PHYSICS

BOOKS - CENGAGE PHYSICS (HINGLISH)

WORK, POWER & ENERGY

Illustration

1. A constant force $\vec{F} = \left(3\hat{i} + 2\hat{j} + 2\hat{k}\right)$ N acts on a particle displacing it from a position $\vec{r_1} = \left(-\hat{i} + \hat{j} - 2\hat{k}\right)m$ to a new position $\vec{r}_2 = \left(\hat{i} - \hat{j} + 3\hat{k}\right)m$. Find the work done by the force.

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2. Three constant forces $\vec{F}_1 = 2\hat{i} - 3\hat{j} + 2\hat{k}$, $\vec{F}_2 = \hat{i} + \hat{j} - \hat{k}$, and $\vec{F}_3 = 3\hat{i} + \hat{j} - 2\hat{k}$ in newtons displace a particle from $(1, -1, 2)$ to

$(-1, -1, 3)$ and then to $(2, 2, 0)$ (displacement being measured in meters). Find the total work done by the forces.

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3. a block of weight 100 N is slowly slid up on a smooth incline of inclination 37^0 by as person. Calculate the work done by the person in moving the block through a distance of 2.0 m, if the drivin force is a. parallel to the inclne and b. in the horizontla direction.

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4. A force $\overrightarrow{F} = 6x\hat{i} + 2y\hat{j}$ displaces a body from $\overrightarrow{r}_1 = 3\hat{i} + 8\hat{j}$ to $\overrightarrow{r}_2 = 5\hat{i} - 4\hat{j}$. Find the work done by the force.

A. $91J$

B. $0J$

C. $182J$

D. $45.5J$

Answer: B

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5. A force $F = a + bx$ acts on a particle in x-direction, where a and b are constants. Find the work done by this force during the displacement from x_1 to x_2.

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6. The displacement of a particle of mass $1kg$ on a horizontal smooth surface is a function of time given by $x = \frac{1}{3}t^3$. Find out the work done by the external agent for the first one second.

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7. A uniform chain of mass m & length L is kept on a smooth horizontal table such that $\frac{L}{n}$portion of the chaing hangs from the table. The work dione required to slowly bringsthe chain completely on the table is

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8. Consider a variable force $F = (3x + 5)N$ acting on a body and if it is displaced from $x = 2m$ to $x = 4m$, calculate the work done by this force.

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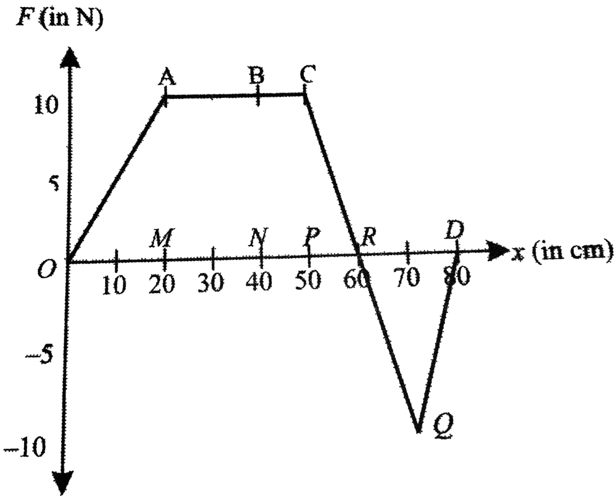
9. From figure, find the work done at the end of displacements: (a) 20cm, (b) 40cm, and (c) 80cm.



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10. A block of mass $5kg$ is being raised vertically upwards by the help of a string attached to it. It rises with an acceleration of $2ms^{-2}$. Find the work done by the tension in the string if the block rises by $2.5m$. Also find the work done by the gravity and the net work done.

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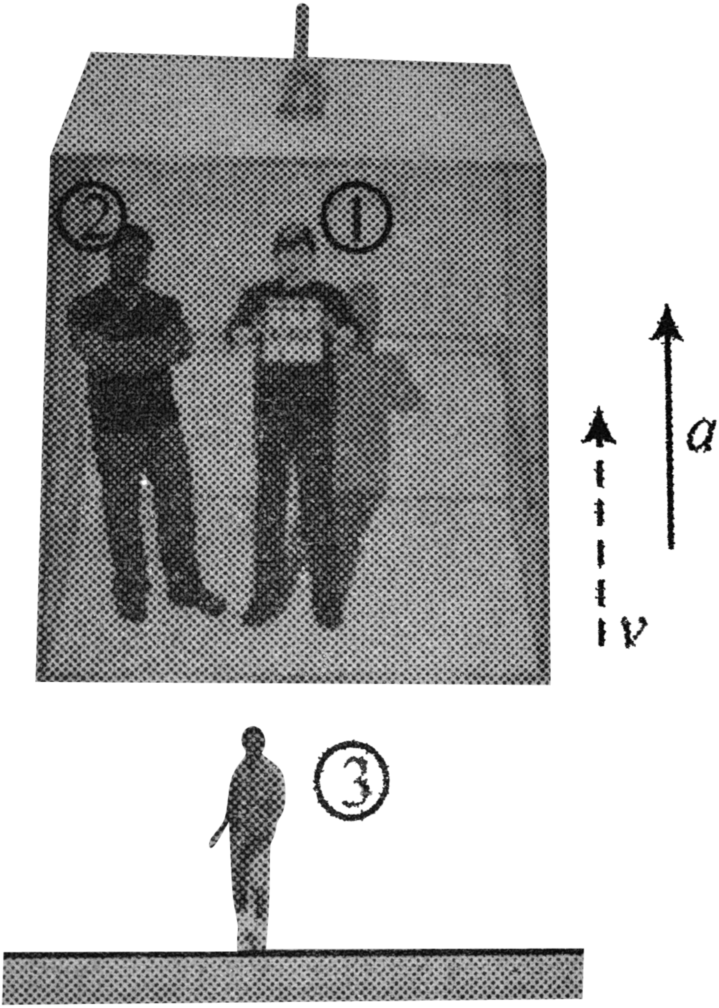
11. A man(1) of mass m strands on an elevator moving with upward acceleration a. A man(2) is standing on the elevator. Elevator starts with initial velocity v_0 at time $t = 0$. Consider time interval t from beginning.

a. What is the work done by normal contact force and gravity on the man(1) as observe by man(2) standing on the elevator and man(3) standing on ground?

b. What is the net work done by normal contact force between man(1) and elevator?



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12. A force of $10N$ is acting on a block of $20kg$ on horizontal surface with coefficient of friction $\mu = 0.2$. Calculate the work done by the force.

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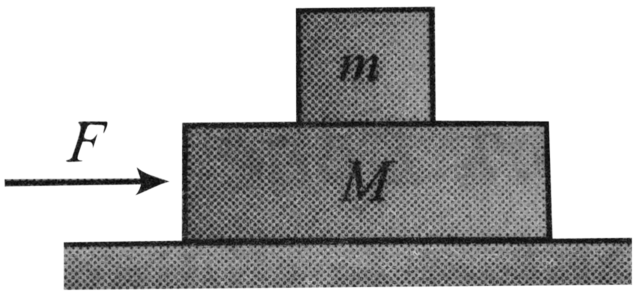
13. A block of mass m is placed on the block of mass M as shown in figure. The horizontal force $\vec{F}$ acts on M during time interval t. If the horizontal surface is smooth, assuming no relative sliding between the blocks, find the

a. work done by friction on the blocks

b. work done by $\vec{F}$ on the lower block



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14. A block of mass 2.0 kg is pushed down an inclined plane of inclination 37^0 with a force of 20N acting parallel to the incline. It is found that the block moves on the incline with an acceleration of $10\frac{m}{s^2}$. If the block started from rest, find the work done a. by the applied force in the first second b. by the weight of the block in the first second and c. by the frictional force acting on the block in the first second. Take $g = 10\frac{m}{s^2}$.

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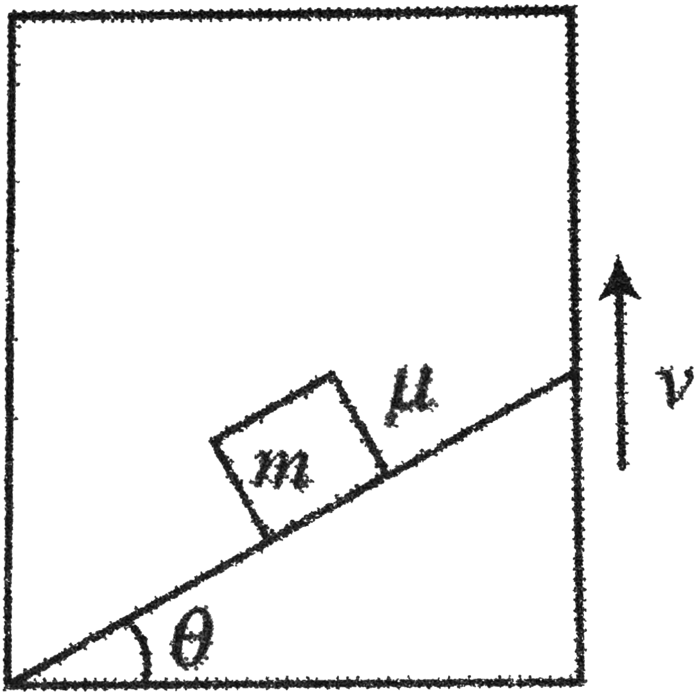
15. An inclined plane is moving up with constant velocity v. A block kept on incline is at rest. Calculate the work done by gravity, friction force, and normal reaciton on block in time interval of t.



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16. A block of mass m is kept over another block of mass M and the system rests on a horizontal surface. A constant horizontal force F acting on the lower block produces an acceleration $\frac{F}{2(m+M)}$ in the sytem. The two blocks always move together. Consider displacement d of the system.

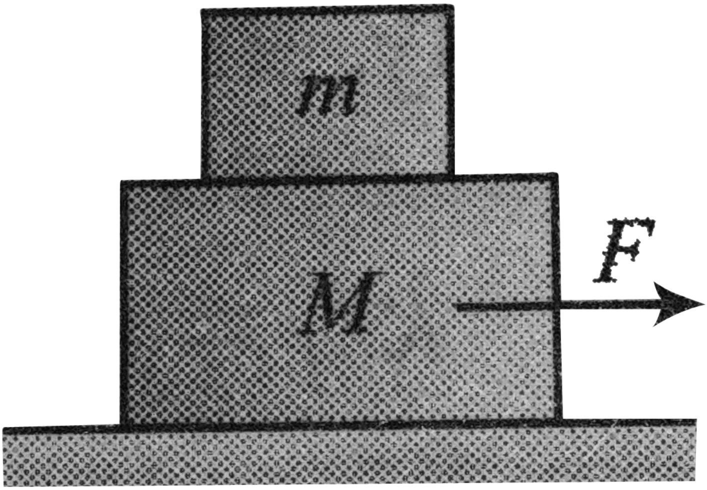
a. Find the work done by friction on bigger block.

b. Find the coefficient of kinetic friction between the bigger block and the horizontal surface.

c. Find the frictional acting on the smaller block.

d. Find the work done by the force of friction on the smaller block by the bigger block.

e. Find the work done by static friction on bigger block.



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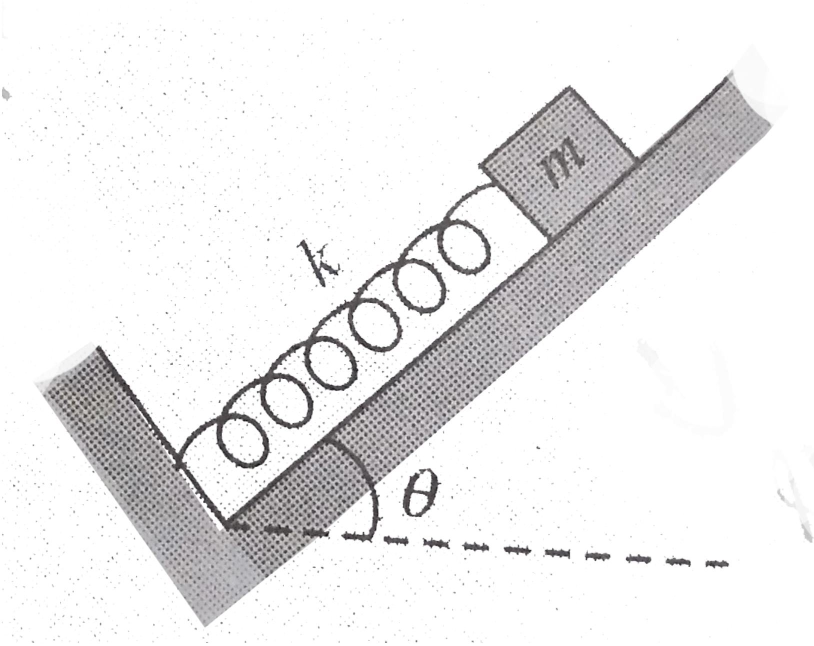
17. A block of mass m welded with a light spring of stiffness k is in equilibrium on an smooth inclined plane with angle of inclination θ. If a variable external force is applied slowly till the spring comes to its relaxed position, find the work done by spring force.



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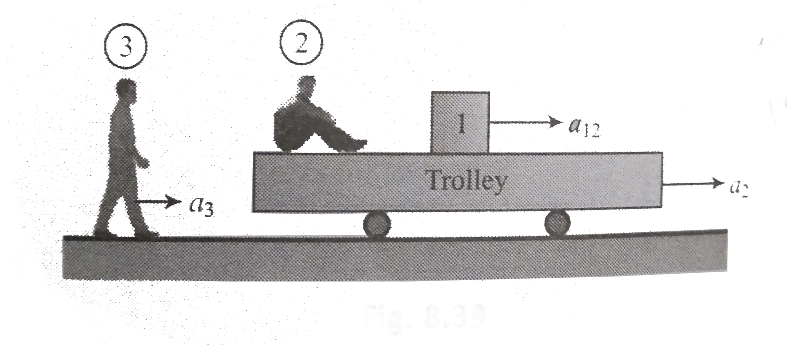
18. A block of mass m_1 moves with an acceleration a_{12} relative to a trolley as shown in figure. The block is being observed by two observers (2) and (3). The observer (2) is at rest with respect to trolley which is moving with acceleration a_2 while the observer(3) is moving on ground with acceleration a_3. What is the work done by the pseudo force as observed by the observers (2) and (3) on the block during time t? Assume zero intial velocities of the bodies and observers.



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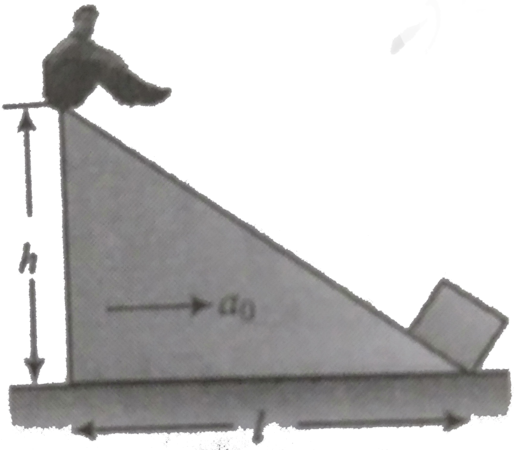
19. A smooth block of mass m moves up from bottom to top of a wedge which is moving with an acceleration a_0. Find the work done by the

pseudo force measured by the person sitting at the edge of the wedge.



A. $\dfrac{ma_0l}{2}$

B. $\dfrac{3ma_0l}{2}$

C. 0

D. ma_0l

Answer: D

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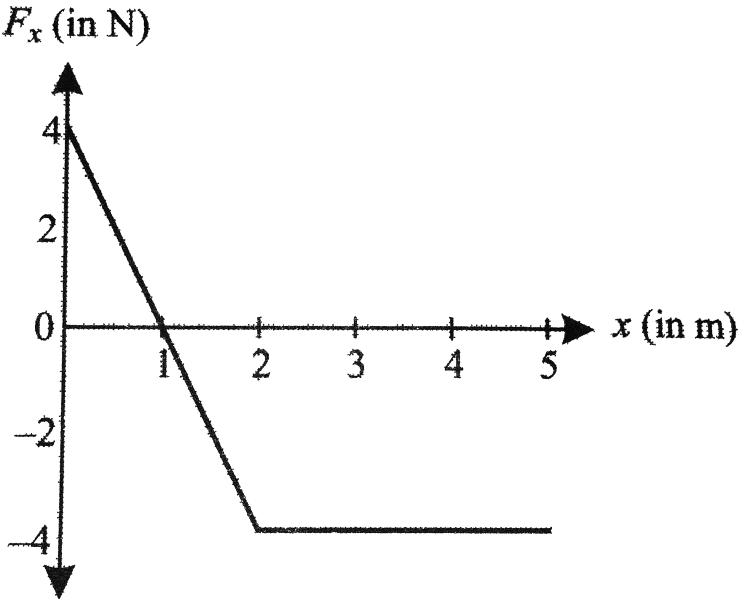
20. The only force acting on a $2.0 - kg$ body as it moves along the x-axis varies as shown in figure. The velocity of the body at $x = 0$ is $4.0ms^{-1}$.



a. What is the kinetic energy of the body at $x = 3.0m$?

b. At what value of x will the body have a kinetic energy of $8.0J$?

c. What is the maximum kinetic energy attained by the body between $x = 0$ and $x = 5.0m$?

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21. A bullet leaving the muzzle of a rifle barrel with a velocity v penetrates a plank and loses one-fifth of its velocity. It then strikes second plank, which it just penetrates through. Find the ratio of the thickness of the planks, supposing the average resistance to the penetration is same in both the cases.

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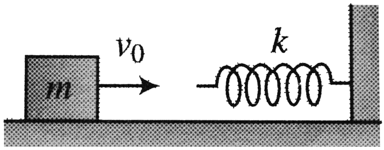
22. A block of mass m is moving with an initial velocity v_0 towards a stationary spring of stiffness k attached to the wall as shown in figure



a. Find the maximum compression in the spring.

b. Is the work done by the spring negative or positive?

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23. In the previous illustration. Consider the situation when the string is completely compressed. Then it begins to relax and will come to its original length.

a. What is the work done by the spring during the period?

b. Is the work done by the spring positive or negative?

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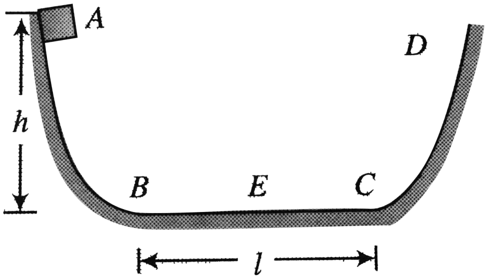
24. A particle slides along a track with elevated ends and a flat central part as shown in figure. The flat part has a length $l = 3m$. The curved portions of the track are frictionless. For the flat part, the coefficient of kinetic friction is $\mu_k = 0.2$. The particle is released at point A which is at height $h = 1.5m$ above the flat part of the track. Where does the particle finally come to rest?



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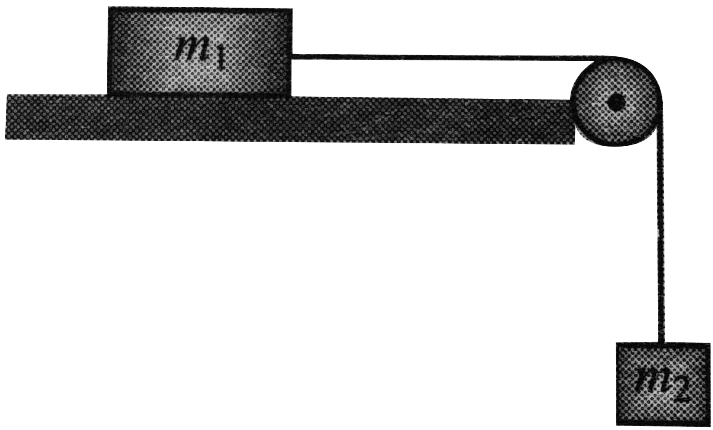
25. Two blocks are connected by a string, as shown in figure. They are released from rest. Show that after they have moved a distance L, their common speed is given by $v = \sqrt{2(m_2 - \mu m_1)gL/(m_1 + m_2)}$, in which μ is the coefficient of kinetic friction between the upper block and the surface. Assume that the pulley is massless and frictionless.



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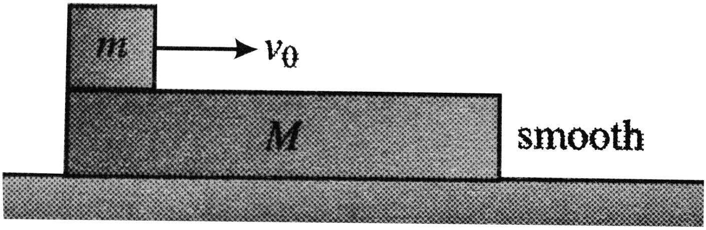
26. A plank of mass M and length L is placed at rest on a smooth horizontal surface. A small block of mass m is projected with a velocity v_0 from the left end of it as shown in figure. The coefficient of friction between the block and the plank is m, and its value is such that the block becomes stationary with respect to the plank before it reaches the other end.



a. Find the time and common velocity when relative sliding between the block and the plank stops.

b. Find the work done by the friction force on the block during the period it slides on the plank. Is the work positive or negative?

c. Calculate the work done on the plank during the same period. Is the work positive or negative?

d. Also, determine the net work done by friction, Is it positive or negative?

