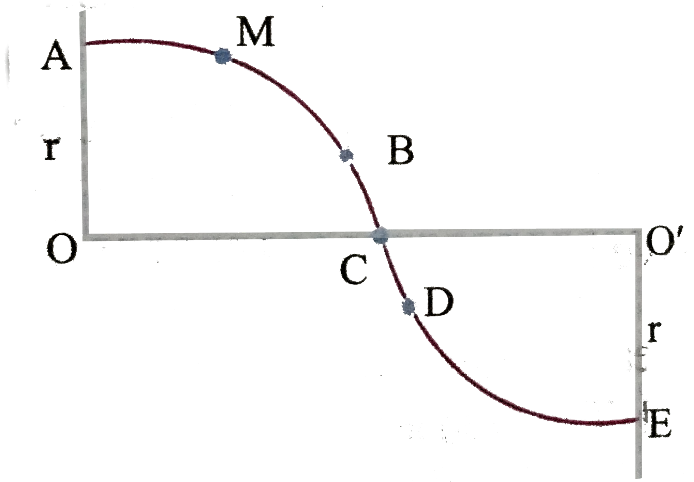
10. $ABCDE$ is a smooth iron track in the vertical plane. The sections ABC and CDE are quarter circles. Points B and D are very close to C. M is a small magnet of mass m. The force of attraction between M and the track is F, which is constant and always normal to the track. M starts from rest at A, then:



A. If M is not to leave the track at C ,then F

$> 2mg$

B. At B , the normal reaction of the track is F - 2mg

C. At D , the normal reaction of the track is F + 2mg

D. The normal reaction of the track is equal to F at some point between A and M

Answer: B::C::D

Watch Video Solution

11. A body moves on a horizontal circular road of radius of r, with a tangential acceleration a_T. Coefficient of friction between the body and road surface is μ. It begin to slip when it's speed is v, then :

A. $v^2 = \mu r g$

B. $\mu g = \frac{v^2}{r} + a_T$

C. $\mu^2 g^2 = \frac{v^4}{r^2} + a_T^2$

D. the force of friction makes an angle $\tan^{-1}\left(\frac{v^2}{a_T \times r}\right)$ with the direction of motion at point of slipping

Answer: B::C

Watch Video Solution

12. Block A is placed on cart B as shown in figure . If the coefficient of static and kinetic friction between the 20 kg block A and 100 kg cart B are both essentially the same value of 0.5 : (g = $10m/s^2$)

A. the blocks A and B will have a common acceleration if P = 60 N

B. acceleration of cart B is $0.98m/s^2$ if P = 40 N

C. acceleration of cart B is greater than that of A is P = 60 N

D. the common acceleration of both the blocks

is $0.667 m / s^2$ if P = 40 N

Answer: A::D

View Text Solution

13. A $3 kg$ block of wood is on a level surface where $\mu_s = 0.25$ and $\mu_s = 0.2$A force of $7N$ is being applied horizontal to the block Mark the correct statement(s) regarding this situation.

A. if the block is initially at rest , it will remain at rest and friction force will be 7 N

B. if the block is initially moving , then it will continue its motion for forever if force applied is in direction of motion of the block .

C. if the block is initially moving and direction of applied force is same as that of motion of block then block moves with an acceleration of $\frac{1}{3} m/s^2$ along its initial direction of motion .

D. if the block is initially moving and direction of applied force is opposite to that of initial motion of block then block decelerates , comes to a stop and starts moving in the opposite direction .

Answer: A::B::C

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14. A force $\vec{F}$ (larger than the limiting friction force) is applied to the left to an object moving to the right on a rough horizontal surface . Then :

A. the object would be slowing down initially.

B. for some time $\overrightarrow{F}$ and friction force will act in same direction and for remaining time they act in opposite directions .

C. the object comes to rest for a moment and after that its motion is accelerating in the direction of $\overrightarrow{F}$

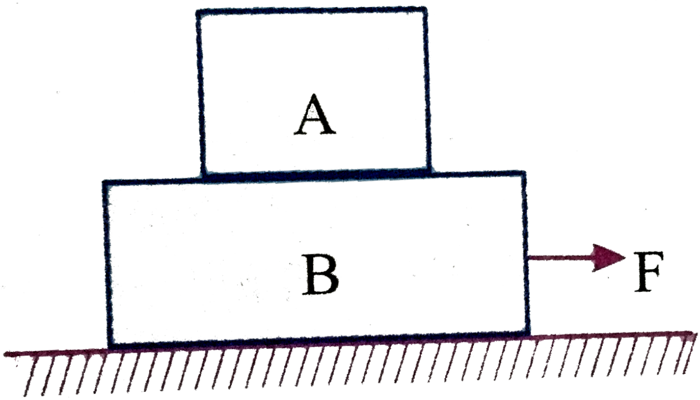
D. the object slows down and finally comes to rest .

Answer: A::B::C

View Text Solution

15. In the co-efficinet of friction between the floor and the body B is 0.1. The co-efficient of friction beteen the bodies B and A is 0.2 A fore F is applied as shown B The mass of A is $m/2$ and of B is m Which of the following statements are ture

?



.