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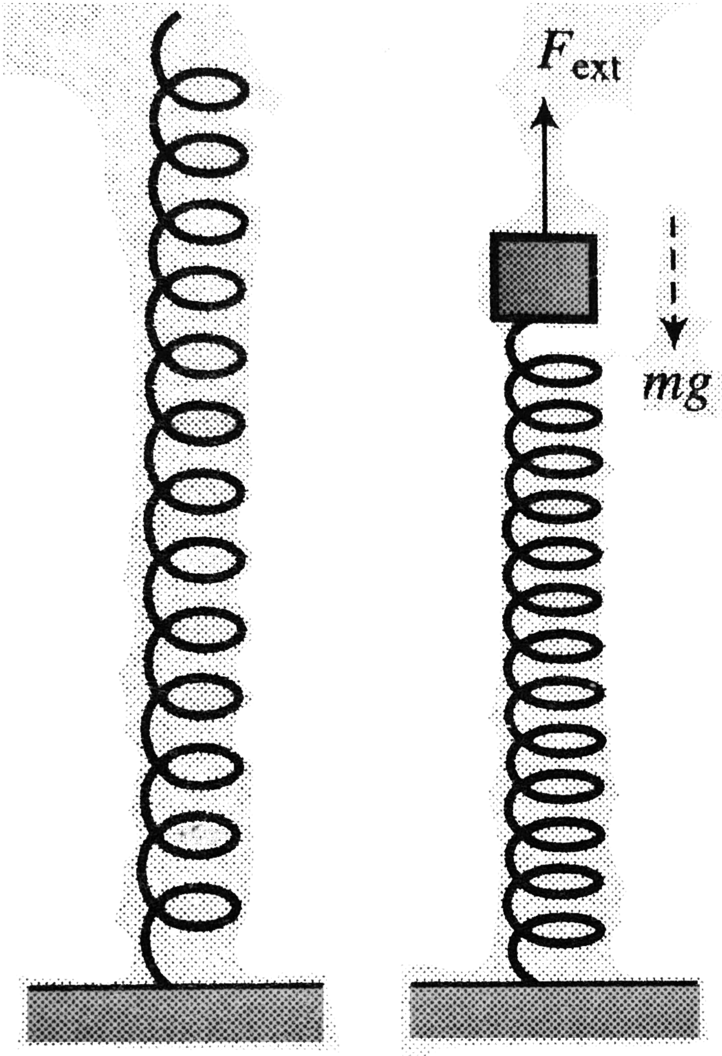
27. A block of mass m is slowly lowered from a point where it just touches a vertical fixed spring of stiffness k, till it remains stationary after the applied force is withdrawn. Find the work done by the external agent(a) in compressing the spring by a distance x and (b) bringing the block to its stable equilibrium position.



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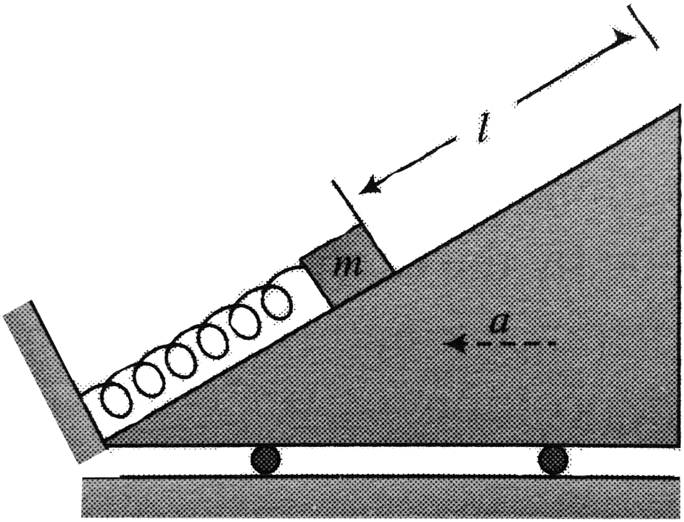
28. A block of mass m is welded with a light spring of stiffness k. The spring is initially relaxed. When the wedge fitted moves with an acceleration a, as shown in figure. 8.60, the block slides through a maximum distance l relative to the wedge. If the coefficient of kinetic friction between the block and the wedges is μ, find the maximum deformation l of the spirng by using work-energy theorem.



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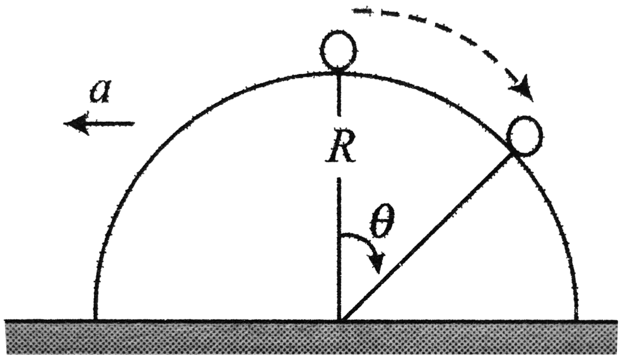
29. A small ball is placed at the top of a smooth hemispherical wedge of radius R. If the wedge is accelerated with an acceleration a, find the velocity of the ball relative to wedge as a function of θ.



A. $\sqrt{2R[g(1-\sin\theta)+aR\cos\theta]}$

B. $\sqrt{2R[g(1+\cos\theta)-aR\sin\theta]}$

C. $\sqrt{2R[g(1-\cos\theta)+aR\sin\theta]}$

D. $\sqrt{2R[g(1+\sin\theta)-aR\cos\theta]}$

Answer: C

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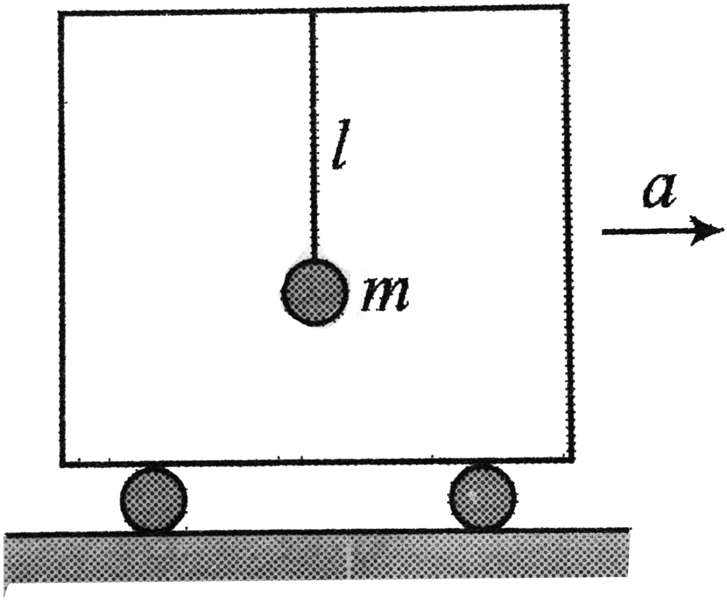
30. A pendulum of mass m and length l is suspended from the ceiling of a trolley which has a constant acceleration a in the maximum deflection θ

of the pendulum from the vertical.



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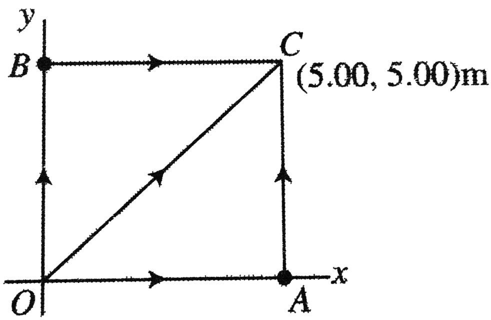
31. A $4.00 - kg$ particle moves from the origin to position C, having coordinate $x = 5.00m$ and $y = 5m$. One force on the particle is the gravitational force acting in the negative y direction. Using equation $W = F\Delta r \cos\theta = \overrightarrow{F}.\Delta\overrightarrow{r}$, calculate the work done by the gravitional force on the particle as it goes from O to C along (a) OAC, (b) OBC, and (c)

OC. Your results should all be identical. Why?



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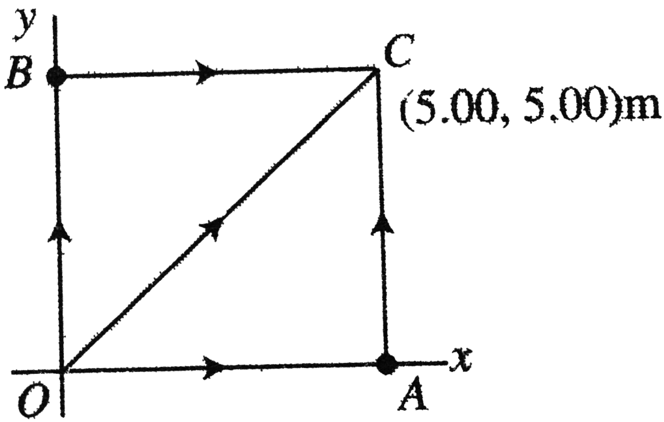
32. A force acting on a particle moving in the x-y plane is given by $\overrightarrow{F}=\left(2y\hat{i}+x^2\hat{j}\right)N$, where x and y are in meters. The particle moves from the origin to a final position having coordinates $x=5.00m$ as shown in figure. Calculate the work done by $\overrightarrow{F}$ on the particle as it moves along (a) OAC, (b) OBC, and (c) OC. (d) Is $\vec{F}$ conservative or non-conservative? Explain.



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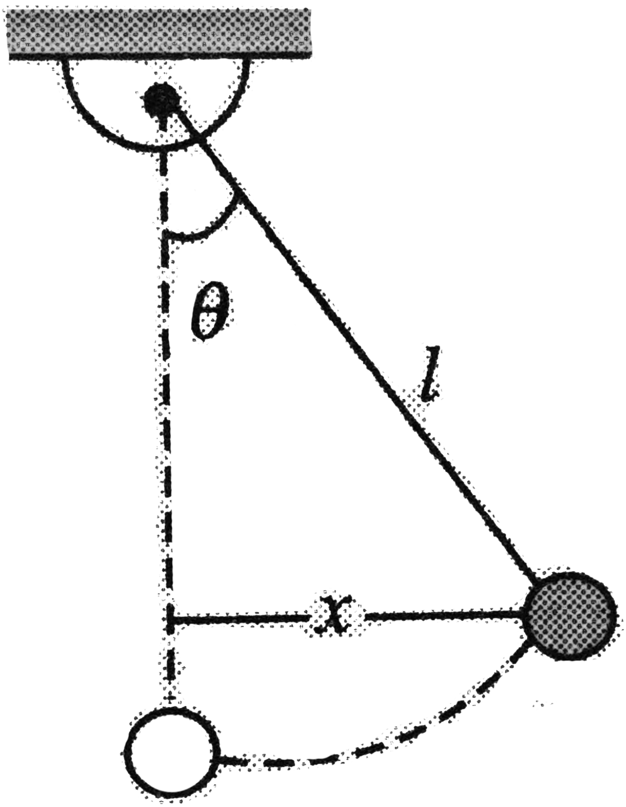
33. A pendulum initially is at rest in vertical position. The bob is pulled slowly towards right. Find the change in gravitational potential energy of the pendulum bob of mass m as the function of x.



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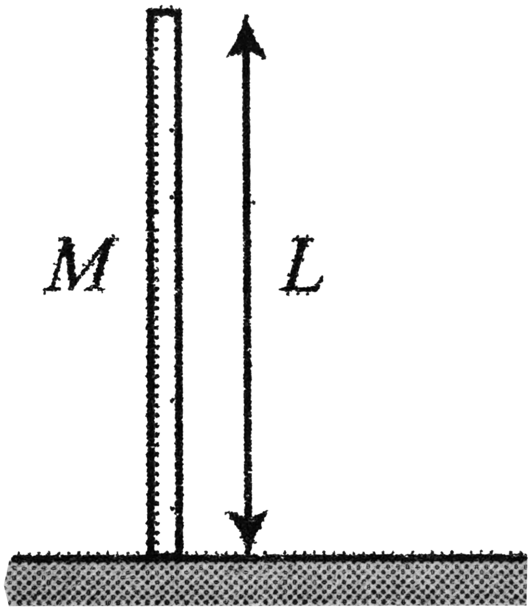
34. A uniform rod of mass M and length L is held vertically upright on a horizontal surface as shown in figure. Assuming zero potential energy at the base of the rod, determine the potential energy of the rod.



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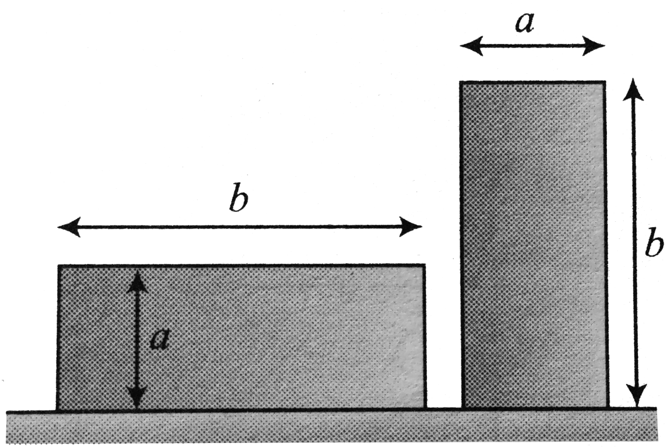
35. A plate of mass m, length b, and breadth a is initially lying on a horizontal floor with length parallel to the floor and breath perpendicular to the floor. Find the work done to erect it on its breadth.



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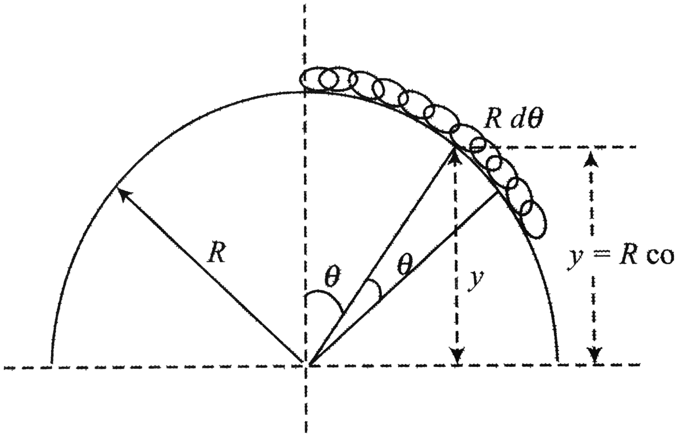
36. A chain of length l and mass m lies of the surface of a smooth hemisphere of radius $R > l$ with one end tied to the top of the hemisphere. Taking base of the hemisphere as reference line, find the gravitational potential energy of the chain.



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37. A conservative force held function is given by $F = k/r^2$, where k is a constant.

a. Determine the potential energy funciton $U(r)$ assuming zero potential energy at $r = r_0$.

b. Also, determine the potential energy at $r = \infty$.

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38. The potential energy of configuration changes in x and y directions as $U = kxy$, where k is a positive constant. Find the force acting on the particle of the system as the function of x and y.

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39. The potential energy of a particle in a certain field has the form $U = (a/r^2) - (b/r)$, where a and b are positive constants and r is the distance from the centre of the field. Find the value of r_0 corresponding to the equilibrium position of the particle, examine whether this position is stable.

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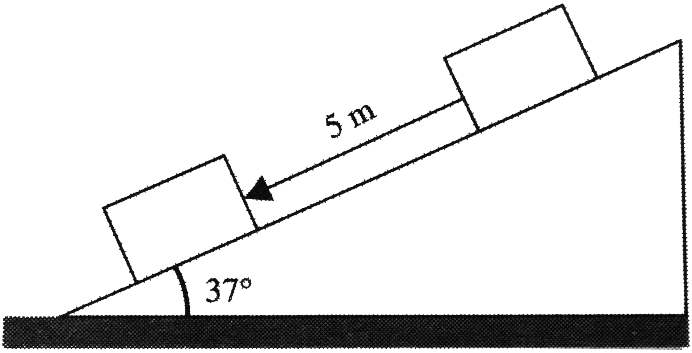
40. A block is placed on the top of a plane inclined at 37° with horizontal. The length of the plane is $5m$. The block slides down the plane and reaches the bottom.



a. Find the speed of the block at the bottom if the inclined plane is smooth.

b. Find the speed of the block at the bottom if the coefficient of friction is 0.25.

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41. A smooth block of mass m is released from rest from a height h. It slides and compresses the spring of stiffness k. Find the maximum compression of the spring .

Taking block spring a system. Now external force is doing work on system and no non-conservative force is present. The mechanincal energy should be conserved.

$\Delta K + \Delta U = 0$

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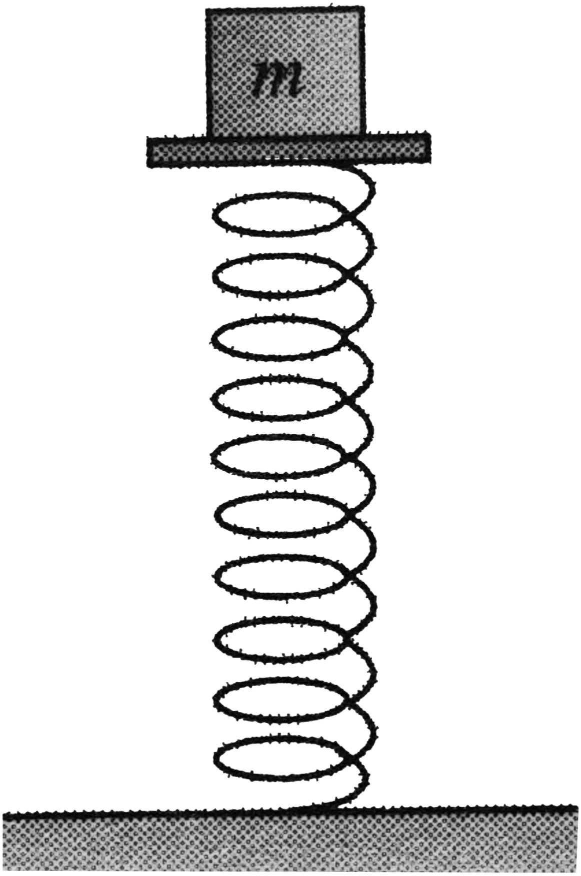
42. A block of mass m is suddenly released from the top of a spring of stiffness constant k.



a. Find the acceleration of block just after release.

b. What is the compression in the spring at equilibrium.

c. What is the maximum compression in the spring.

d. Find the acceleration of block at maximum compression in the spring.

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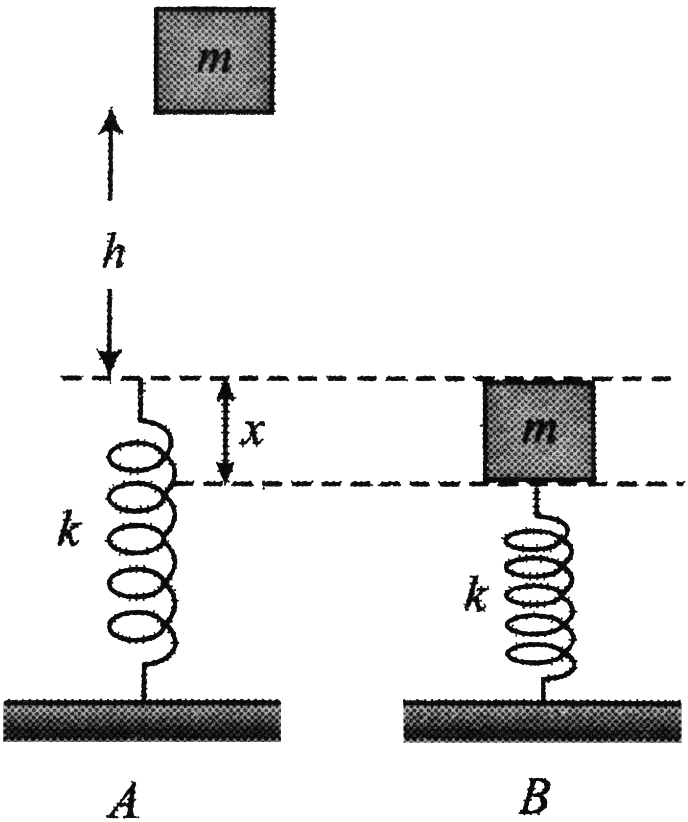
43. A block of mass m strikes a light pan fitted with a vertical spring after falling through a distance h. If the stiffness of the spring is k, find the maximum compression of the spring.



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44. Two blocks of masses m and M connected by a light spring of stiffness k, are kept on a smooth horizontal surface as shown in figure. What should be the initial compression of the spring so that the system will be about to break off the surface, after releasing the block m_1?

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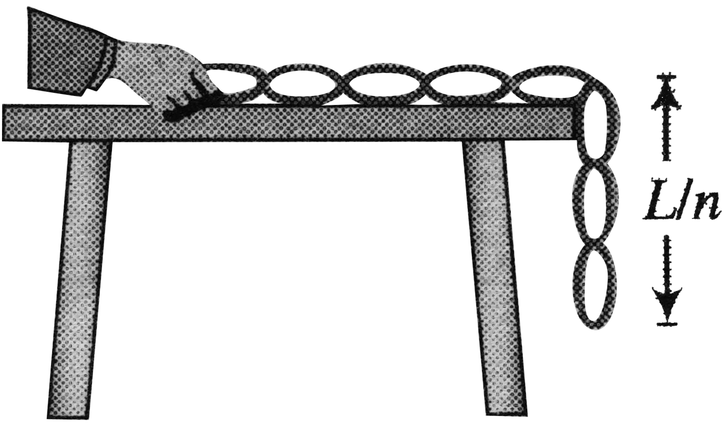
45. A chain of length L and mass M is held on a frictionless table with $(1/n)th$ of its length hanging over the edge. When the chain is released, find the velocity of chain while leaving the table.



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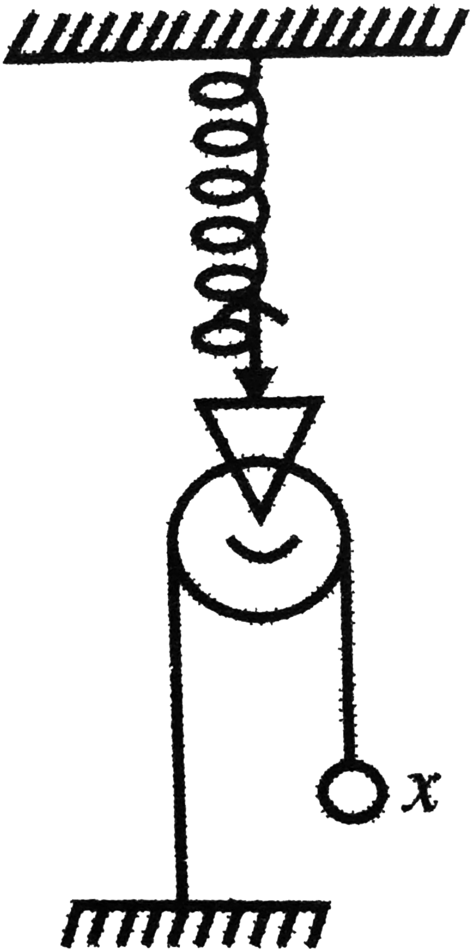
46. A body of mass m hangs by an inextensible string that passes over a smooth mass less pulley that is fitted with a light spring of stiffness k as shown in figure. If the body is released from rest and the spring is released, calculate the maximum elongation of the spring.



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47. A particle tide to the end of a string oscillates along a circular arc in a vertical plane. The other end of the string is fixed at the center of the circle. If the string has a breaking strength of twice the weight of the particles,

a. find the maximum distance that the particle can cover in one cycle of oscillation. The length of the string is $50cm$.

b. Find the tension in the extreme position.

c. Find the acceleration of the particle at bottom and extreme position.

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48. The bob of a pendulum at rest is given a sharp hit to impat a horizontal velocity $\sqrt{10gl}$ where l is the length of the pendulum. Find the tension in the string when a. the string is horizontal. B. The bob is at its highest point and c. the string makes an angle of 60^0 with teh upward vertical.

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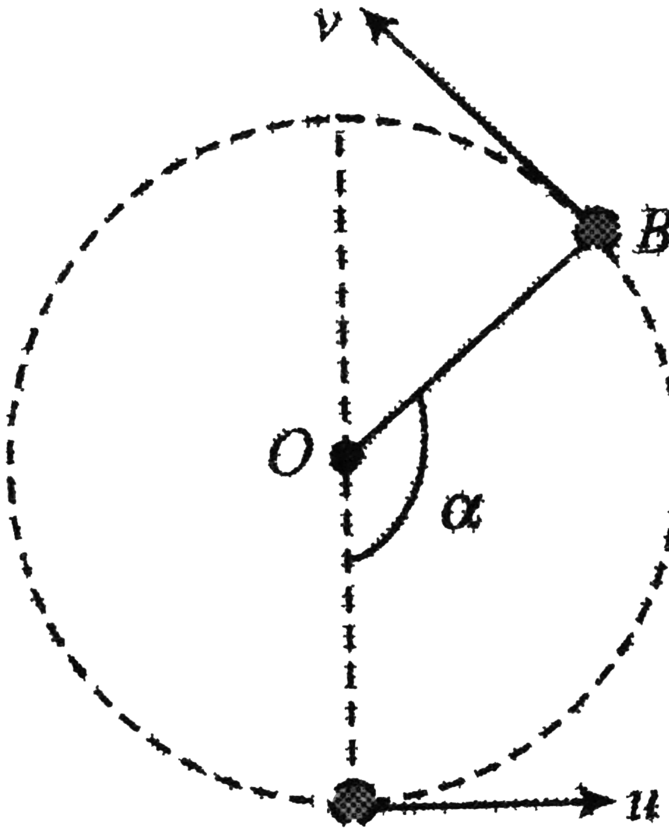
49. The bobo of a pendulum at rest is given a sharp hit to impart a horizontal velocity u where l is the length of the pendulum. Find the angle rotated by the string before it becomes slack.



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50. A particle of mass m is kept on a fixed , smooth sphere of radius R at a position, where the radius through the particle makes an angle of 30^0 with the vertical. The particle is releases from this position. a. What is the force exerted by the sphere on the particle just after the release? b. Find the distance travelled by the particle before it leaves contact with the sphere.

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51. A particle of mass m is kept on the top of a smooth sphere of radius R. It is given a sharp impulse which imparts it a horizontal speed v. a. find the normal force between the sphere and the particle just after the impulse. B. What should be the minimum value of v for which the particle does not slip on the sphere? c. Assuming the velocity v to be half the minimum calculated in part, d. find the angle made by the radius through the particle with the vertical when it leaves the sphere.

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52. A small ball attached with one end of an inextensible thread is moving in a vertical circle. Ratio of its maximum to minimum velocity is $2:1$. Calculate tension in thread and acceleration of the ball at the moment when velocity of the ball is directed vertically downward. $\left(g = 10ms^{-2}\right)$.

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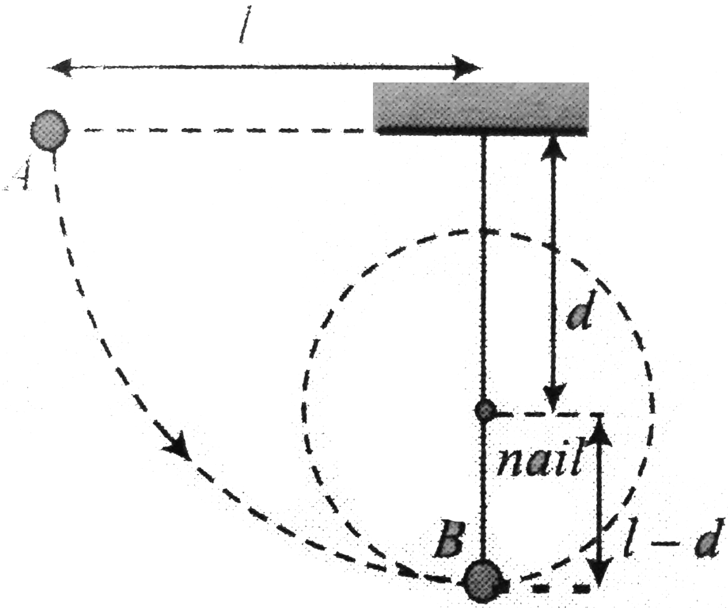
53. In the given system, when the ball of mass m is released, it will swing down the dotted arc.

a. How fast will it reach the lowest point in its swing? A nail is located at a distance d below the point of suspension.



b. Show that d must at $0.6l$, if the ball is to swing completely around a circle centered along the nail.

c. If $d = 0.6l$, find the change in tension in the string just after it touches the nail.

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54. A point mass m starts from rest and slides down the surface of a frictionless hemisphere of radius r as shown figure. Measure angle from the vertical and potential energy from the top. Find

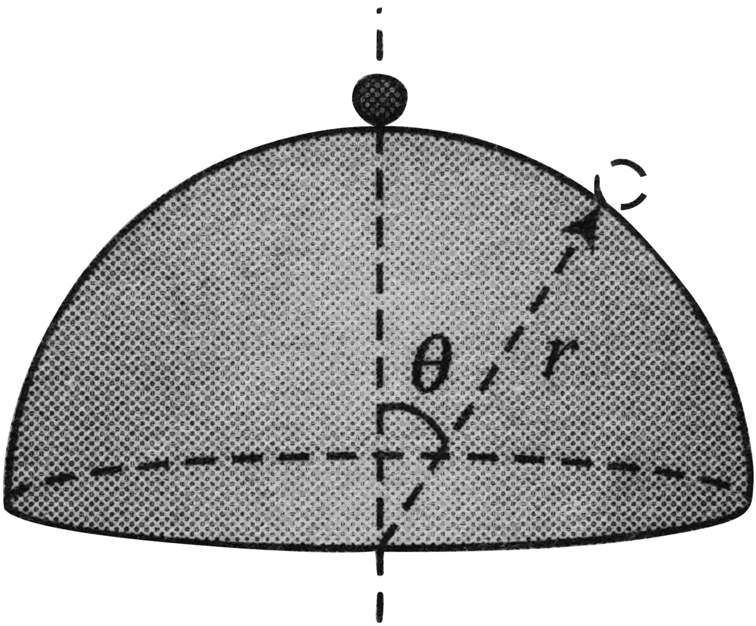
a. Find the changes in potential energy of the mass with angle

b. Find the kinetic energy as a function of angle

c. Find the radial and tangential acceleration as a function of angle

d. Find the angle at which the mass files off the hemisphere

e. If there is friction between the mass and hemisphere, does the mass fly off at a greater or lesser angle than in part (d) ?



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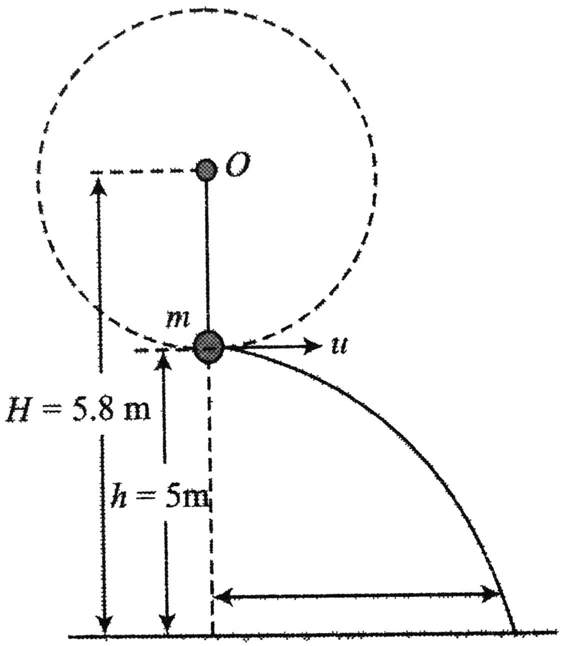
55. A small sphere tied to the string of length $0.8m$ is describing a vertical circle so that the maximum and minimum tensions in the string are in the ratio $3:1$. The fixed end of the string is at a height of $5.8m$ above ground.

(a) Find the velocity of the sphere at the lowest position.



(b) If the string suddenly breaks at the lowest position, when and where will the sphere hit the ground?

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56. A block is tied to one end of a light string of length 1 whose other end is fixed to a rigid support. The block is given a speed of $\sqrt{7gl/2}$ from the lowermost position. Find the height and speed at which the block leaves the circle. Also find the maximum height to which it rises finally.

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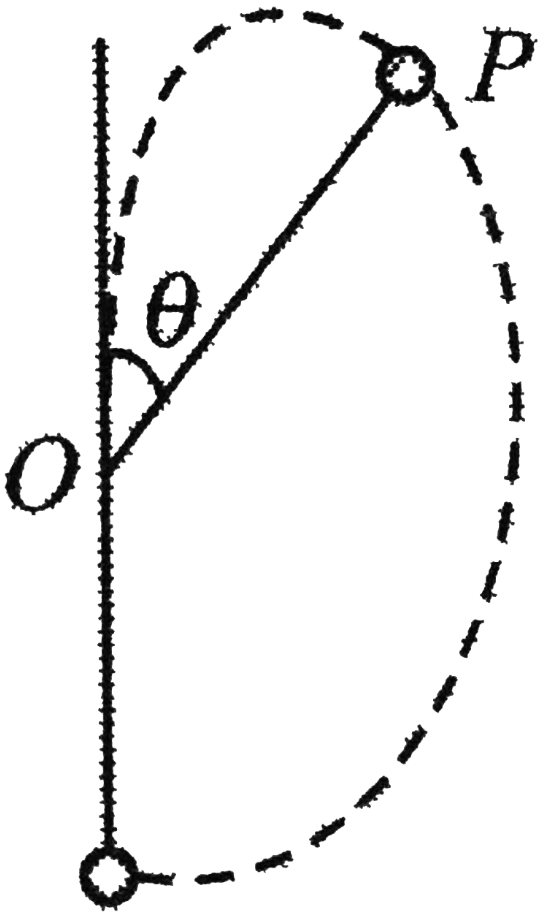
57. A point mass m connected to one end of inextensible string of length l and other end of string is fixed at peg. String is free to rotate in vertical plane. Find the minimum velocity given to the mass in horizontal direction so that it hits the peg in its subsequent motion.



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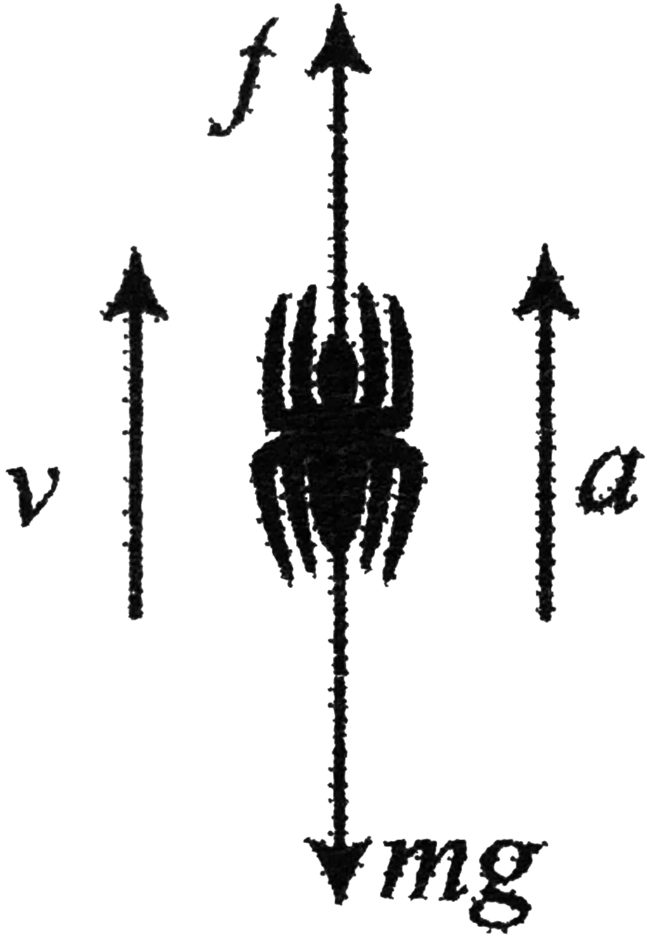
58. An insect of mass m moves up along a hanging stationary thread, with acceleration a. Find the power delivered by the gravity after a time t.



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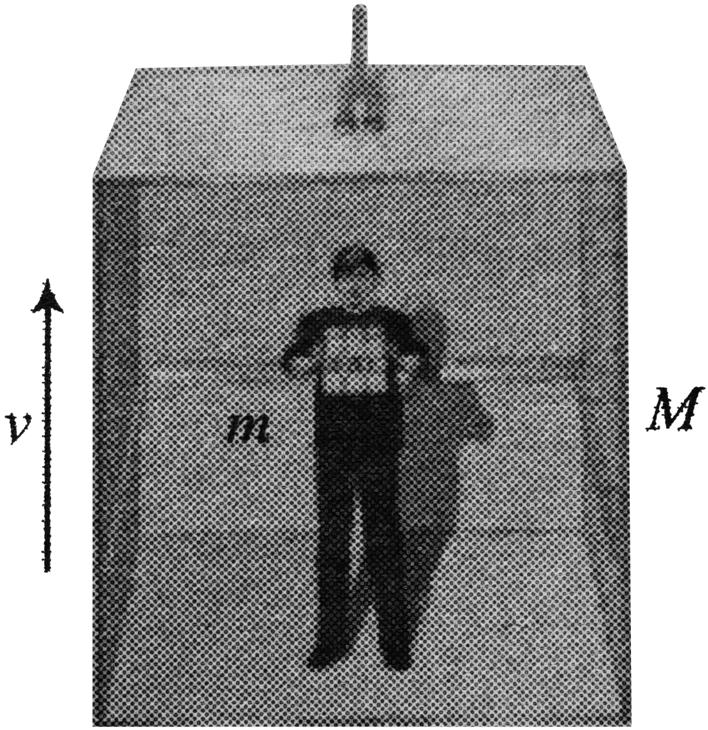
59. An elevator of mass M with a person of mass m is moving upward with uniform velocity $\vec{v}$. What is the power delivered by the elevator?



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60. A body is thrown with a velocity v_0 at an angle θ_0 with horizontal. Find the (a) instantaneous power delivered by gravity after a time t measured from the instant of projection and (b) average power delivered by gravity during the time t.

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61. A horizontal constant force F pulls a block of mass m placed on a horizontal surface. If the coefficient of kinetic friction between the block and ground is μ, find the power delivered by the external agent after a time agent after a time t measured from the beginning of action of the force.

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62. A small body of mass m is located on a horizontal plane at the point O. The body of mass m is located on a horizontal plane at the point O. The body acquires a horizontal velocity v_0. Find,

(a) the mean power developed by the friction force during the whole time of motion, if the friction coefficient $k = 0.27$, $m = 1.0kg$, and $v_0 = 1.5m/s$,

(b) the maximum instantaneous power developed by the friction force, if the friction coefficient varies as $k = \alpha x$, where α is a constant, and x is the distance from the point O.

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63. A car of mass $500kg$ moving with a speed $36kmh$ in a straight road unidirectionally doubles its speed in 1 min . Find the power delivered by the engine.

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64. An automobile of mass m accelerates, starting from rest, while the engine supplies constant power P, its position and instantaneous velocity changes w.r.t. time assuming the automobile starts from rest.

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65. A water pump, rated $400W$, has an efficiency of 75%. If it is employed to raise water through a height of $40m$, find the volume of water drawn in 10 min.

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66. A pump is required to lift $1000kg$ of water per minute from a well $20m$ deep and eject it at a rate of $20ms^{-1}$.

a. How much work is done in lifting water?

b. How much work is done in giving in KE?

c. What HP(horsepower) engine is required for the purpose of lifting water?

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Solved Examples

1. Figure. A smooth circular path of radius R on the horizontal plane which is quarter of a circle A block of mass m is taken from position A to B under the action of a constant force F. Calculate the work done by force F.

a. If it is always directed horizontally

b. If the block is pulled by a force F which is always tangential to the surface

c. Block is pulled with a constant force F which is always directed towards the point B

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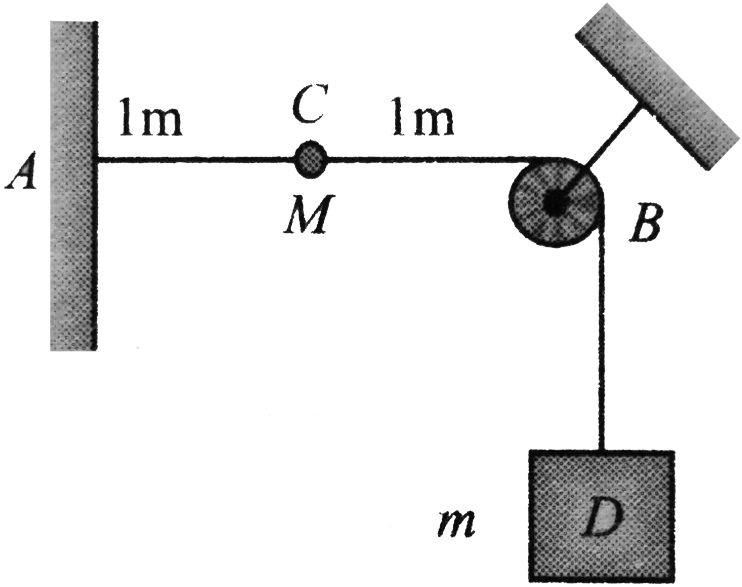
2. A string with one end fixed on a rigid wall, passing over a fixed frictionless pulley at a distance of $2m$ from the wall, has a point mass M of $2kg$ attached to it at a distance of $1m$ from the wall. A mass m of $0.5kg$ is attached to the free end. The system is initially held at rest so that the stirng is horizontal between wall and pulley and vertical beyond the pulley as shown in figure.



What will be the speed with which point mass M will hit the wall when the system is released? $\left(g = 10ms^{-2}\right)$

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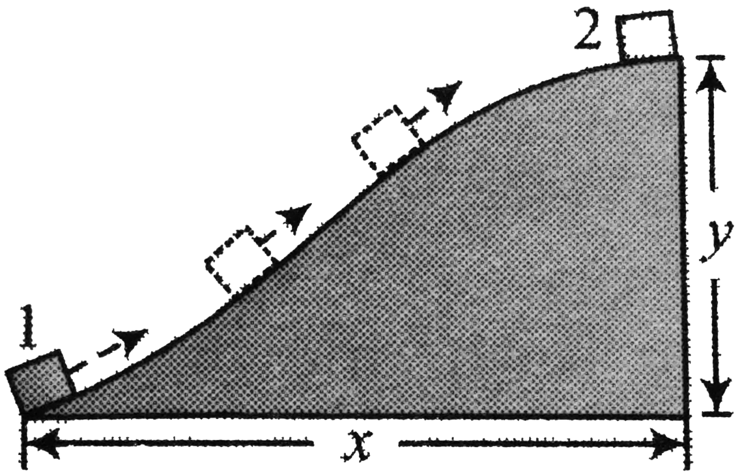
3. A block of mass m is slowly pulled along a curved surface from position 1 and 2. If the coefficient of kinetic friction between the block and surface is μ, find the work done by the applied force.



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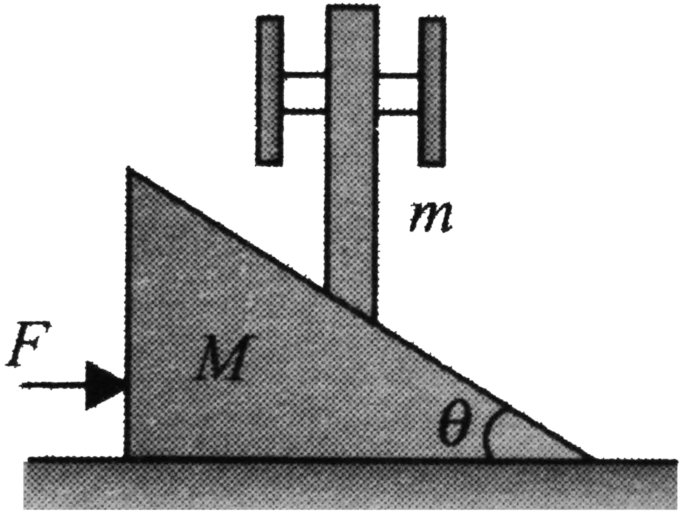
4. A vertical rod of mass m is kept on a wedge of mass M. If a horizontal force F acts on the wedge and the rod is constrained to move vertically, after releasing the rod-wedge system, (a) find their speeds when the wedge moves through a distance x. (b) What is the power delivered by the rod on the wedge aftre a time t measured from the instant of release?