A. The bodies will move together if F = 0.25 mg .

B. The body A will slip with respect to B if F =

0.5 mg

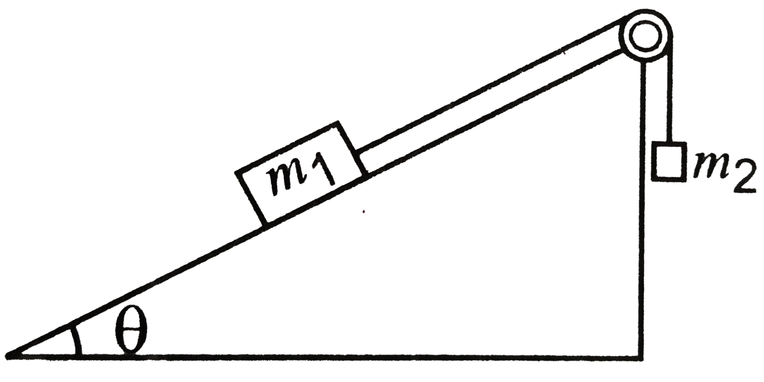
C. The bodies will move together if F = 0.5 mg .

D. The bodies will be rest if F = 0.1 mg.

Answer: A::B::D

Watch Video Solution

16. Mass m_1 moves on a slope making an angle θ with the horizontal and is attached to mass m_2 by a string passing over a frictionless pulley as shown in The co-efficient of friction between m_1 and the slopping surface is μ Which of the following statements are true ?



A. If $m_2 > m_1 \sin\theta$, the body will move up the plane .

B. If $m_2 > m_1(\sin\theta + \mu\cos\theta)$, the body will move up the plane .

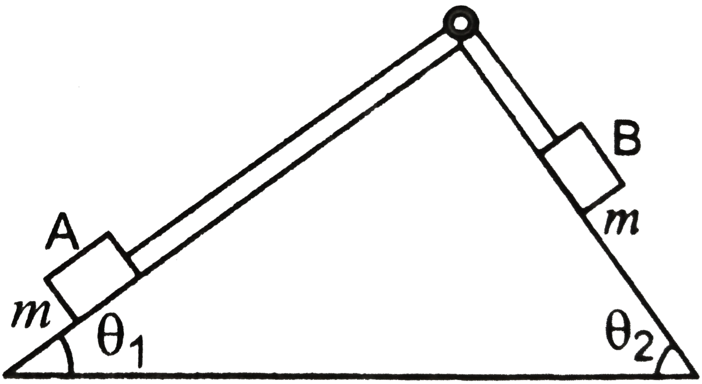
C. If $m_2 < m_1(\sin\theta + \mu\cos\theta)$, the body will move up the plane .

D. If $m_2 < m_1(\sin\theta - \mu\cos\theta)$, the body will move down the plane .

Answer: B::D

Watch Video Solution

17. A body a of mass m slides on plane inclined at angle θ_0 to the horizontal and μ_1 is the coefficient of friction between A and the plane A is connected by a light string passing over a frictionless pulley to another body B also of mass m slidding on a frictionless plane inclined at angle θ_2 to the horizontal Which of the following statements are ture ?



A. A will never move up the plane

B. A will just start moving up the plane when $\mu = \sin\theta_2 - \sin\theta_1) / \cos\theta_1$

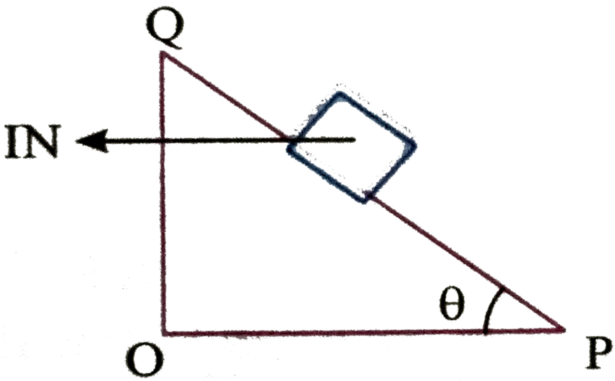
C. For A to move up the plane θ_2 must always be greater than θ_1

D. B will always slide down with constant speed

Answer: B::C

Watch Video Solution

18. A small block of mass of $0.1kg$ lies on a fixed inclined plane PQ which makes an angle θ with the horizontal. A horizontal force of $1N$ acts on the block through its centre of mass as shown in the figure. The block remains stationary if (take $g = 10m/s^2$)



A. $\theta = 45^\circ$

B. $\theta > 45^\circ$ and a frictional force acts on the block towards P

C. $\theta > 45^\circ$ and a frictional force acts on the block towards Q

D. $\theta < 45^\circ$ and a frictional force acts on the block towards Q

Answer: A::C

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Assertion Reason

1. (A) : Force of friction applied by ground on the wheels of a bicycle is always in the direction of motion of the bicycle .

(R) : Force of friction always opposes the relative motion between the surfaces in contact .

A. If both A and R are true and R is the correct explanation of A .

B. If both A and R are true but R is not correct explanation of A .

C. If A is true but R is false .

D. If A is false but R is true

Answer: D

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2. (A) : In the given Fig . 7 . 184 , a force 20 N pulls a block of mass 10 kg on a rough floor . If coefficient of friction is $\mu = 0.4$, force of friction acting on the block will be 20 N .