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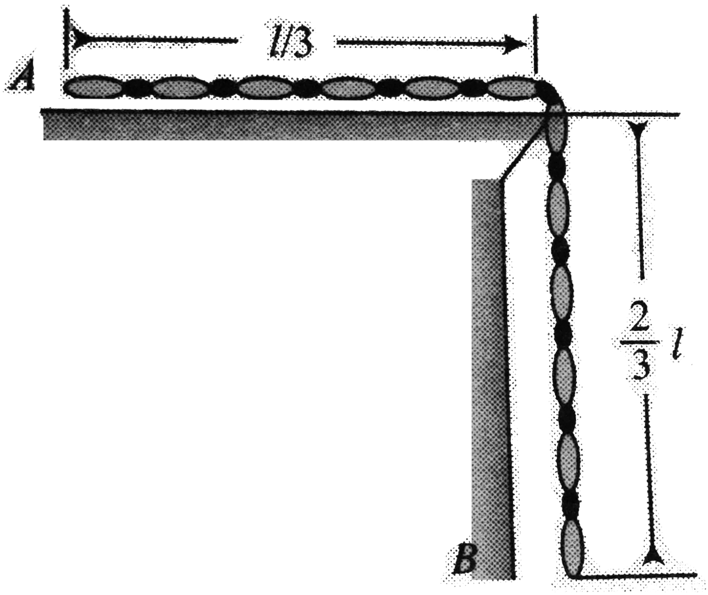
5. A uniform chain of mass m and length l is at the verge of sliding under the effect of gravity of the hanging part. Find the



a. coefficient of friction, between chain and table.

b. work done by friction and gravity till the chain leaves the table if the hanging part is pulled gently and released.

c. speed of the chain at the time of leaving the table in part (b) .

d. work done by the external force acting at the end A of the chain in slowly pulling the chain completely onto the table.

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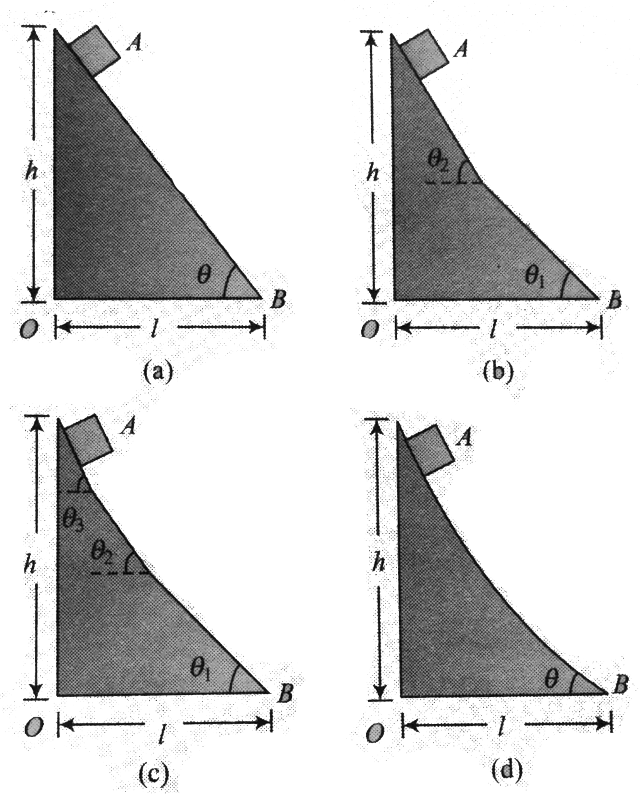
6. Block of mass m are released from rest and they slide down the inclined surface as shown in figure. Show that the work done by the frictional forces on the blocks are same in all the cases. Also calculate the speeds with which the blocks reach point B. The coefficient of friction for all the surface is μ_k.



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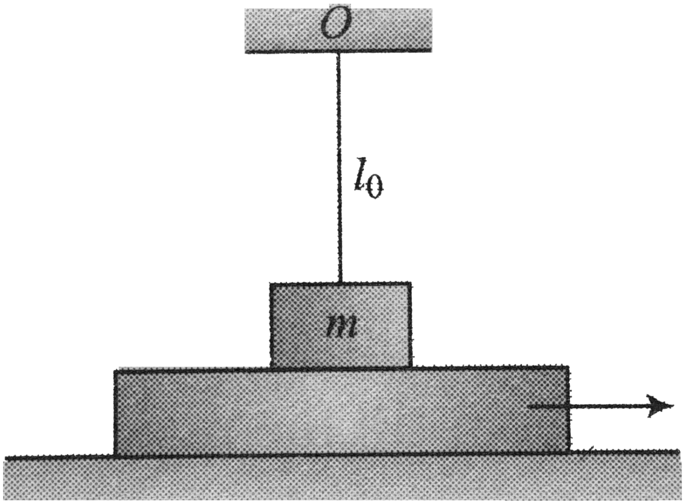
7. A horizontal plane supports a plank with a bar of mass m placed on it and attached by a light elastic non-deformed cord of length l_0, to a point O. The coefficient of friciton between the bar and the plank is equal to m. The plank is slowly shifted to the right until the bar starts sliding over it. It occurs at the moment when the cord derivates from the vertical by an angle θ.



Find the work that has been performed by the moment by the frictional force acting on the bar in the reference frame fixed to the plane.

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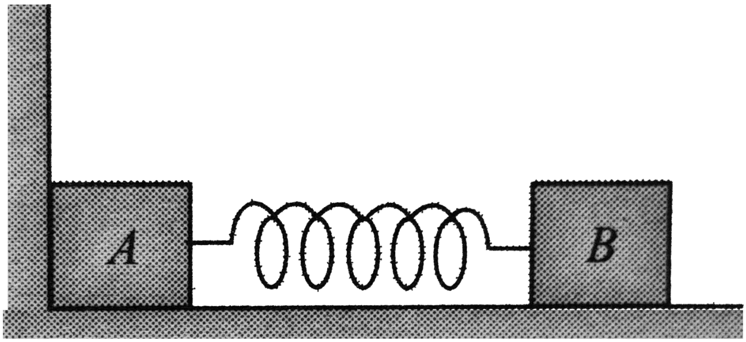
8. Two identical blocks A and B, each of mass $m = 2kg$ are connected to the ends of an ideal spring having force constant $K = 1000Nm^{-1}$. System of these blocks and spring is placed on a rough floor. Coefficient of friction between blocks and floor is $m = 0.5$. Block B is passed towards left so that spring gets compressed.



Calculate initial minimum compression x_0 of spring such that block A leaves contact with the wall when system is released.

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9. A small bar A resting on a smooth horizontal plane is attached by threads to a point P and by means of weightless pulley, to a weight B possessing the same mass as the bar itself. The bar is also attached to a point O by means of a light non-deformed spring of length $l_0 = 50cm$ and stiffness $k = mg/l_0$, where m is the mass of the bar. The thread PA having been burned, the bar starts moving to the right. Find its velocity at the moment when it is breaking off the plane.

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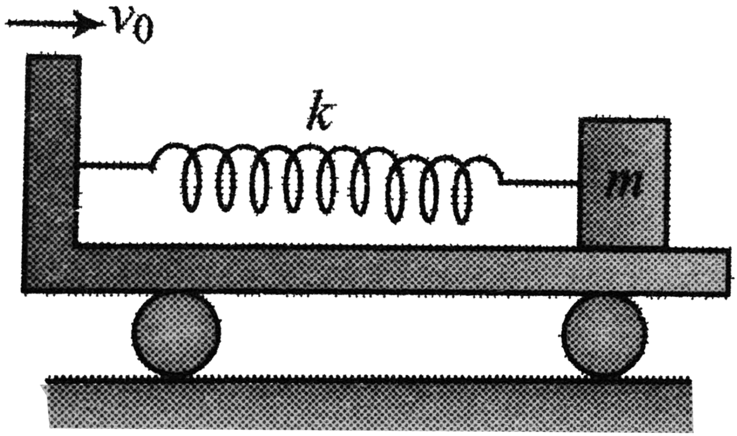
10. A block of mass m is connected rigidly with a smooth wedge (plank) by a light spring of stiffness k. If the wedge is moved with constant velocity v_0, find the work done by the external agent till the maximum compression of the spring.



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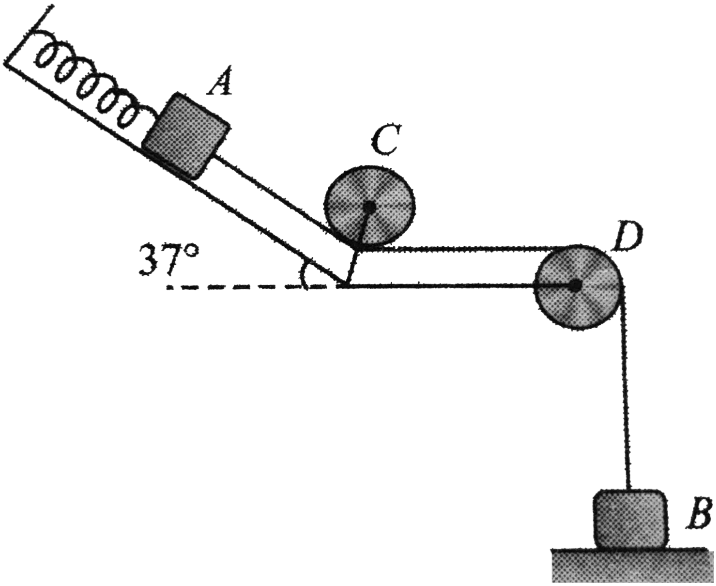
11. A block A of mass $m = 5kg$ is attached with a spring having force constant $K = 2000Nm^{-1}$. The other end of the spring is fixed to a rough plane, inclined at 37° with horizontal and having coefficient of friction $m = 0.25$. Block A is gently placed on the plane such that the spring has no tension. Then block A is released slowly. Calculate elongation of the spring when equilibrium is achieved. Now an inextensible thread is connected with block A and passes below pulley C and over pulley D, as shown in figure. Other end of the thread is connected with another block B of mass $3kg$. Block B is resting over a table and thread is loose. If the table collapse suddenly and B falls freely through $80/9cm$, the thread becomes taut, calculate combined speed of blocks at that instant, and maximum elongation of spring in the process of motion. $(g = 10ms^{-2})$.



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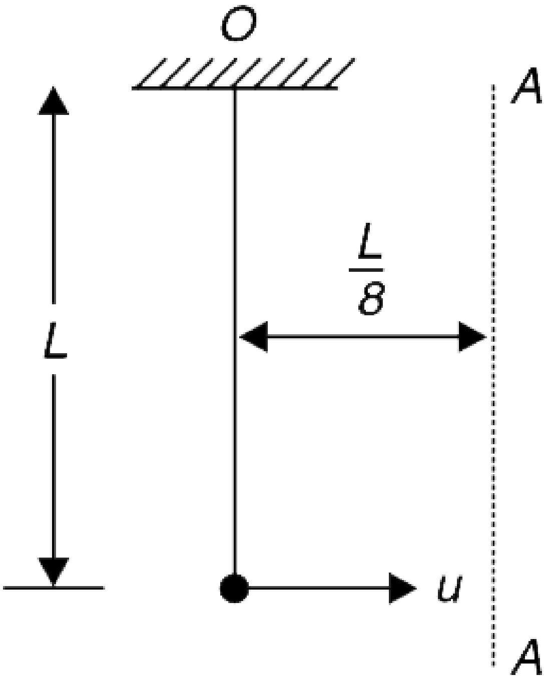
12. A particle is suspended vertically from a point O by an inextensible mass less string of length L. A vertical line AB is at a distance of $\frac{L}{8}$ from O as shown in figure. The particle is given a horizontal velocity u. At some

point, its motion ceases to be circular and eventually the object passes through the line AB. At the instant of crossing AB, its velocity is horizontal. Find u.



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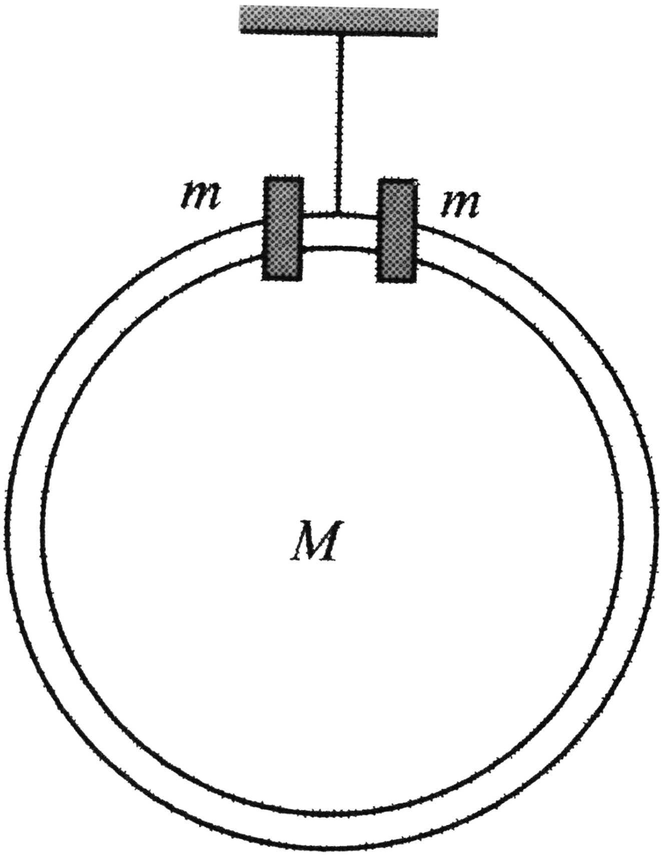
13. A loop of mass M with two identical rings of mass m at its top hangs from a ceiling by an inextensible string. If the rings gently pushed horizontally in opposite directions, find the angular distance covered by each ring when the tension in the string vanishes for once during their motion.



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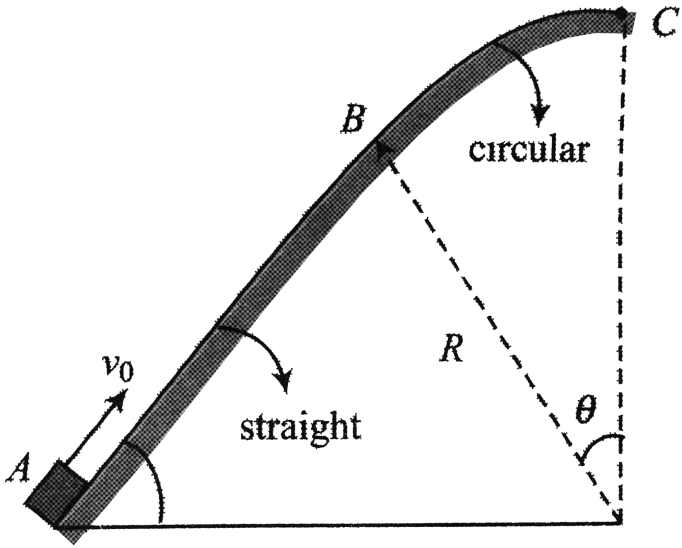
14. A block of mass m is projected up with a velocity v_0 along an inclined plane of angle of inclination $\theta = 37^{\circ}$. The coefficient of friction between the inclined plane AB and blocks is $\mu(=\tan\theta)$. Find the values of v_0 so that the block moves in a circular path from B to C.



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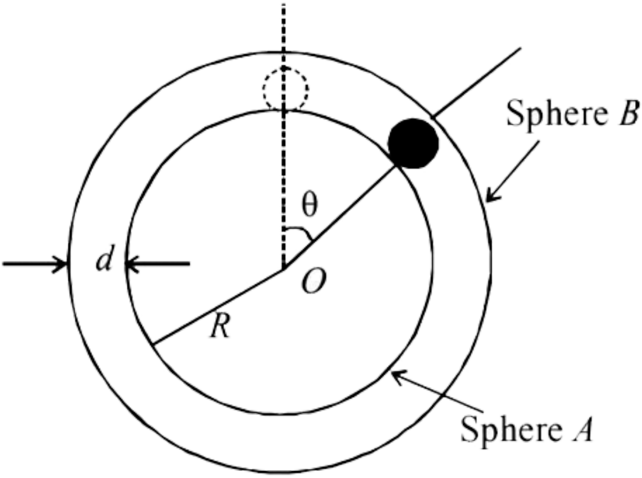
15. A spherical balll of mass m is the highest point in the space between two fixed , concentic sphere A and B the smaller the two sphere A has a radius R and the space between the two spheres has a width d . The bell has a disneter very dightly less then d . All surface are frictionless . The bell is a given a gentle push (owards the right in the figure) The upward vertical is denoted by θ (shown ijn the figure)



(a)Express the total normal reaction force exerted by the sphore on the as a finction of angle θ

(b) Let N_(A) and $N_B$denote in the magnitubes of the normal reaction force on the bell evered by the sphare A and B repectively Skech the variation of N_A and N_(B)$asfunctionsof$cos theta $\in theran \geq$ 0 le theta le pi $bydraw \in gtwoseparategraph \in youranswerb\infty ktak \in g$ cos theta ` an the horizental axas.

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Exercise 8.1

1. Discuss whether any work is being done by each of the following agents and, if so, whether the work is positive or negative: (a) a chicken scratching the ground, (b) a person studying, (c) a crane lifting a bucket of concrete, (d) the gravitational force on the bucket in part (c), and (e) the leg muscles of a person in the act of sitting down.

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2. State the following statements as true or false.

a. The work done by a force on a body is equal to the dot product of the force and displacement of the body.

b. Instantaneously, work is not defined.

c. When several forces act on a body, the total work is the same as the work done by their resultant.

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3. When we apply a force on a wall of infinite mass but the wall remains at rest, have we done any work on the wall? Does the wall do work on us?

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4. When you walk on a surface, who does work on what? If the surface has more friction, will more work be doen? If the surface is frictionless and we try to walk, will any work be done?

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5. A man is running down an inclined plane. Is he doing work or is work being done on him? Why is it that under normal circumstances when we are running down an inclined plane we feel that we are doing work?

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6. A car is travelling on road at $50 km h^{-1}$. The driver applies brakes and brings the car to rest. Which frictional force does more work: (a) the force between the wheels and the brakes or (b) the force between the wheels and the road?

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7. There are two inclined planes with the same vertical height, but with different angles of inclination. Two bodies of mass m each are placed at the bottom of the inclined plane. Two external forces of equal magnitude do work in taking the bodies to the top of the inclined plane. Which force does more work?

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8. In a tug of war, one team is giving way to other. What work is being done and by whom?

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9. A cyclist comes to a skidding stop in $10m$. During this process, the force on the cycle due to the road is $200N$ and is directly opposite to the motion.

a. How much work does the road do on the cycle?

b. How much work does the cycle do on the road?

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10. A gardener moves a lawn roller through a distance of $100m$ with a force of $50N$. Calculate his wages if he is to be paid 10 paise for doing $25J$ of work. It is given that the applied force is inclined at 60° to the direction of motion.

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11. A body constrained to move along the z-axis of a co-ordinate system, is subjected to a constant force $\overrightarrow{F}$ given by $\overrightarrow{F} = -\hat{i} + 2\hat{j} + 3\hat{k}$ Newton where $\hat{i}, \hat{j}$and $\hat{k}$ represent unit vectors along x-,y-,and z-axes of the system, respectively. Calculate the work done by this force in displacing the body through a distance of $4m$ along the z-axis.

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12. An object is displaced from point $A(2m, 3m, 4m)$ to a point $B(1m, 2m, 3m)$ under a constant force $F = \left(2\hat{i} + 3\hat{j} + 4\hat{k}\right)N$. Find the work done by this force in this process.

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13. An object is displaced from positin vector $r_1 = \left(2\hat{i} + 3\hat{j}\right)$ m to $r_2 = \left(4\hat{i} + 6\hat{j}\right)$ m under a forc $F = \left(3x^2\hat{i} + 2y\hat{j}\right)N$ Find the work done by this force.

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14. An object is displaced from a point A(0, 0, 0) to B(1m, 1m , 1m) under a force $\vec{F} = \left(y\hat{i} + x\hat{j}\right)N$. Find the work done by this force in this process.

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15. A force $\vec{F} = (3xN)\hat{i} + (4N)\hat{j}$, with x in meter, acts on a particle, changing only the kinetic energy of the particle. How mcuh work is done on the particle as it moves from coordinates $(2m, 3m, 5m)$ to $(3m, 0m, 6m)$? Does the speed of the particle increase, decrease, or remain the same?

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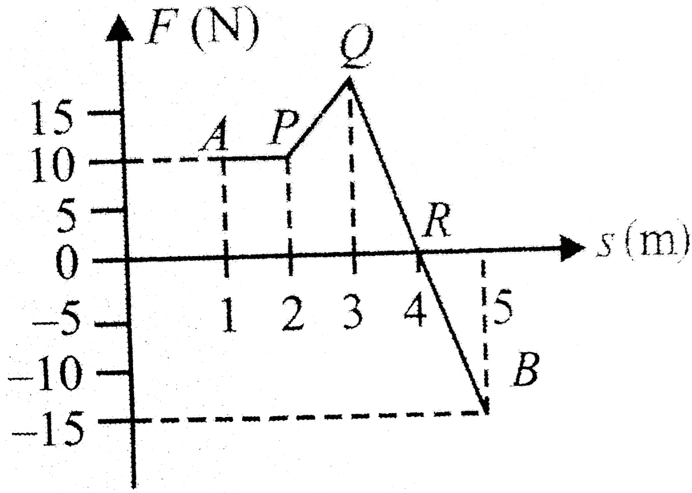
16. A body moves from point A to B under the action of a force, varying in magnitude as shown in figure. Obtain the work done. Force is expressed in newton and displacement in meter.



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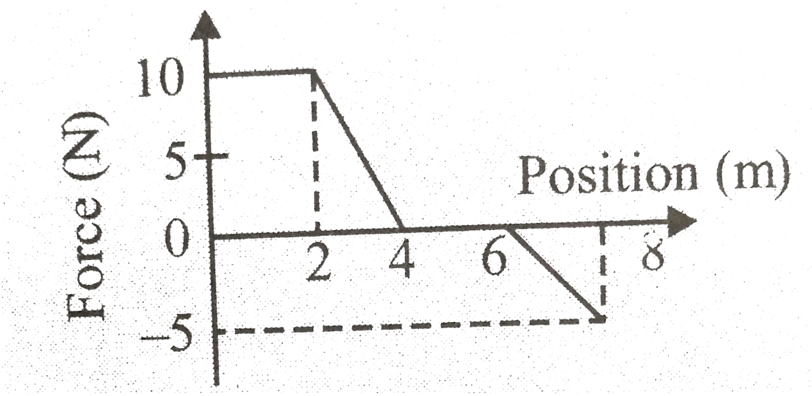
17. A $10-kg$ block moves in a straight line under the action of a force that varies with position as shown in figure. How much work does the force do as the block moves from origin to $x = 8m$?



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18. A force F acts on a body such that it is always at an angle of 45° to the direction of motion. The body moves in a circle and covers a semicircle of radius R. What is the work done by the force F?

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19. A force F is exerted on a body of mass M, which is connected to a spring (spring constant k). The body has a constant acceleration a.

Calculate the work done by the external force in moving the body by a distance D.

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20. A body is thrown on a rough surface such that the friction force acting on it is linearly varying with the distance travelled by it as $f = ax + b$. Find the work done by the friction on the box if before coming to rest the box travels a distance s.

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21. One end of a fixed spring is pulled by an average force of $10N$ through a distance of $5cm$, find the work done by the spring.

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22. A block of mass m is pulled slowly by a minimum constant force on a rough (μ) horizontal surface through a distance x. Find work done by force F.

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23. The work done by an external agent in pulling a spring from a deformation of $10cm$ to $15cm$ is W_1. When pulled, the spring from a deformation of $15cm$ to $20cm$, the work done is W_2. Find W_1 / W_2.

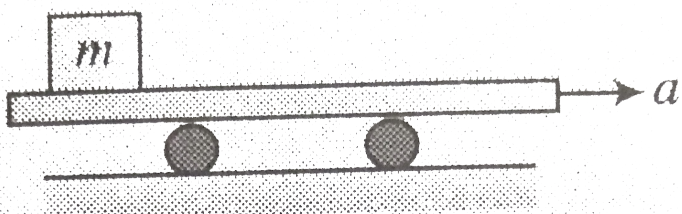

Fig. 8.47

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24. A block of mass m is kept on a rough plank which moves with a horizontal acceleration a. If the plank was at rest at $t = 0$, and the block does not slide relative to the plank, find the work done by friction on the (a) block, (b) plane, (c) system, (block+plank) during time t.

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25. In the previous question, if $a > \mu_s g$, find the work done by friction on the block during time t.

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Exercise 8.2

1. The kinetic energy of a body is increased by 21%. What is the percentage increase in the magnitude of linear momentum of the body?

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2. A particle of mass $0.5kg$ travels in a straight line with velocity $v = ax^{3/2}$ where $a = 5m^{-1/2}s^{-1}$. What is the work done by the net force during its displacement from $x = 0$ to $x = 2m$?

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3. Can kinetic energy be negative? Explain.

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4. The kinetic energy of an object depends on the frame of reference in which its motion is measured. Give an example to illustrate this point.

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5. You are reshelving books in a library. You lift a book from the floor to the top shelf. The kinetic energy of the book on the floor was zero and the kinetic energy of the book on the top shelf is zero, so no change occurs in the kinetic energy even though you did some work in lifting the books. Is the work-kinetic energy theorem violated?

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6. What is the reason that we burn out our body fat only when we walk briskly? Why does normal walking not burn out the same amount of body fat when the distance covered remains the same?

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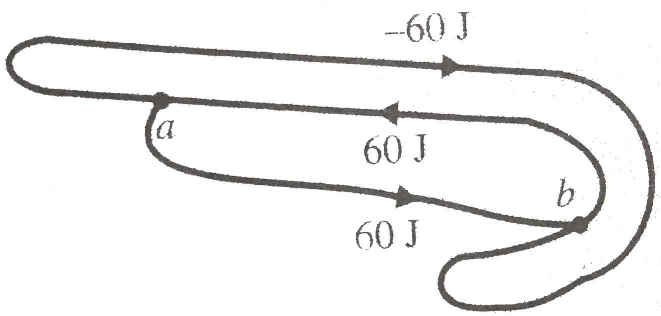
7. Figure shows three paths connecting points a and b, A single force F does the indicated work on a particle moving along each path in the indicated direction. On the basis of this information, is force F conservative?



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8. The potential energy of a conservative force field is given by

$U = ax^2 - bx$

where, a and b are positive constants. Find the equilibrium position and discuss whether the equilibrium is stable, unstable or neutral.

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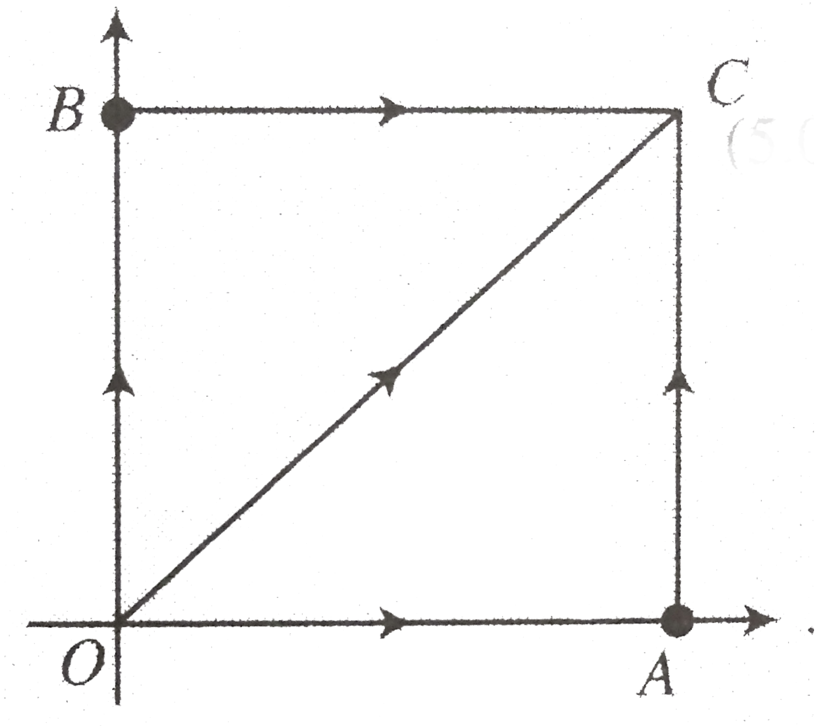
9. A particle moves in x-y plane in figure under the influence of a friction force with magnitude $3.00N$ and acting in the direction opposite to the

particle's displacement. Calculate the work done by the friction force on particle as it moves along the following closed paths: (a) path OA followed by AC and return path AO, (b) path OA followed by AC and the return path CO, (c) path OC followed by the return path CO, and (d) each of your three answers should be non-zero. What is the significant of this observation?



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10. A single conservative force acting on a particle varies as $\overrightarrow{F} = (-Ax + Bx^2)\hat{i}N$, where A and B are constants and x is in meters. (a) Calculate the potential energy function $U(x)$ associated with this force, taking $U = 0$ at $x = 0$. (b) Find the change in potential energy and the change in kinetic energy of the system as the particles moves from $x = 2.00m$ to $x = 3.00m$.

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11. A potential energy function for a two-dimensional force is the form $U = 3x^2y - 7x$. Find the force that acts at the point (x, y).

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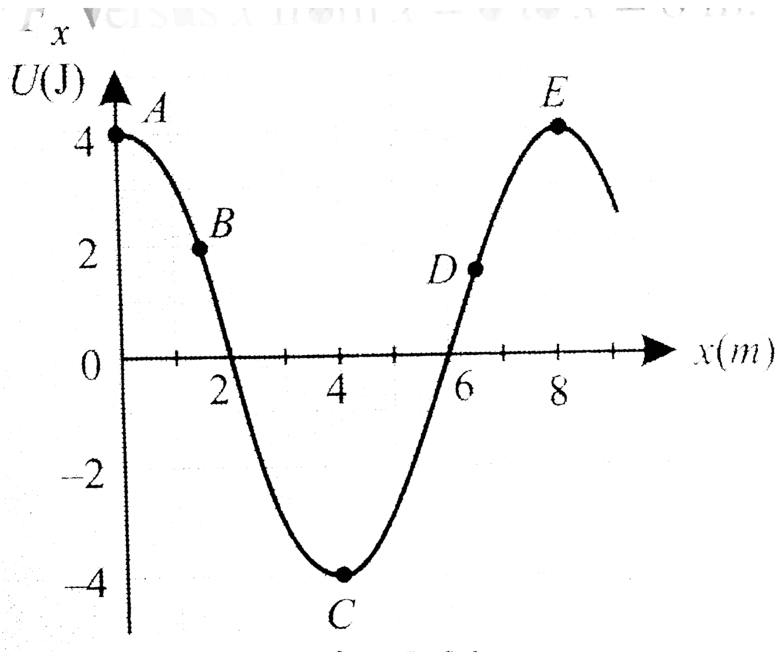
12. For the potential energy curve shown in figure.

(a) Determine whether the force F_x is positive, negative, or zero at the five points indicated, (b) Indicate points of stable, unstable, and neutral equilibrium, (c) Sketch the curve for F_x versus x from $x = 0$ to $x = 8m$.



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13. Is it possible exert a force which does work on a body without changing its kinetic energy? If so, give example.

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14. The kinetic friction force acting on a sliding body moving in a straight line is constant, but it is non-conservative. Explain.

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15. A single conservative force acting on a particle varies as $\overrightarrow{F} = (-Ax + Bx^2)\hat{i}N$, where A and B are constants and x is in meters. (a) Calculate the potential energy function $U(x)$ associated with this force, taking $U = 0$ at $x = 0$. (b) Find the change in potential energy and the change in kinetic energy of the system as the particles moves from $x = 2.00m$ to $x = 3.00m$.

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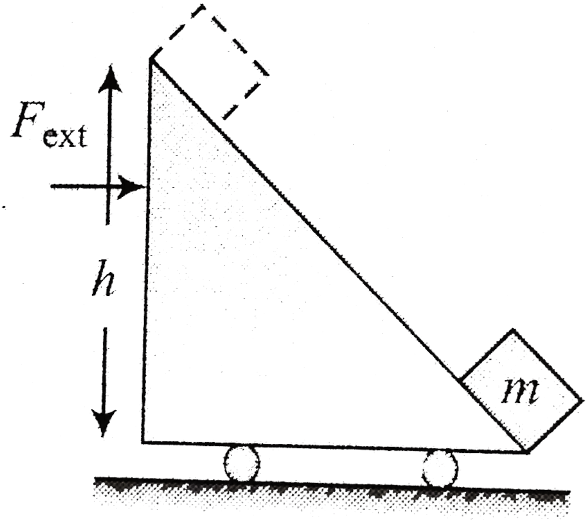
16. A block of mass m is placed at the bottom of a massless smooth wedge which if placed on a horizontal surface. When we push the wedge with a constant force, the block moves up the wedge. Find the work done by the external agent when the block has a speed v and is reaches the top

of the wedge.



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17. A particle is projected in gravity with a speed v_0. Using W-E theorem, find the speed of the particle as the function of vertical distance y.

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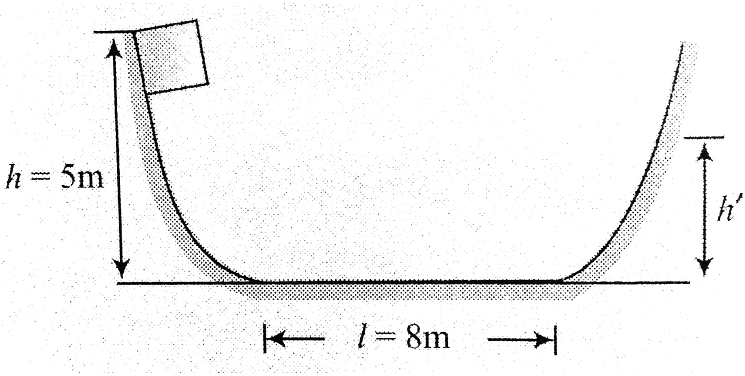
18. A block is released from rest from a height $h = 5m$. After travelling through the smooth curved surface it moves on the rough horizontal surface through a length $1 = 8m$ and climbs onto the other smooth curved surface through a height h'. If $\mu = 0.5$, find h'.



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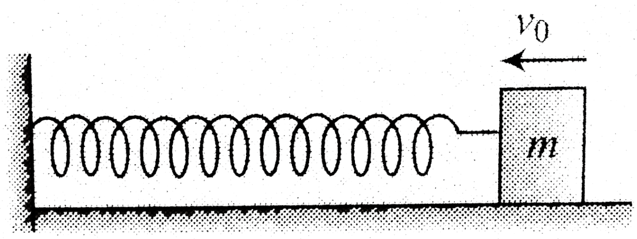
19. A block of mass m is connected with a rigid wall by light spring of stiffness k. Initially the spring is relaxed.



If the block is pushed with a velocity v_0, it oscillates back and forth and stops. Assuming μ as the coefficient of kinetic friction between block and ground, find the work done by friction till the block stops.

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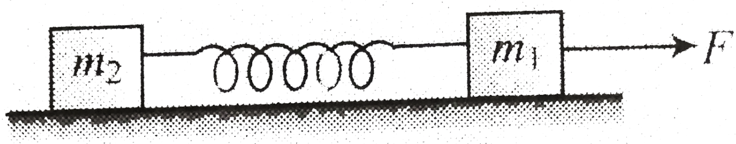
20. Two blocks of masses m_1 and m_2 inter connected by a spring of stiffness k are placed on a horizontal surface. If a constant horizontal force F acts on the block m_1 it slides through a distance x whereas m_2 remains stationary. If the coefficient of friction between all contacting surfaces is μ, find the speed of the block m_1 as the function x.



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21. A ball of mass m is thrown in air with speed v_1 from a height h_1 and it is at a height $h_2(>h_1)$ when its speed becomes v_2 . Find the work done on the ball the air resistance.

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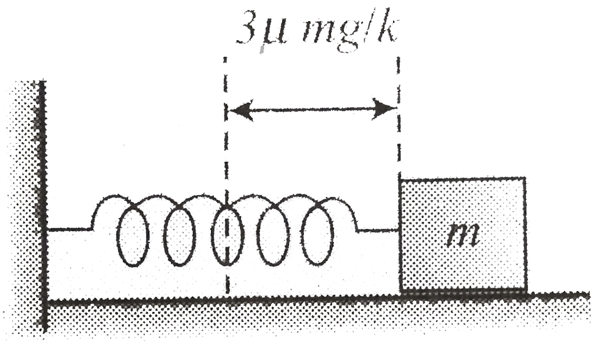
22. A spring block system is placed on a rough horizontal surface having coefficient of friciton μ. The spring is given initial elongation $3\mu mg / k$ (where m=mass of block and k=spring constant) and the block is released from rest. For the subsequent motion, find



a. Initial acceleration of block

b. Maximum compression in spring

c. Maximum speed of the block

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23. Find the maximum energy stored in the spring shown in figure, for which the block remains stationary on the rough horizontal surface.

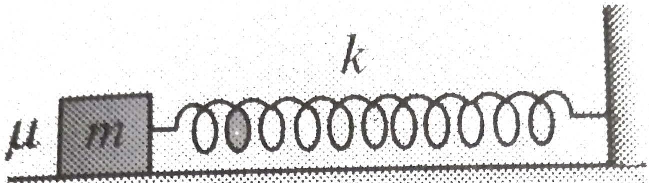

Fig. 8.87

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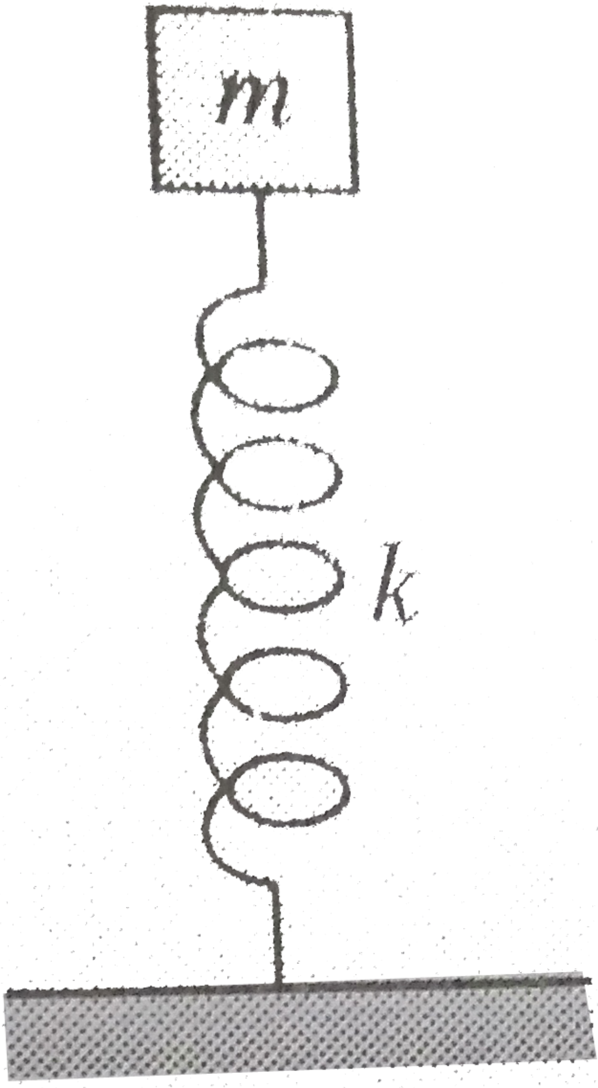
24. A block of mass m held touching the upper end of a light spring of force constant K as shown in figure. Find the maximum potential energy stored in the spring if the block is released suddenly on the spring.



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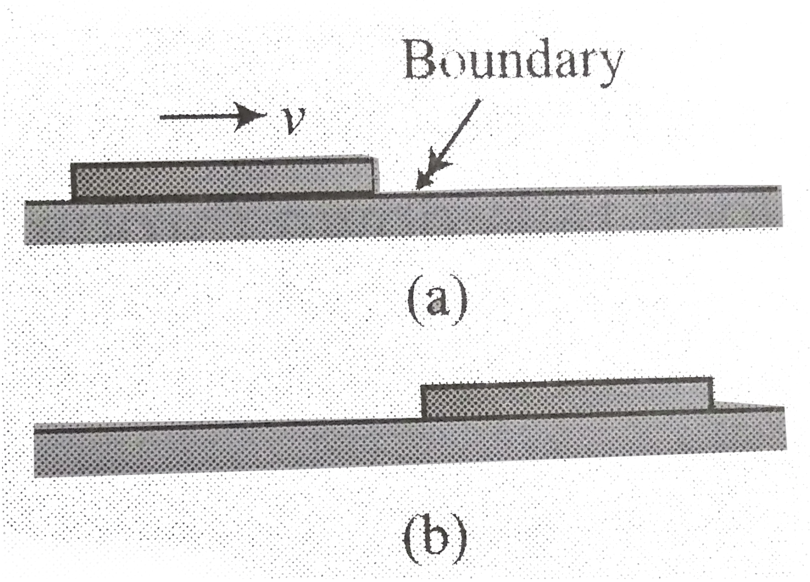
25. A uniform board of length L is sliding along a smooth (frictionless) horizontal plane as in figure. The board then slides across the boundary with a rough horizontal surface. The coefficient of kinetic friction between the board and the second surface surface is μ_k



a. Find the acceleration of the board at the moment its front end has traveled a distance x beyond the boundary.

b. The board stops at the moment its back end reaches the boundary, as in figure. Find the initail speed v of the board.

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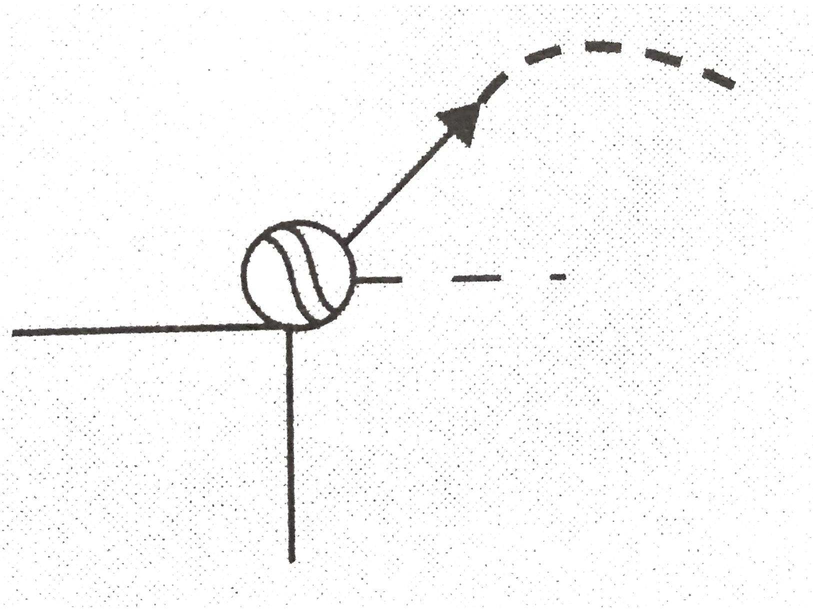
Exercise 8.3

1. Figure shows a light, inextensible string attached to a cart, which can slide along a frictionless horizontal rail aligned along the x axis. The left end of the string is pulled over a pulley of negligible mass and friction and fixed at height $h = 3m$ from the ground level. The cart slides from $x_1 = 3\sqrt{3}m$ to $x_2 = 4m$ and during the move, tension in the string is kept constant at $50N$. Find the change in kinetic energy of the cart in joules. (Use $\sqrt{3} = 1.3$)



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2. A boy throws a ball with initial velocity u at an angle of projection θ from a tower of height H.

Neglecting air resistance, find

a. How high above the building the ball rises

b. Its speed just before it hits the ground.