(R) : Force of kinetic friction is slightly less than the limiting value of force of friction .

A. If both A and R are true and R is the correct explanation of A .

B. If both A and R are true but R is not correct explanation of A .

C. If A is false but R is false .

D. If A is false but R is true

Answer: B

View Text Solution

3. (A) : A body of mass 10 kg is placed on a rough inclined surface $(\mu = 0.7)$. The surface is inclined to horizontal at angle 30° . Acceleration of the body down the plane will be zero .

(R) : Work done against friction always converts to heat .

A. If both A and R are true and R is the correct explanation of A .

B. If both A and R are true but R is not correct explanation of A .

C. If A is false but R is false .

D. If A is false but R is true

Answer: B

View Text Solution

4. Assertion: The acceleration of a body down a rough inclined plane is grater than the acceleration due to gravity.

Reason: The body is able to slide on an inclined plane only when its acceleration is greater than acceleration due to gravity.

A. If both A and R are true and R is the correct explanation of A .

B. If both A and R are true but R is not correct explanation of A .

C. If A is false but R is false .

D. If A is false but R is true

Answer: C

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5. Assertion : Angle of repose is equal to angle of limiting friction. Reason : When the body is just at the point of motion, the force of friction in this stage is called as limiting friction.

A. If both A and R are true and R is the correct explanation of A .

B. If both A and R are true but R is not correct explanation of A .

C. If A is false but R is false .

D. If A is false but R is true

Answer: B

Watch Video Solution

6. (A) : Kinetic friction force is non-conservative in nature .

(R) : Net work done by kinetic friction on a block is always completely converted into heat .

A. If both A and R are true and R is the correct explanation of A .

B. If both A and R are true but R is not correct explanation of A .

C. If A is true but R is false .

D. If A is false but R is true

Answer: C

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7. (A) : If a body is trying to slip over a surface then friction acting on the body is necessarily equal to the limiting friction .

(R) : Static friction can be less than the limiting friction force .

A. If both A and R are true and R is the correct explanation of A .

B. If both A and R are true but R is not correct explanation of A .

C. If A is true but R is false .

D. If A is false but R is true

Answer: D

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8. (A) : It is easier to maintain the motion than to start it on rough surface .

(R) : Dynamic/kinetic friction is less than the force of limiting friction .

A. If both A and R are true and R is the correct explanation of A .

B. If both A and R are true but R is not correct explanation of A .

C. If A is false but R is false .

D. If A is false but R is true

Answer: A

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9. (A) : Polishing a surface beyond a certain limit increases rather than decreases the frictional forces .

(R) : When the surface is polished beyond a certain limit , the molecules exert strong attractive force . This is called surface adhesion , to overcome which additional force is required . Hence frictional force increases .

A. If both A and R are true and R is the correct explanation of A .

B. If both A and R are true but R is not correct explanation of A .

C. If A is false but R is false .

D. If A is false but R is true

Answer: A

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10. (A) : Friction forces does not depend on visible area of contact .

(R) : Limiting friction force is dependent on normal reaction .

A. If both A and R are true and R is the correct explanation of A .

B. If both A and R are true but R is not correct explanation of A .

C. If A is true but R is false .

D. If A is false but R is true

Answer: B

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11. Asseration : A block of mass m starts moving on a rough horizontal surface with a velocity v. It stops due to friction between the block and the surface after moving through a ceratin distance. The surface is now tilted to an angle of 30° with the horizontal and same block is made to go up on the surface with the same initial velocity v. The decrease in the mechanical energy in the second situation is small than the first situation.

Reason : The coefficient of friction between the block and the surface decreases with the increase in the angle of inclination.

A. If both A and R are true and R is the correct explanation of A .

B. If both A and R are true but R is not correct explanation of A .

C. If A is false but R is false .

D. If A is false but R is true

Answer: C

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12. STATEMENT-1: It is easier to pull a heavy object than to push it on a level ground and

STATEMENT-2: The magnitude fo frictional force depends on the nature of the two surfaces in contact.

A. If both A and R are true and R is the correct explanation of A .

B. If both A and R are true but R is not correct explanation of A .

C. If A is false but R is false .

D. If A is false but R is true

Answer: B

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Matrix Match

1. Figure given along side shows a block pressed against a rough vertical wall with a force F as shown in side view . Column -I shows angle at which force F is applied and Column-II gives information about corresponding friction force , match them .

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2. Two blocks of mass m_1 and $m_2 (m_2 > m_1)$ are placed in contact with each other on an inclined plane as shown in figure . The coefficient of friction between m_1 and surface is μ_1 and between m_2 and surface is μ_2.

View Text Solution

3. Fig. 7. 187 (a) shows a system of two blocks of masses m and $M(>m)$ placed on a surface , there is no friction between the blocks and the surface . A force F is applied to the system as shown resulting in the motion of the system .