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3. An elevatore is moving up with a constant velocity. Two different masses are attached to two different springs of same spring constant. Say you do two operations expanding the spring or compressing the spring by the same distance. Which operation consumes more energy: expanding the spring or compressing it?

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4. Consider the two cases:

a. A says that the potential energy of a book placed on a shelf is $10J$.

b. B says that the potential energy of the same book is $-10J$.

Which one of them is wrong? Justify.

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5. Consider the two cases:

a. A says that the potential energy of a book placed on a shelf is $10J$.

b. B says that the potential energy of the same book is $-10J$.

Which one of them is wrong? Justify.

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6. A small block of mass 100 g is pressed again a horizontal spring fixed at one end to compress the sprign through 5.0 cm. The spring constant is 100 N/m. When released, the block moves hroizontally till it leaves the spring. Where will it hit the ground 2 m below the spring?

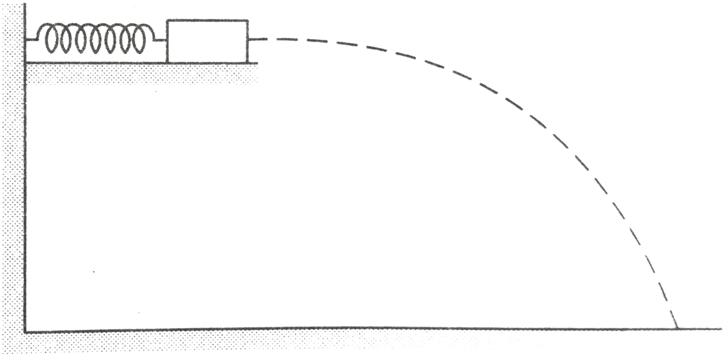

Figure 8-E11

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7. A rock of mass m is dropped to the ground from a height h. A second rock, with mass $2m$, is dropped from the same height. When the second rock strikes the ground, what is its kinetic energy? (a) Twice that of the first rock, (b) four times that of the first rock, (c) same as that of the first rock, (d) half as much as that of the first rock, (e) impossible to determine.

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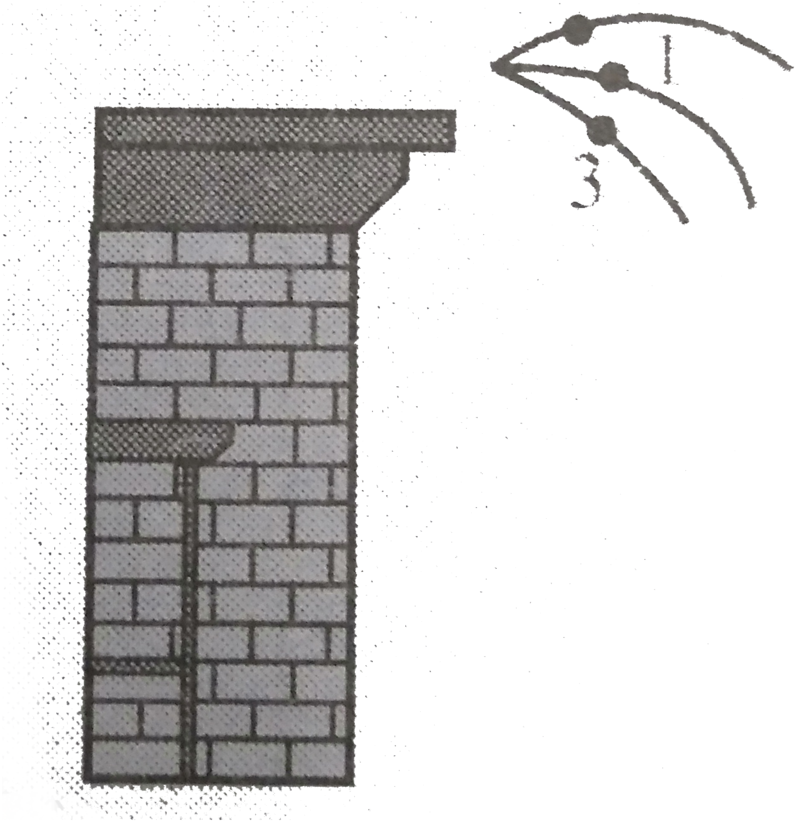
8. Three identical balls are thrown from the top of a building, all with the same initial speed. As shown in figure., the first ball is thrown horizontally, second above horizontal level, and third at an angle below the horizontal. Neglecting air resistance, rank the speeds of the balls at the instant each hits the ground.



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9. A lorry and a car moving with the same kinetic energy are brought to rest by the application of brakes which provides equal retarding forces. Which of them will come to rest in a shorter distance?

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10. In case of a moving body as force of friction is μmg, can we regard μmgx as potential energy similar to mgh?

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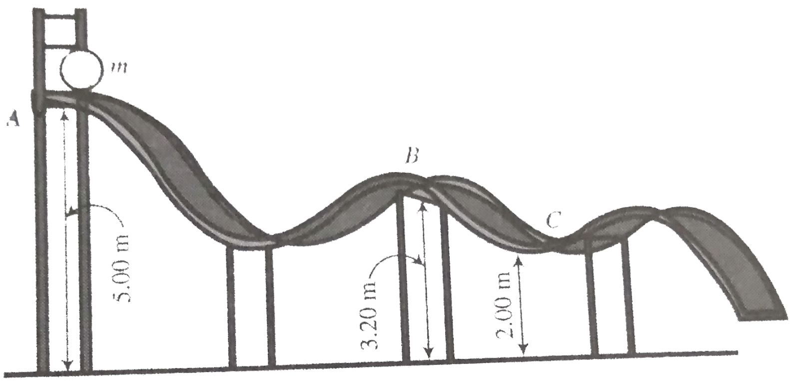
11. A particle of mass $m = 5.00 kg$ is released from point A and it slides on the frictionless track shown in figure. Determine (a) the particle's speed at points B and C and (b) the net work done by the gravitational force as the particle moves from A to C.



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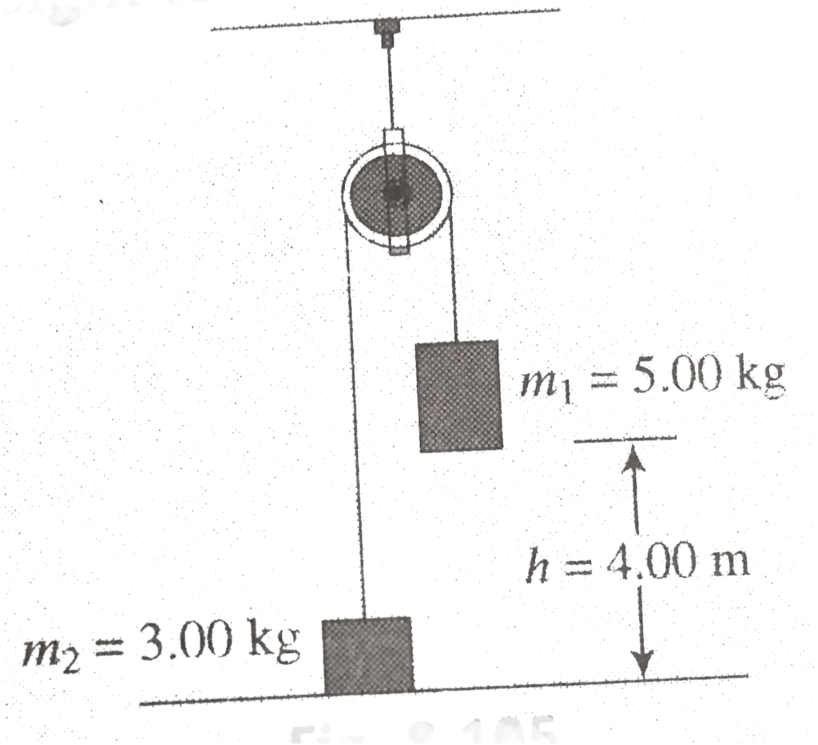
12. Two objects are connected by a light string passing over a light, frictionless pulley as shown in figure. The object of mass $5.00 kg$ is released from rest. Using the isolated system model, (a) determine the speed of the $3.00 kg$ object just as the $5.00 - kg$ object hits the ground,

(b) find the maximum height to which the $3.00 - kg$ object rises.



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13. At time t, the kinetic energy of a particle is $30.0J$ and the potential energy of the system to which it belongs is $10.0J$. At some later time t_f, the kinetic energy of the particle is $18J$, what are the potential energy and the total energy at time t_f? If the potential energy of the system at time t_3 is $5.00J$, are any non-conservative forces acting on the particle? Explain.

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14. Under the action of a force, a $2kg$ body moves such that its position x as a function of time is given by $x = \frac{t^3}{3}$ where x is in metre and t in second. The work done by the force in the first two seconds is .

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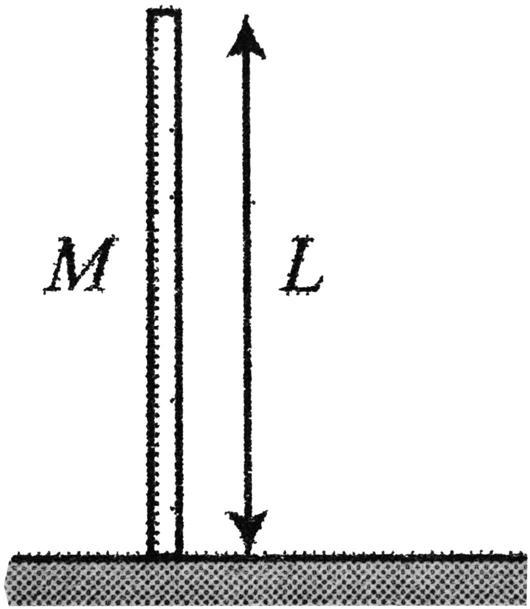
15. A uniform rod of mass M and length L is held vertically upright on a horizontal surface as shown in figure. Assuming zero potential energy at the base of the rod, determine the potential energy of the rod.



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16. A uniform chain of length l and mass m overhangs a smooth table with its tow third pat lying on the tabl. Find the kinetic energy of the chain s it completely slips off the table.

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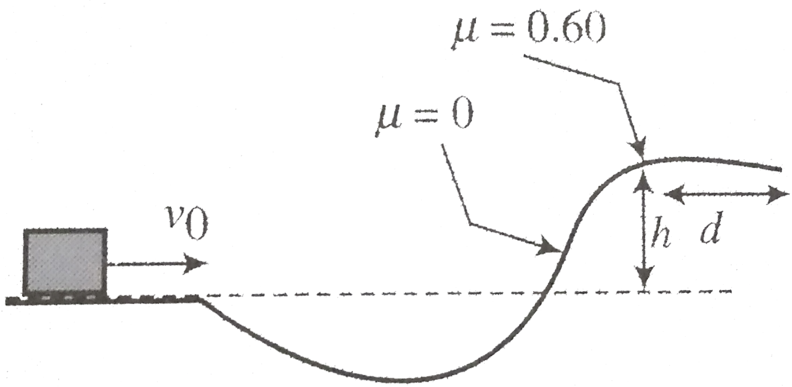
17. Figure, a block slides along a track from one level to a higher level by moving through an intermediate valley. The track is friction less until the block reaches the higher



level. Then there is friction force which stops the block at a distance d. The block's initial speed v_0 is $6.0ms^{-1}$, the height difference h is $1.1m$, and the coefficient of kinetic friction μ is 0.60. Find d.

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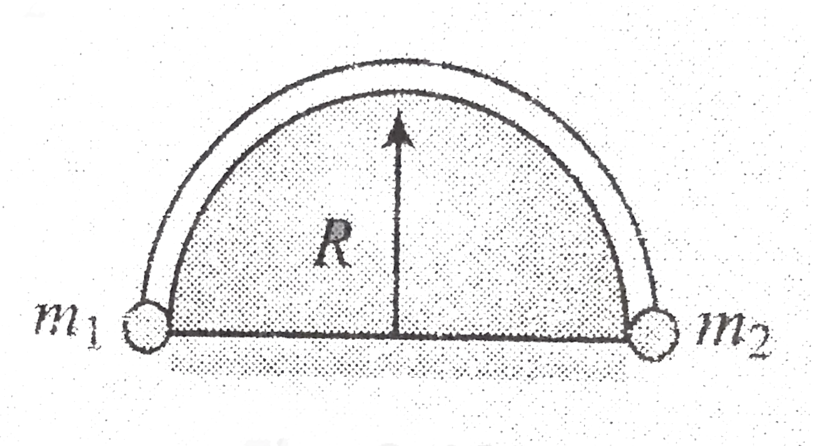
18. Two smooth balls of mass m_1 and m_2 connected by a light inextensible string are at the opposite points of horizontal diameter of a smooth semi cylindrical surface of radius R. If m_1 is released, find its speed at any angular distance θ moved by m_2.



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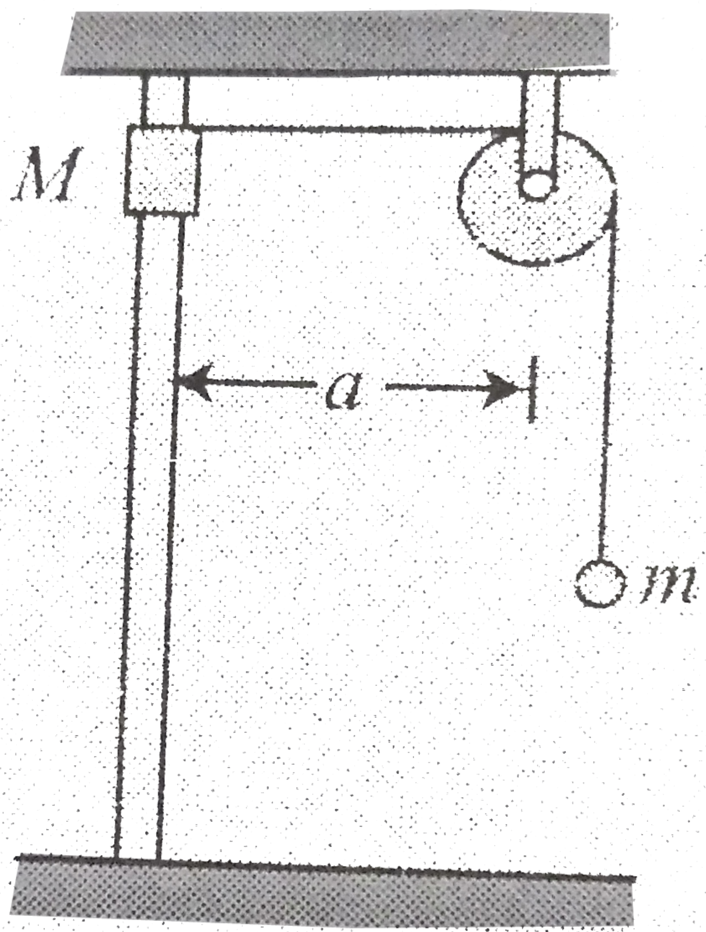
19. In figure, an inextensible string that connects two bodies of mass M and m, passing over a fixed smooth pulley. The body M slides along a smooth vertical rigid bar. If the body M is released from the given position, find the maximum distance raised by body m.



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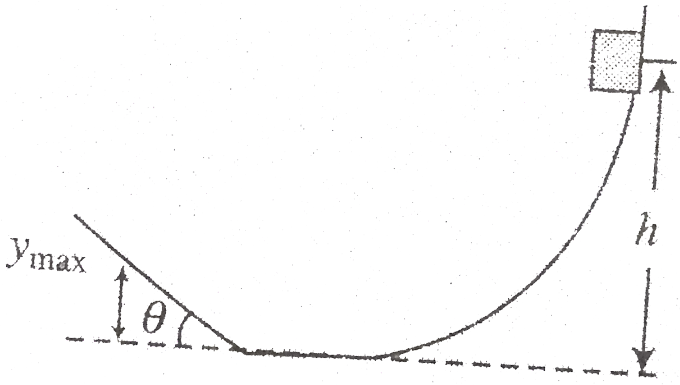
20. A block slides down a curved frictionless track and then up an inclined plane as in figure. The coefficient of kinetic friction between the block and incline is μ_k. Find the maximum height reached by the clock.



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21. A child's pogo stick(figure) stores energy in a spring with a force constant of $2.5 \times 10^4 Nm$. At position (A) $(x_A = 0.10m)$, the spring compression is a maximum and the child is momentarily at rest. At position (B) $(x_B = 0)$, the spring is relaxed and the child is moving upward. At position (C), the child is again momentarily at rest at the top of the jump. The combined mass of child and pogo stick is $25kg$. (a)

Calculate the total energy of the child-stick-earth system if both gravitational and elastic potential energies are zero for $x = 0$. (b) Determine x_C. (c) Calculate the speed of the child at $x = 0$. (d) Determine the value of x for which the kinetic energy of the system is a maximum. (e) Calculate the child's maximum upward speed.

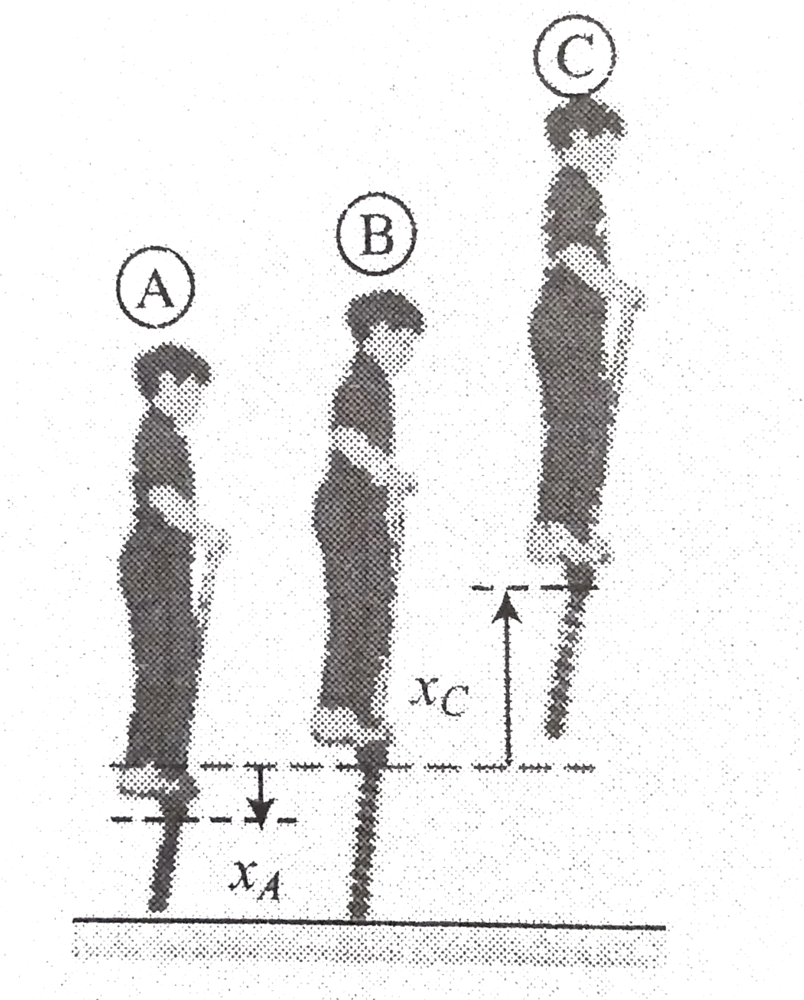

Fig. 8.110

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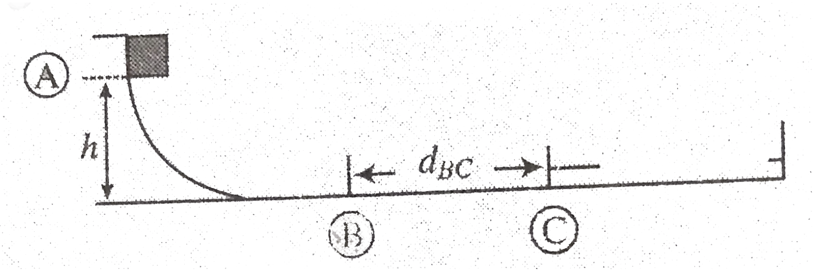
22. A block of mass m is released from point (A) in figure. The track is frictionless except for the position between points (B) and (C), which has a length of d_{BC}. The block travels down the track, hits a spring of force constant k, and compresses the spring x from its equilibrium position before coming at rest momentarily. Determine the coefficient of kinetic friction between the block and the rough surface between (B) and (C).



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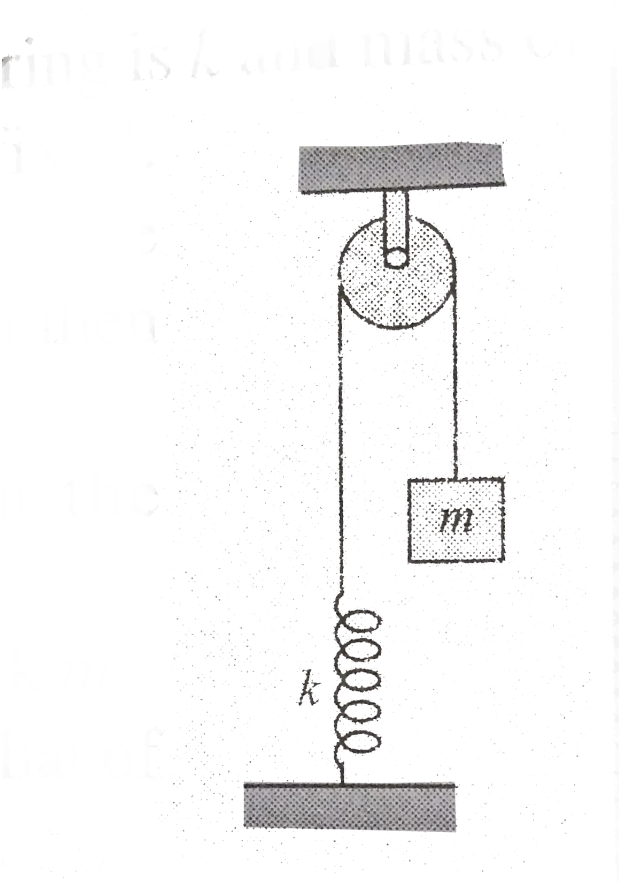
23. In figure, the stiffness of the spring is k and mass of the block is m. The pulley is fixed. Initially, the block m is held such that the elongation in the spring is zero and then released from rest. Find:

a. the maximum elongation in the spring.

b. the maximum speed of the block m. Neglect the mass of the spring and that of the string. Also neglect the friction.