Fig. 7.187 (b) also shows a system of blocks of masses m and M . Masses m and M have , respectively , the same values as in Fig . 7.187 (a) . There is no friction between the lower block and the surface on which the system is placed but friction is present at the constant of the two blocks . A force F, having the same value as in Fig. 7.187 (a) , is applied to the lower block resulting in the motion of the system such that both blocks move together with a common acceleration . Match Column-I and II.

4. Coefficient of friction between the block and the surface in each of the given figures being 0.4 , match Column - I and II .

(Take g = $10m/s^2$)

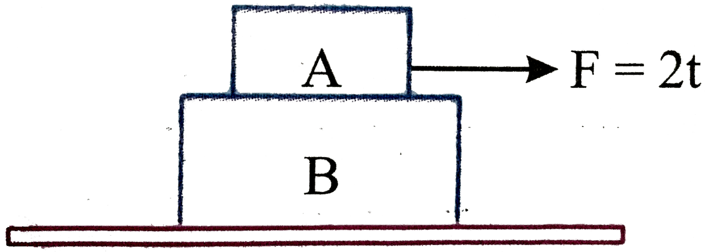
View Text Solution

5. Consider the situations given in the following figures and match Column-I and II . Take coefficient of kinetic friction as 1 and g = $10m/s^2$:

View Text Solution

Integer Answer

1. Two blocks A and B of mass $2kg$ and $4kg$ are placed one over the others as shown in figure. A time vaying horizontal force $F = 2t$ is applied on the upper blocks as shown in figure. Here t is in second and F is in newton. Coefficient of friction between A and B is $\mu = \frac{1}{2}$ and the horizontal surface over which B is placed is smmoth. $(g = 10m/s^2)$. If acceleration of blocks A as a function of time is given by $a_A = t/c$ then find value of c. $(t \le 7.5s)$



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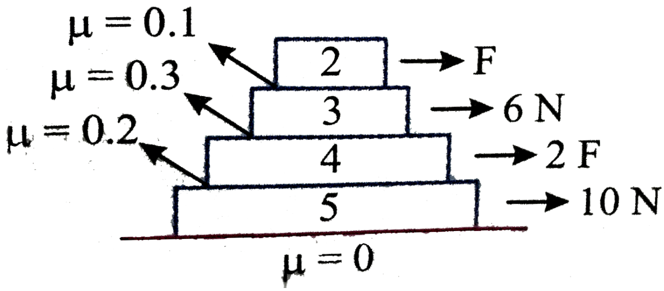
2. Calculate F such that frictional force acting on all blocks zero.



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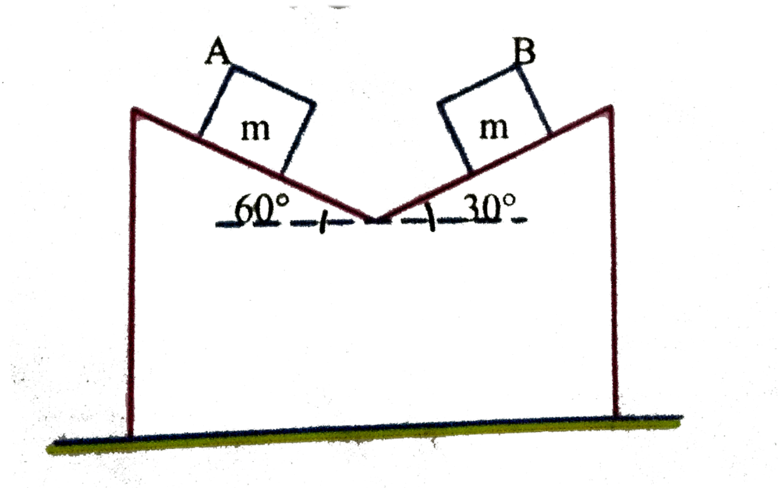
3. Two small block $m = 2kg$ each kept on wedge of mass $12kg$. There is no friction between blocks and wedge coefficient of friction between wedge and ground in $\mu = 0.3$. Calculate frictional force by ground on wedge.



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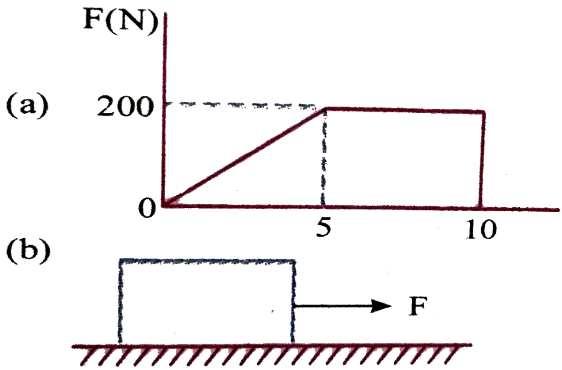
4. A $20kg$ block is originally at rest on a horizontal surface for which the coefficient of friction is 0.6. A horizontal force F is applied such that it varies with time as shown in the figure (a) & (b). If the speed of the block after $10s$ is $8v$ then find v. (Take $g = 10m / s^2$)



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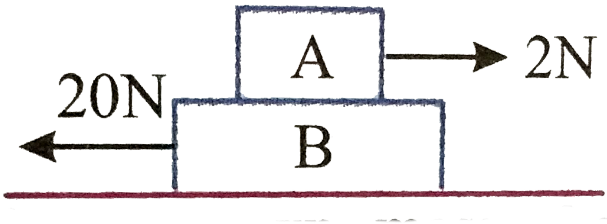
5. Block B is placed on a smooth surface. Block A is placed on rough surface of bolck B with coefficient of friction 0.60. The mass of A and B are $2kg$ and $4kg$ respectively. Find the frictional force between A and B (in N)



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6. μ is coefficient of friction between all surfaces . Block A is kept over block B on inclined plane . The minimum force required such that 'A' block can accelerate along applied force is mg sin $\theta + n\mu g \cos\theta$, calculate n .

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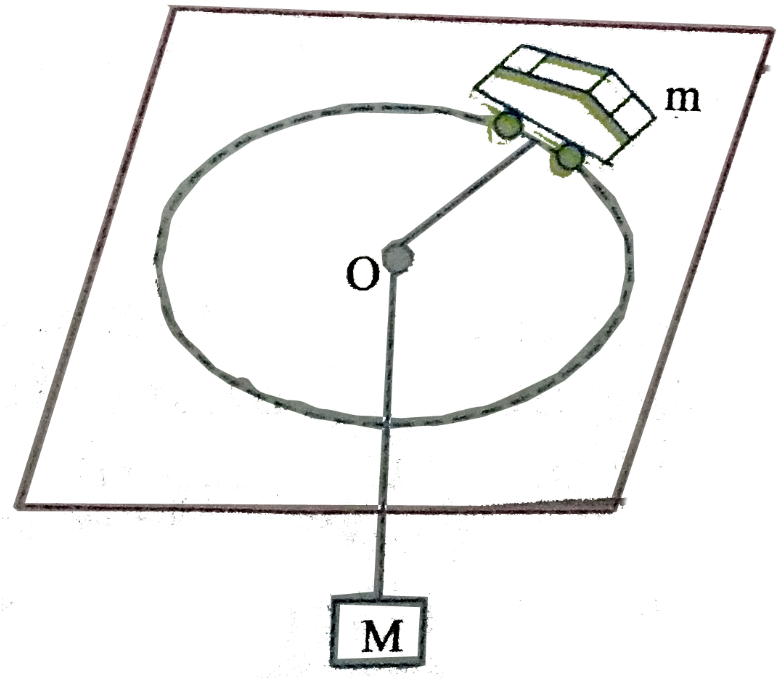
7. A toy car of mass m can travel at a fixed speed. It moves in circle on a fixed horizantal table. A string is connected to the car and attached to a block os mass M that hangs as shown in figure (the portion of string below the table is always vertical). The coefficient of friction between the surface of table and tyres of the toy car is μ. Find the ratio of the maximum radius to the minimum radius for which the toy car can move in a circular path with center O on table.

$\left(Given M = 3kg, m = 2kg, \mu = \frac{1}{2}\right)$



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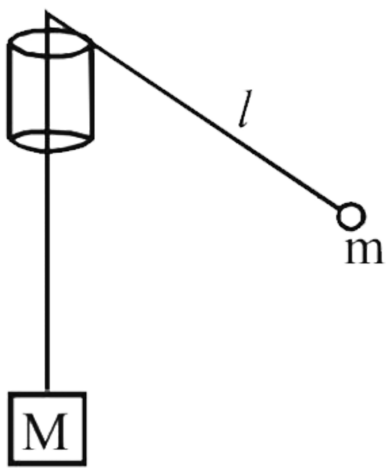
8. A large mass M and a small mass m hang at two ends of a string that passes over a smooth tube as shown in the figure. The mass m moves around a circular path which lies in a horizontal plane. The length of string from the mass m to the top of the tube is l and θ is the 'angle' this length makes with the vertical. What should be the frequency of rotation of mass m, so that the mass M remains stationary?



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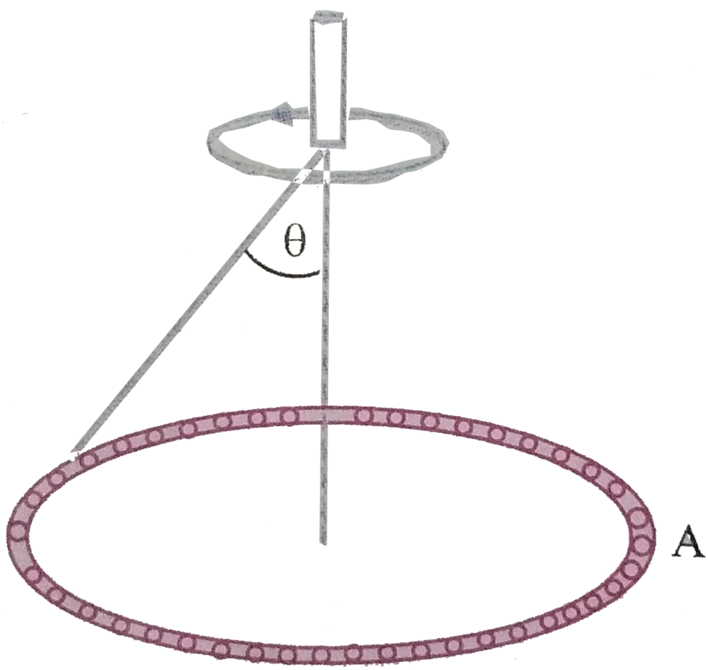
9. A closed chain A of mass m = 0.36kg is attached to a vertical rotating shaft by means of thread showin in fig. and rotated with a constant angular velocity $\omega = 35 rad / s$. The thread forms an angle $\theta = 45^\circ$ with the vertical. Then the tension of the thread is