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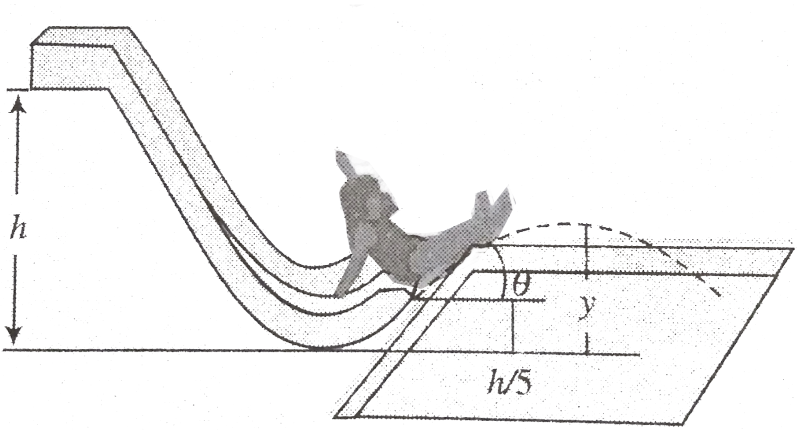
24. A child slides without friction from a height h along a curved water slide (figure). She is launched from a height $h/5$ into the pool. Determine her maximum airbone height y in terms of h and θ.



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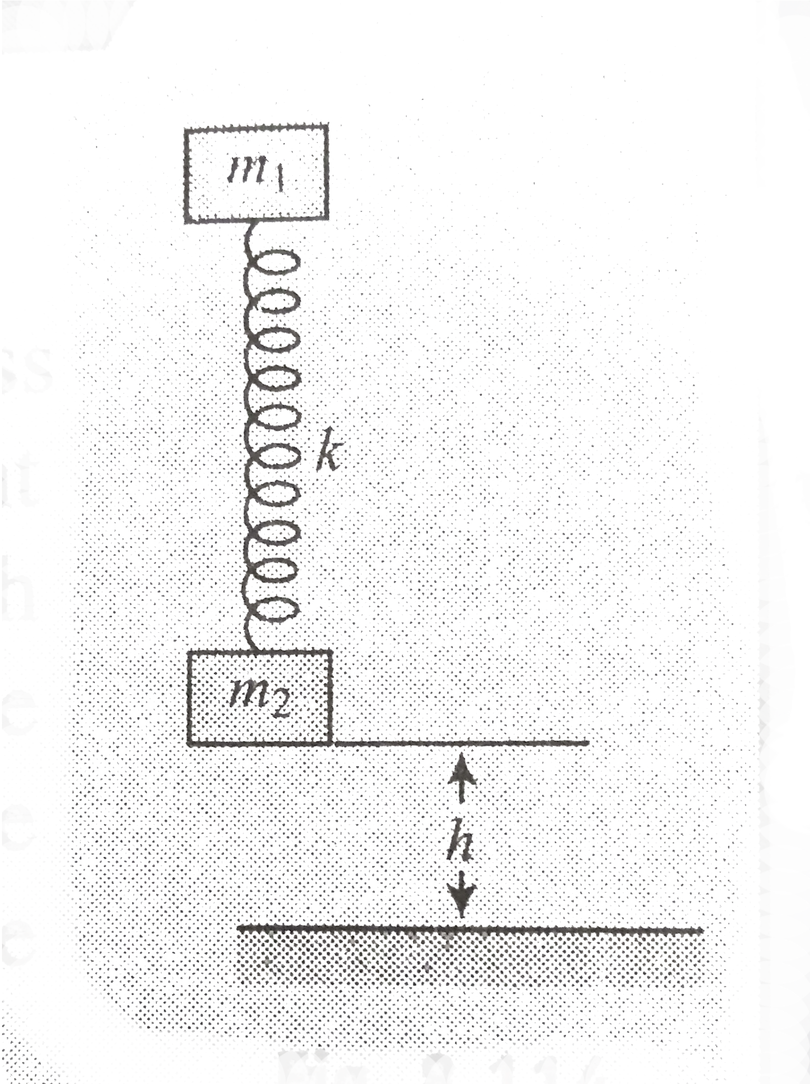
25. A spring-mass system (m_1 + massless spring + m_2) fall freely from a height h before m_2 colliding inelastically with the ground. Find the maximum value of h so that block m_2 will break off the surface. Assume k=stiffness of the spring.



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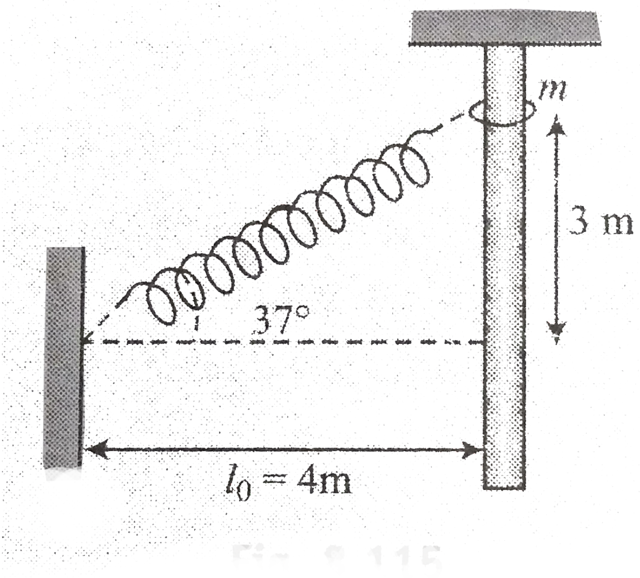
26. A ring of mass $m = 10kg$ can slide through a vertical rod with friction. It is connected with a spring of force constant $k = 100Nm^{-1}$. The relaxed length of spring is $4m$. The ring is displaced $3m$ as shown in the figure and released. Find velocity of ring when spring becomes horizontal.



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Exercise 8.4

1. Figure shows a smooth track, a part of which is a circle of radius r. A block of mass m is pushed against a spring of spring constant k fixed at the left end and is then released. Find the initial compression of the spring so that the block presses the track with a force mg when it reaches the point P, where the radius of the track is horizontal.

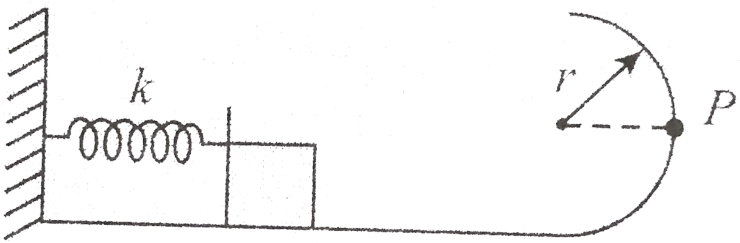

Fig. 8.150

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2. A particle of mass m is kept on a fixed , smooth sphere of radius R at a position, where the radius through the particle makes an angle of 30^0 with the vertical. The particle is releases from this position. a. What is the force exerted by the sphere on the particle just after the release? b. Find the distance travelled by the particle before it leaves contact with the sphere.

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3. A particle is suspended from a fixed point by a string of lengh $5m$. It is projected from the equilibrium position with such a velocity that the string slakens after the particle has reached a height $8m$ above lowest point. Find the velocity of the particle, just before the string slackens. Find also, to what to what height the particle can rise further?

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4. A heavy particle hanging from a fixed point by a light inextensible string of length l is projected horizonally with speed $\sqrt{gl}$. Find the speed of the particle and the inclination of the string to the vertical at the instant of the motion when the tension in the string is equal to the weight of the particle.

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5. A ball is attached to a horizontal cord of length l whose other end is fixed. (a) If the ball is released, what will be its speed at the lowest point of its path? (b) A peg is located a distance h directly below the point of attachment of the cord. If $h = 0.75l$, what will be the speed of the ball when it reaches the top of its circular path about the peg?

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6. A smooth spehre of radius R is made to translate oin a straight line with a constant acceleration a. A particle kept on the top of the sphere is released rom there at zero velocity with respect to the sphere. Find the speed of the particle with respect to the sphere as a functon of the angle θ it slides.

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7. The block on the loop shown slides without friction. At what height from A it starts so that it passes against the track at B with a net upward force equal to its own weight? The radius of the loop is R.

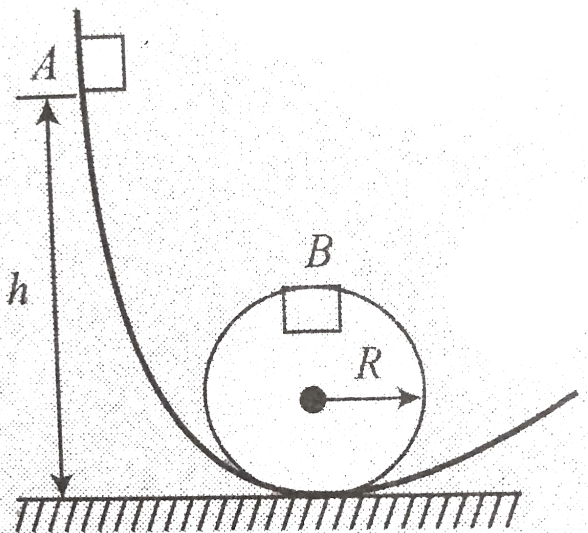

Fig. 8.151

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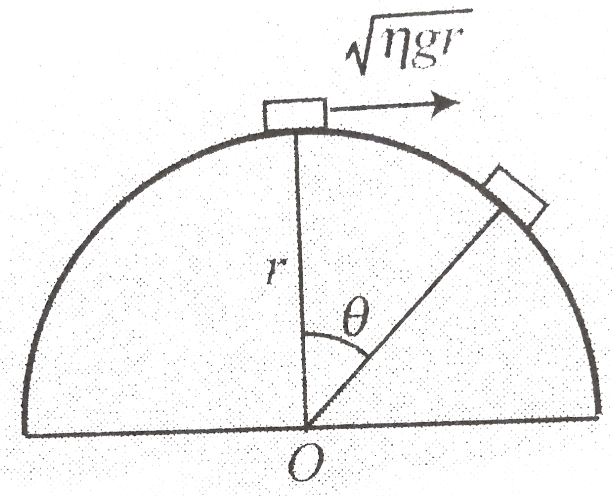
8. A particle rests on the top of a smooth hemisphere of radius r. It is imparted a horizontal velocity of $\sqrt{\eta g r}$. Find the angle made by the radius vector joining the particle with the vertical at the instant the particle losses contact with the sphere.



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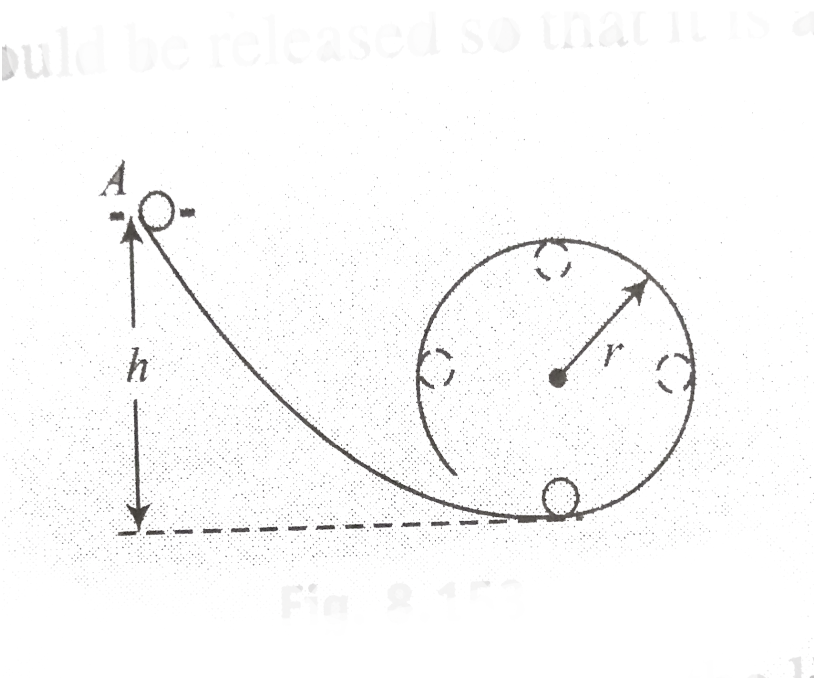
9. A block is released from rest at the top of an inclined plane which later curves into a circular track of radius r as shown in figure. Find the minimum height h from where it should be released so that it is able to complete the circle.



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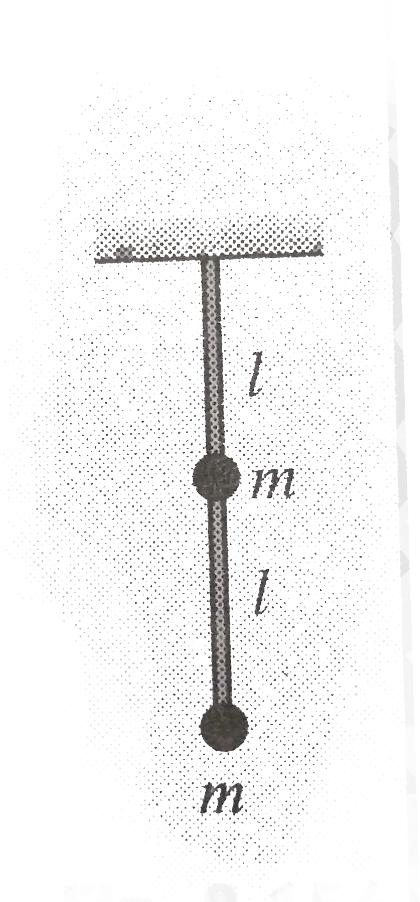
10. Two point masses m are connected the light rod of length l and it is free to rotate in vertical plane as shown in figure. Calculate the minimum horizontal velocity is given to mass so that it completes the circular

motion in vertical lane.



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11. A simple pendulum of length l and mass m free to oscillate in vertical plane. A nail is located at a distance $d = l - a$ vertically below the point of suspension of a simple pendulum. The pendulum bob is released from the position where the string makes an angle of 90° from vertical. Discuss the motion of the bob if (a) $l = 2a$ and (b) $l = 2.5a$.

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12. A bob of mass m suspended by a light inextensible string of length 'l' from a fixed point. The bob is given a speed of $\sqrt{6gl}$. Find the tension in the string when string deflects through an angle 120° from the vertical.

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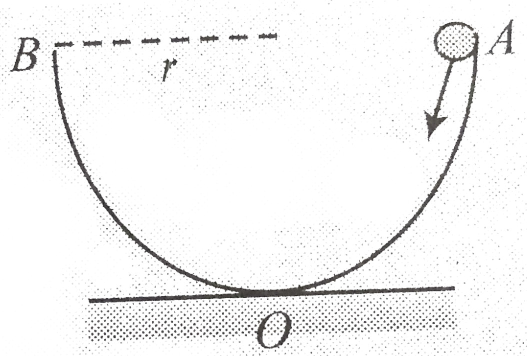
13. AOB is a smooth semicircular track of radius r. A block of mass m is given a velocity $\sqrt{2rg}$ parallel to track at point A. Calculate normal reaction between block and track when block reaches at point O.



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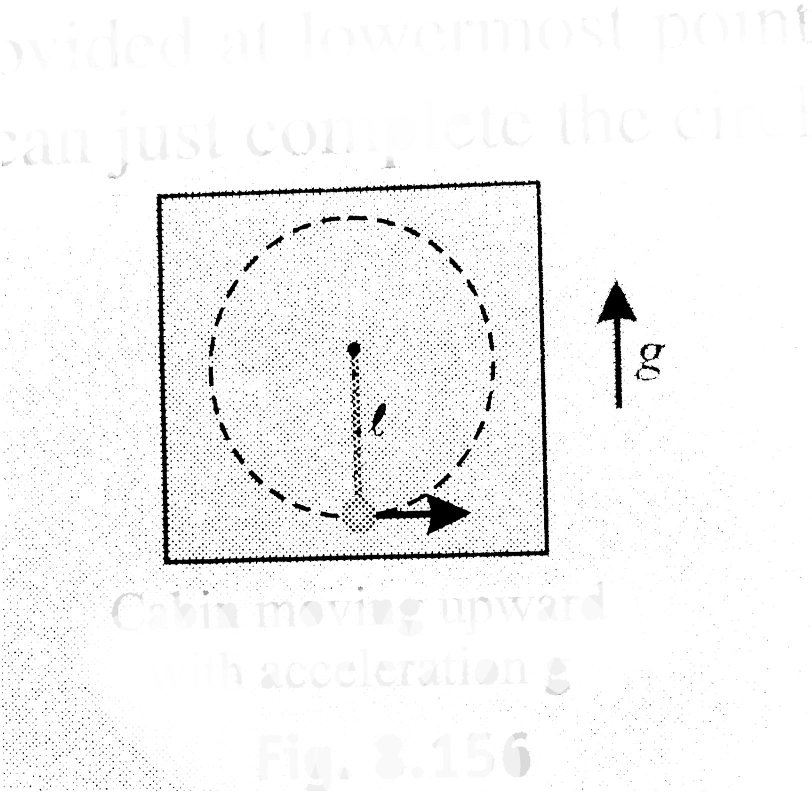
14. A cabin is moving upwards with a constant acceleration g. A boy standing in the cabin wants to whirl a particle of mass m in a vertical circle of radius l. (Mass is attached to an ideal string.) Calculate minimum velocity which should be provided at lowermost point (w.r.t cabin) so that particle can just complete the circle.



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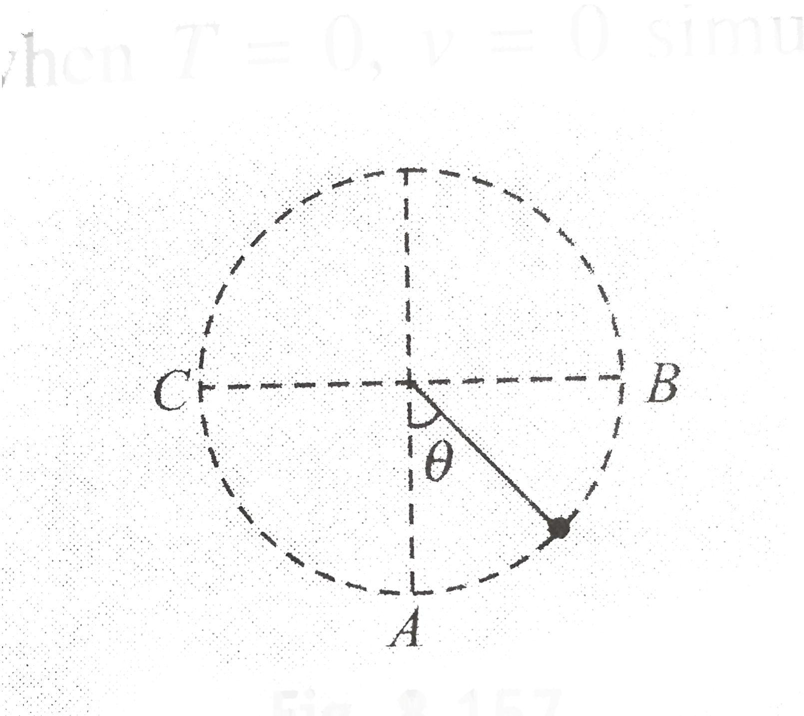
15. Find the minimum speed at A so that the ball can reach at point B as shown in figure. Also discuss the motion of particle when $T = 0, v = 0$

simultaneously at $\theta = 90^\circ$



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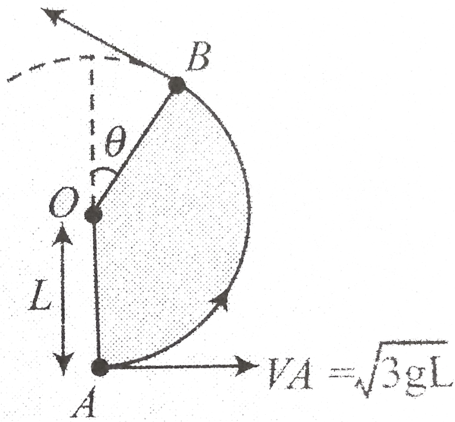
16. A particle in projected with velocity $\sqrt{3gL}$ at point A (lowest point of the circle) in the vertical plane. Find the maximum height about horizontal level of point A if the string slacks at the point B as shown in figure.



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Exercise 8.5

1. A block moves in uniform circular motion because a cord tied to the block is anchored at the center of a circle. Is the power of the force exerted on the block by the cord positive, negative, or zero?

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2. What is the power of an engine which can lift 20 metric tonne of coal per hour from a $20 - m$ deep mine?

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3. A $1 - KW$ motor pumps out water from a well $10m$ deep. Calculate the quantity of water pumped out per second.

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4. The blades of a windmill sweep out a circle of area A. (a) If the wind flows at a velocity v perpendicular to the circle, what is the mass of the air passing through in time t? (b) What is the kinetic energy of the air? (c) Assume that the windmill converts 25% of the wind's energy into electrical energy, and that $A = 30m^2$, $v = 36kmh^{-1}$ and the density of air is $1.2kgm^{-3}$, what is the electrical power produced?

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5. One coolie takes 1min to raise a box through a height of $2m$. Another one takes $30s$ for the same job and does the same amount of work. Which one of the two has greater power and which one uses greater enegy?

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6. A large family uses $8KW$ of power. Direct solar energy is incident on the horizontal surface at an average rate of $200Wm^{-2}$. If 20% of this energy can be converted to useful electrical energy, how large an area is needed to supply $8kW$?

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7. An elevator can carry a maximum load of $1800kg$ (elevator + passengers) is moving up with a constant speed of $2ms^{-1}$. The friction force opposite the motion is $4000N$.What is minimum power delivered by the motor to the elevator?