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10. A table with smooth horizontal surface is placed in a cabin which moves in a circle of a large radius R = 100 m with ω = 3 rad/s (see figure) . A smooth pulley of small radius is fastened to the table . Two masses m and 2m placed on the table are connected through a string going over the pulley . initially the masses are held by a person with the strings along the outward radius and then the system is released from rest (with respect to the cabin) . Then the magnitude of the initial acceleration of the mass m as seen from the cabins is $n \times 100$. Find n .

View Text Solution

11. A solid body starts rotating about a stationary axis with an angular acceleration $\alpha = (2.0 \times 10^{-2}) t rad / s^2$ here t is in seconds. How soon after the beginning of rotation will the total acceleration vector of an arbitrary point of the body form an angle $\theta = 60^\circ$ with its velocity vector?

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12. A 20 kg block is originally at rest on a horizontal surface for which the coefficient of friction is 0.6 . A horizontal force F is applied such that it varies with time as shown in the figure (a) and (b) . If the speed of the block after 10 s is 8 v then find v . (Take g = $10m/s^2$)

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13. Block A and B are connected by a rod of negligible mass as shown in Fig . 7.199 . The mass of each block is 170 kg . The coefficient of friction between inclined plane and blocks A and B are 0.2 and 0.4 respectively . The tension in the rod is found to be 50 x newtons, the value of x is :

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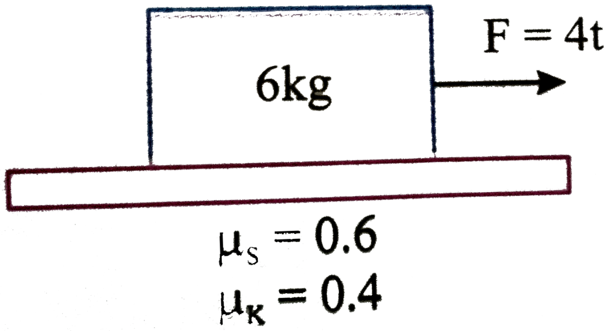
14. A $6kg$ blocks is kept over a rough surface with coefficients of friction $\mu_s = 0.6$ and $\mu_k = 0.4$ as shown in figure. A time varying force $F = 4t$ (F in newton and t in second) is applied on the block as shown. Find the acceleration of block at $t = 5\,\text{sec.}$ (

Taking $g = 10m/s^2$)



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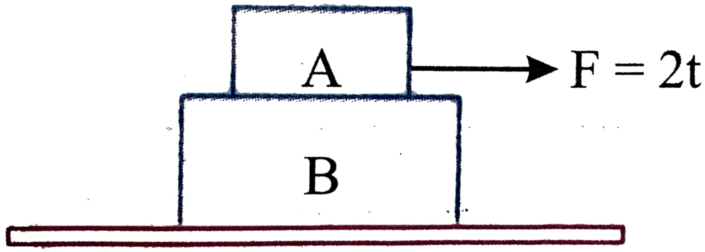
15. Two blocks A and B of mass $2kg$ and $4kg$ are placed one over the others as shown in figure. A time vaying horizontal force $F = 2t$ is applied on the upper blocks as shown in figure. Here t is in second and F is in newton. Coefficient of friction between A and B is $\mu = \frac{1}{2}$ and the horizontal surface over which B is placed is smmoth. $(g = 10m / s^2)$. If acceleration of blocks A as a function of time is given by $a_A = t / c$ then find value of c. $(t \leq 7.5s)$



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16. Two blocks of masses M_1 and M_2 connected by a light spring rest on a horizontal plane . The coefficient of friction between the blocks and the surface is equal to μ . The minimum constant force that has to be applied in the horizontal direction to the block of mass M_1 in order to shift the other block is $\left(M_1 + \frac{M_2}{\alpha}\right)\mu g$, then α is :

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17. Two blocks A and B of mass 2 kg and 4 kg are placed one over the other as shown in Fig. (a) . A time varying horizontal force F = 2t is applied on the upper block . Here t is in second and F is in newton . A graph drawn between accelerations of A and B on y-axis and time on x-axis is shown in

Fig. (b) . Then $\tan\theta = \frac{1}{K}$, K = ...

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18. A block A of mass 2 kg rests on another block B of mass 8 kg which rests on a horizontal floor . The coefficient of friction between A and B is 0.2 while that between B and floor is 0.5 . When horizontal force F = 25 N is applied on the block B , the force of friction between A and B is (in N) .

View Text Solution

19. Coefficient of friction between two blocks shown in Fig. 7.203 is $\mu = 0.4$. The blocks are given velocities of 2 m/s and 8 m/s in the directions shown in figure . The time when relative motion between them will stop is (in sec) . :

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

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Comprehension Type

1.

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

A. 2N

B. 0

C. 8 N

D. 10 N

Answer: A

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2.

The acceleration of 10 kg block when F = 30 N ,

A. $2m/s^2$

B. $3m/s^2$

C. $1m/s^2$

D. none of these

Answer: A

View Text Solution

3.

Find the minimum value of F for which 5 kg being to slide if the coefficient of friction between the blocks is changed to 0.5 :

A. 10 N

B. 30 N

C. 45 N

D. no value exist

Answer: C

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4. Two bodies A and B of masses 10 kg and 5 kg are placed very slightly separated as shown in figure . The coefficient of friction between the floor and the blocks are $\mu_s = \mu_k = 0.4$. Block A is pushed by an external force F . The value of F can be changed . When the welding between block A and ground breaks , block A will start pressing block B and when welding of B also breaks , block B will start pressing the vertical wall .

If F = 20 N , with how much force does block A presses the block B ?

A. 10 N

B. 20 N

C. 30 N

D. zero

Answer: D

View Text Solution

5. Two bodies A and B of masses 10 kg and 5 kg are placed very slightly separated as shown in figure . The coefficient of friction between the floor and the blocks are $\mu_s = \mu_k = 0.4$. Block A is pushed by an external force F . The value of F can be changed . When the welding between block A and ground breaks , block A will start pressing block B and when welding of B also breaks , block B will start pressing the vertical wall .

If F = 50 N , the friction force acting between block

B and ground will be :

A. 10 N

B. 20 N

C. 30 N

D. zero

Answer: A

View Text Solution

6. Two bodies A and B of masses 10 kg and 5 kg are placed very slightly separated as shown in figure . The coefficient of friction between the floor and the blocks are $\mu_s = \mu_k = 0.4$. Block A is pushed by an external force F . The value of F can be changed . When the welding between block A and ground breaks , block A will start pressing block B and when welding of B also breaks , block B will start pressing the vertical wall .

The force of friction acting on B varies with the applied force F according to curve :

A.

B.

C.

D.

Answer: B

View Text Solution

7. A block of mass M slides on a frictionless surface with an initial speed of v_0 . On top of block is small box of mass m . The coefficient of friction between box and block are μ_s and μ_k . The sliding block encounters an ideal spring with force constant k .

Answer the following questions :

Assuming no relative motion between box and block what is the maximum possible acceleration of block and box at the instant of maximum compression ?

A. $\mu_s g$

B. $\frac{\mu_s \mathrm{Mg}}{m}$

C. $\frac{\mu_s (M+m) g}{m}$

D. $\frac{\mu_s \mathrm{mg}}{M}$

Answer: A

View Text Solution

8. A block of mass M slides on a frictionless surface with an initial speed of v_0 . On top of block is small box of mass m . The coefficient of friction between box and block are μ_s and μ_k . The sliding block encounters an ideal spring with force constant k . Answer the following questions :

What is maximum value of k for which it remains true that box does not slide ?

A. $\left(\frac{\mu_s g}{v_0}\right)^2 \frac{M}{(M+m)}$

B. $\left(\frac{\mu_s g}{v_0}\right)^2 (M+m)$

C. $\left(\frac{\mu_s g}{2v_0}\right)^2 \frac{(M+m)^2}{M}$

D. none of these

Answer: B

View Text Solution

9. A block of mass M slides on a frictionless surface with an initial speed of v_0 . On top of block is small box of mass m . The coefficient of friction between box and block are μ_s and μ_k . The sliding block encounters an ideal spring with force constant k .

Answer the following questions :

Suppose the value of k is just slightly greater than the value found in Q.2 , so that the box begins to slide just as the spring reaches maximum compression . The accelerations of box and block are respectively :

A. $a_{\text{Box}} = \mu_k g,\ a_{\text{Block}} = \dfrac{m(\mu_s - \mu_k) + \mu_s M}{M} g$

B. $a_{\text{Box}} = (\mu_s - \mu_k) g,\ a_{\text{Block}} = (\mu_s - \mu_k) \dfrac{mg}{M}$

C. $a_{\text{Box}} = \mu_k g,\ a_{\text{Block}} = (\mu_s + \mu_k) \dfrac{mg}{M}$

D. none of the above

Answer: A

View Text Solution

10. A frame of reference that is accelerated with respect to an inertial frame of reference is called a non-inertial frame of reference. A coordinate system fixed on a circular disc rotating about a fixed axis with a constant angular velocity ω is an example of non=inertial frame of reference. The relationship between the force $\overrightarrow{F}_{rot}$ experienced by a particle of mass m moving on the rotating disc and the force $\overrightarrow{F}_{\in}$ experienced by the particle in an inertial frame of reference is

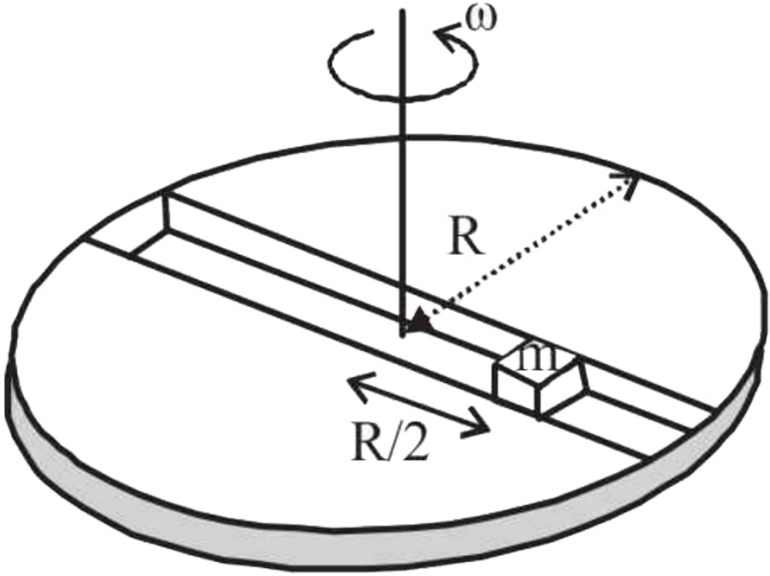
$$\vec{F}_{rot} = \vec{F}_{in} + 2m\left(\vec{v}_{rot} \times \vec{\omega}\right) + m\left(\vec{\omega} \times \vec{r}\right) \times \vec{\omega}$$

.

where $\vec{v}_{rot}$ is the velocity of the particle in the rotating frame of reference and $\vec{r}$ is the position vector of the particle with respect to the centre of the disc.

Now consider a smooth slot along a diameter fo a disc of radius R rotating counter-clockwise with a constant angular speed ω about its vertical axis through its center. We assign a coordinate system with the origin at the center of the disc, the x-axis along the slot, the y-axis perpendicular to the slot and the z-axis along the rotation axis $\left(\vec{\omega} = \omega\hat{k}\right)$.

A small block of mass m is gently placed in the slot at $\vec{r}(R/2)\hat{i}$ at $t = 0$ and is constrained to move only along the slot.



The distance r of the block at time is

A. $\frac{R}{2}\cos 2\omega t$

B. $\frac{R}{2}\cos\omega t$

C. $\frac{R}{4}\left(e^{\omega t}+e^{-\omega t}\right)$

D. $\frac{R}{4}\left(e^{2\omega t}+e^{-2\omega t}\right)$

Answer: C

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11. A frame of reference that is accelerated with respect to an inertial frame of reference is called a non-inertial frame of reference. A coordinate system fixed on a circular disc rotating about a fixed axis with a constant angular velocity ω is an example of non=inertial frame of reference. The relationship between the force $\overrightarrow{F}_{rot}$ experienced by a particle of mass m moving on the rotating disc and the force $\overrightarrow{F}_{\in}$ experienced by the particle in an inertial frame of reference is

$$\overrightarrow{F}_{rot} = \overrightarrow{F}_{in} + 2m\left(\overrightarrow{v}_{rot} \times \overrightarrow{\omega}\right) + m\left(\overrightarrow{\omega} \times \overrightarrow{r}\right) \times \overrightarrow{\omega}$$

.

where $\overrightarrow{v}_{rot}$ is the velocity of the particle in the rotating frame of reference and $\overrightarrow{r}$ is the position vector of the particle with respect to the centre of the disc.

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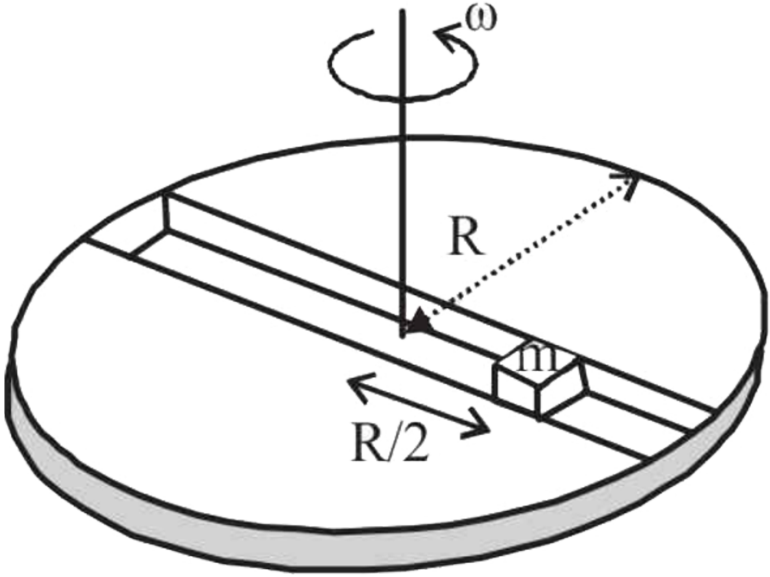

The net reaction of the disc on the block is

A. $m\omega^2 R\sin\omega t\,\hat{j} - mg\hat{k}$

B. $\frac{1}{2}m\omega^2 R\left(e^{\omega t} - e^{-\omega t}\right)\hat{j} + mg\hat{k}$

C. $\frac{1}{2}m\omega^2 R\left(e^{2\omega t} - e^{-2\omega t}\right)\hat{j} + mg\hat{k}$

D. $-m\omega^2 R\cos\omega t\,\hat{j} - mg\hat{k}$

Answer: B

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