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8. Two persons of equal weight are running at speeds of $4ms^{-1}$ and $5ms^{-1}$, respectively. Both increase their speeds by $1ms^{-1}$ in a time span of $10s$. Who does more work? Who develops more power?

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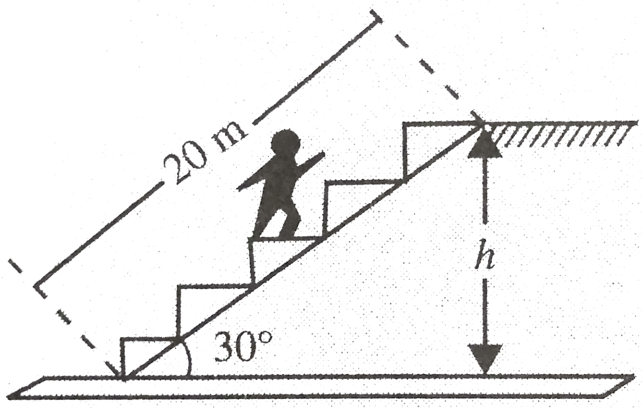
9. A $90-kg$ man runs up an escalator while it is not in operation in $10s$. What is the average power developed by the man. Suppose the escalator is running so that the escalator steps move at a speed of $0.5m^{-1}$. What is then the power developed by the man as seen by the ground reference if he moves at the same speed relative to the escalator steps as he did when the escalator is not in operation?



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10. A pump is required to lift $1000 kg$ of water per minute from a well $12 m$ deep and eject it with a speed of $20 ms^{-1}$. How much work is done per minute in lifting the water and what must be the power output of the pump?

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11. A helicopter lifts a body of mass $100kg$ to a height of $500m$ at a constant speed. It takes $5 \min$ to lift the body. Find the work done by the helicopter and the power required.

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12. A $700N$ marine in basic training climbs a $10.0m$ vertical rope at a constant speed in $8.00s$. What is his power output?

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13. The electric motor of a model train accelrates the train from rest to $0.620ms^{-1}$ in $21.0ms$. The total mass of the train is $875g$. Find the average power delivered to the train during the acceleration.

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14. Water falling from a $50m$ high fall is to be used for generating electric energy. If $8 \times 10^5 kg$ in water falls per hour and half the gravitational potential energy can be converted into electric energy, how many $100W$ lamps can be lit?

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15. A particle of mass m is moving in a circular path of constant radius r, such that its centripetal force F_r varies with time t as $F_r = K^2 r t^2$, where k is a constant. What is the power delivered to the particle by the forces acting on it?

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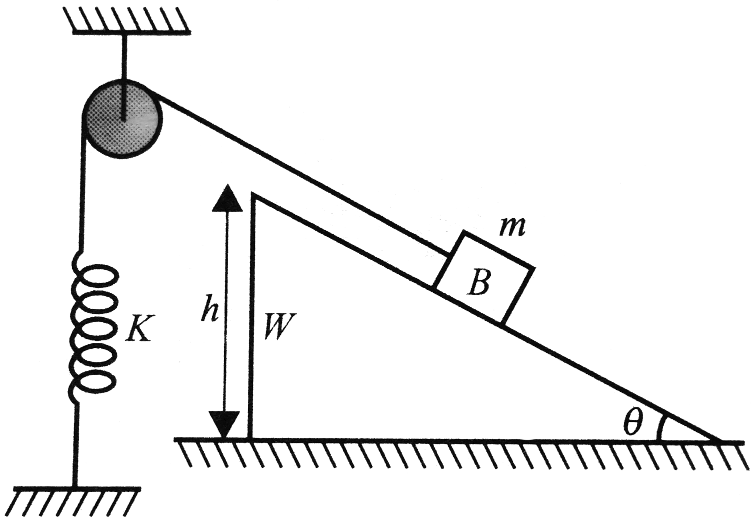
Subjective

1. In figure, the pulley shown is smooth. The spring and the string are light. Block B slides down from the top along the fixed rough wedge of inclination θ. Assuming that the block reaches the end of the wedge, find the speed of the block at the end. Take the coefficient of friction between the block and the wedge to be μ and that the spring was relaxed when the block was released from the top of the wedge.



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2. The potential energy (in SI units) of a particle of mass $2kg$ in a conservative field is $U = 6x - 8y$. If the initial velocity of the particle is $\overrightarrow{u} = -1.5\hat{i} + 2\hat{j}$, then find the total distance travelled by the particle in the first two seconds.

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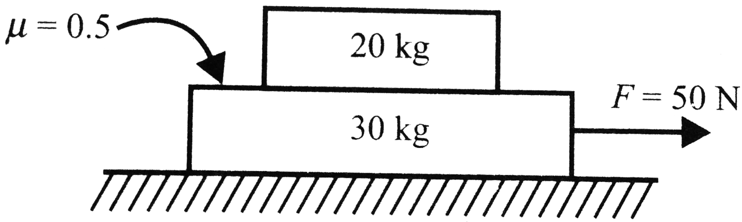
3. A small block of mass $20kg$ rests on a bigger block of mass $30kg$, which lies on a smooth horizontal plane. Initially the whole system is at rest. The coefficient of friction between the blocks is 0.5. The horizontal force $F = 50N$ is applied on the lower block.



a. Find the work done by fricitonal force on upper block and on the lower block in $t = 2s$.

b. Is the magnitude of work done by the frictional force on upper and lower blocks same?

c. Is the work done by the frictional force on the upper block converted to heat or mechanical energy or both?

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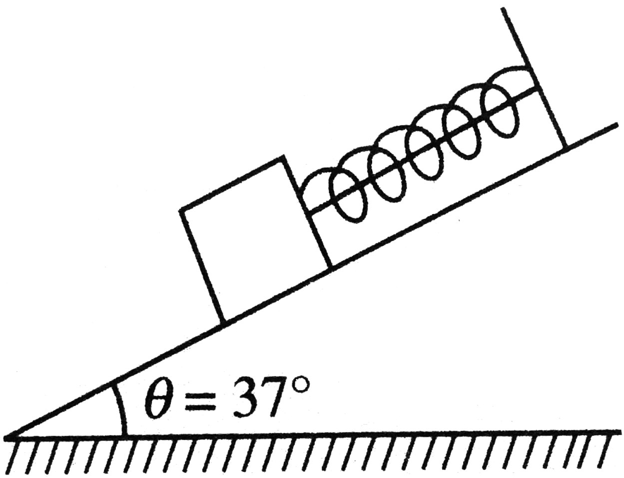
4. A small block of mass $m = 1kg$ is attached with one end of the spring of force constant $K = 110Nm^{-1}$. Other end of the spring is fixed to a rough plane having coefficient of friction $\mu = 0.2$. The spring is kept in its natural length by an inextensible thread ties between its ends as shown in figure. If the thread is burnt, calculate the elongation of the spring when the block attains static equilibrium position.



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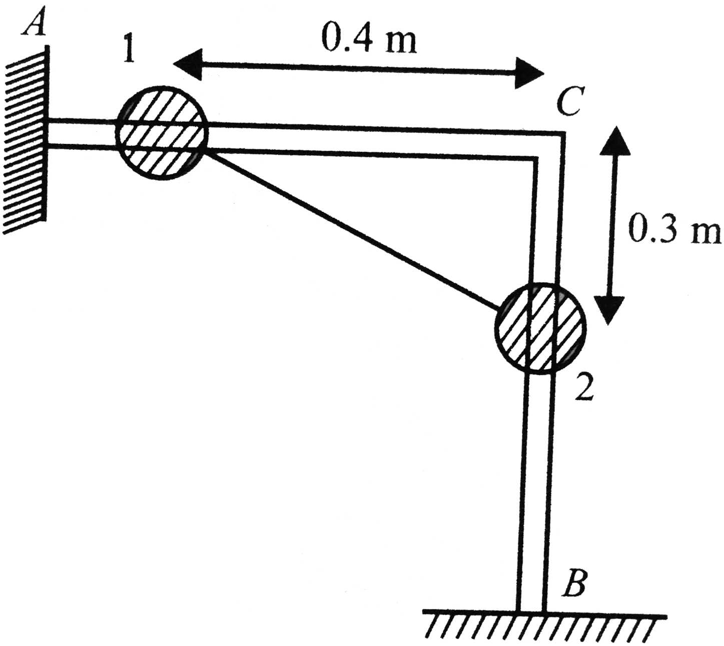
5. Two identical beads, each of $m = 100g$, are connected by an inextensible massless string, which can slide along the two arms AC and

BC of a rigid smooth wire frame in a vertical plane. If the system is released from rest, the kinetic energy of the first bead when the second bead has moved down by a distance of $0.1m$ is $\times x10^{-3}J$. Find the value of $x\left(g = 10ms^{-2}\right)$ (shown situation is after movement of $0.1m$).



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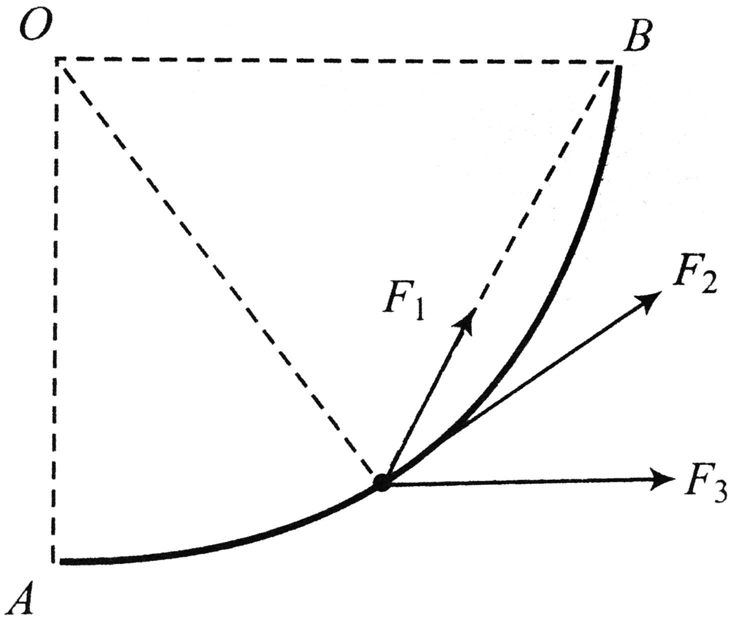
6. AB is a quarter of smooth circular track of radius $R = 6m$. A particle P of mass $0.5kg$ moves along the track from A to B under the action of the following forces.



a. A force F_1 directed always towards the point B, its magnitude is constant and is equal to $20N$.

b. A force F_2 directed along the instantaneous tangent to the circular track, its magnitude is $(15 - 10S)N$, where S is the distance travelled in metre.

c. A horizontal force of magnitude $30N$.

Find the work done by forces mentioned in (a), (b) and (c)

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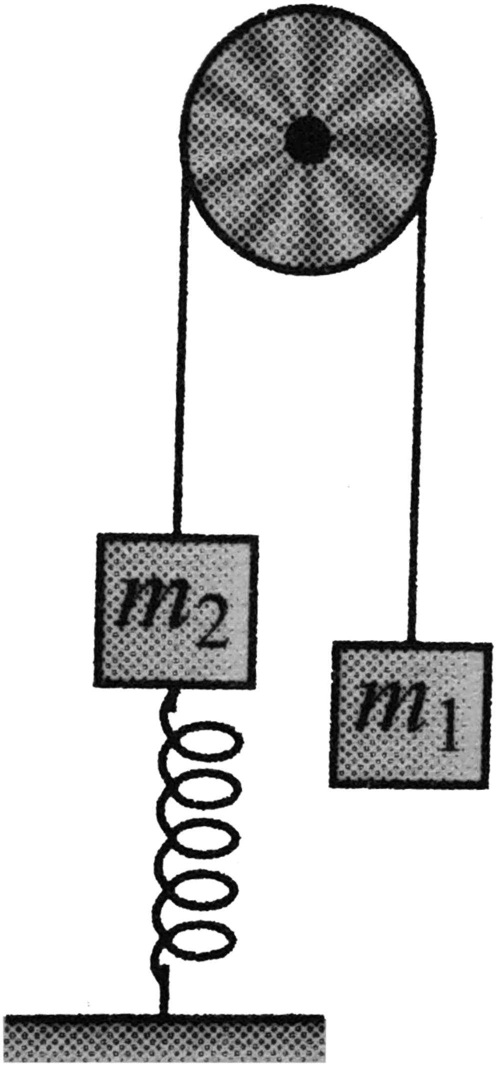
7. In an ideal pulley particle system, mass m_2 is connected with a vertical spring of stiffness k. If mass m_2 is released from rest, when the spring is underformed, find the maximum compression of the spring.



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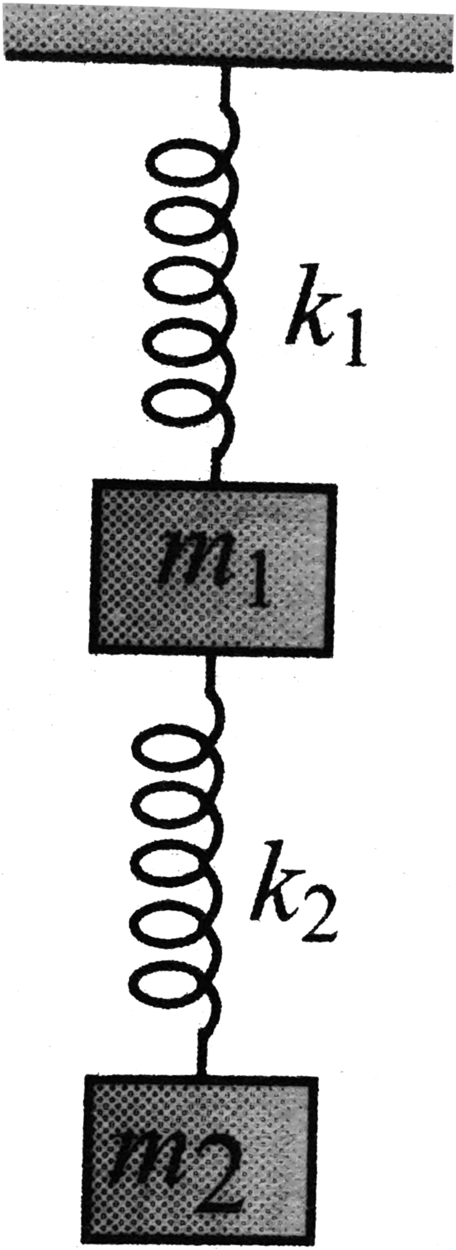
8. Given $k_1 = 1500Nm^{-1}, k_2 = 500Nm^{-1}, m_1 = 2kg, m_2 = 1kg$. Find:



a. potential energy stored in the spring in equilibrium, and

b. work done in slowly pulling down m_2 by $8cm$.

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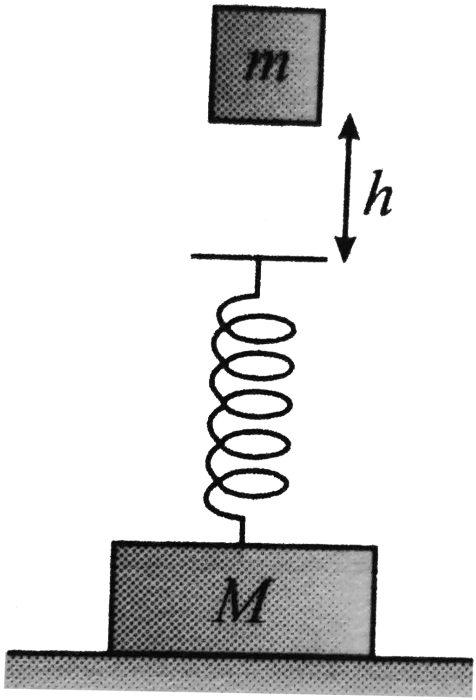
9. A block of mass m is dropped onto a spring of constant k from a height h. The second end of the spring is attached to a second block of mass M as shown in figure. Find the minimum value of h so that the block M bounces off the ground. If the block of mass m sticks to the spring immediately after it comes into contact with it.



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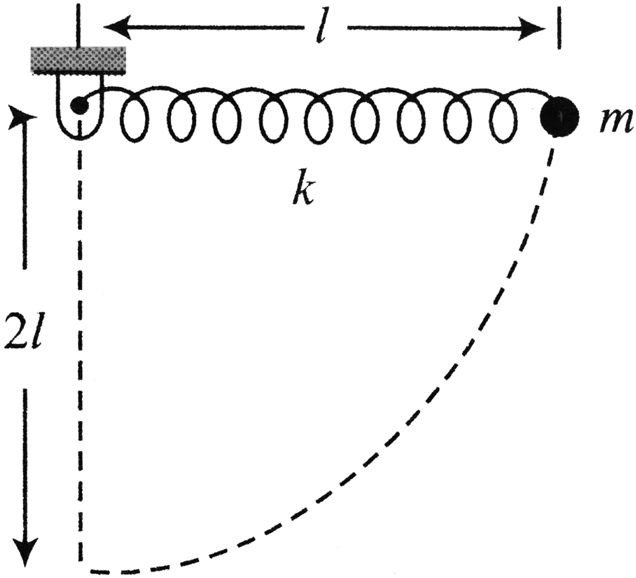
10. A particle of mass m attached with a massless spring natural length l and stiffness k is released from rest from the horizontal position of the relaxed spring. When the particle passes through its lowest point, the maximum length of the spring becomes $2l$. Find the:



a. speed of the particle at its lowest point.

b. acceleration of the particle at its lowest position.

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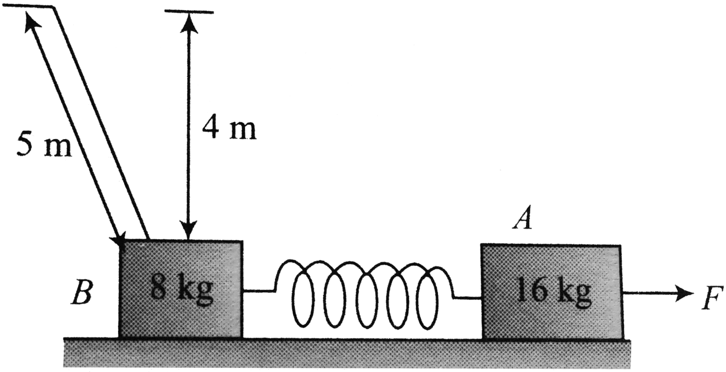
11. Two blocks having masses $8kg$ and $16kg$ are connected to the two ends of a light spring. The system is placed on a smooth horizontal floor. An inextensible string also connects B with ceiling as shown in the figure at the initial moment. Initially the spring has its natural length. A constant horizontal force F is applied to the heavier block as shown.

What is the maximum possible value of F so the lighter block doesn't loose contact with ground?



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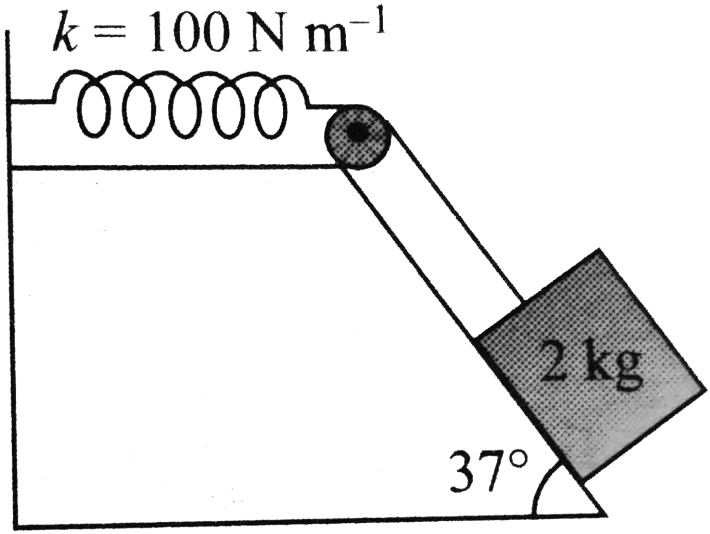
12. a. A $2-kg$ situated on a smooth fixed incline is connected to a spring of negligible mass, with spring constant $k=100Nm^{-1}$, via a frictionless pulley. The block is released from rest when the spring is unstretched. How far does the block moves down the incline before coming (momentarily) to rest? What is its acceleration at its lower point?



b. The experiment is repeated on a rough incline. If the block is observed to move $0.20m$ down along the incline before it comes to instantaneous rest, calculate the coefficient of kinetic friction.

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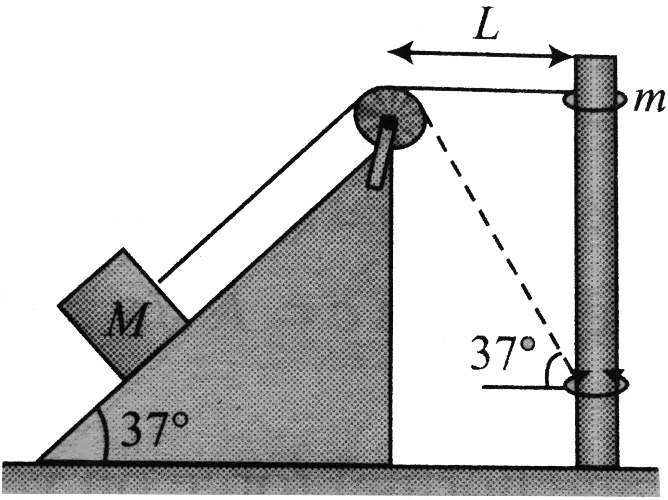
13. A ring of mass $m = 1kg$ can slide over a smooth vertical rod. A light string attached to the ring passing over a smooth fixed pulley at a distance of $L = 0.7m$ from the rod as shown in figure.



At the other end of the string mass $M = 5kg$ is attached, lying over a smooth fixed inclined plane of inclination angle 37°. The ring is held in level with the pulley and released. Determine the velocity of ring when the string makes an angle $(\alpha = 37^\circ)$ with the horizontal. $[\sin 37^\circ = 0.6]$

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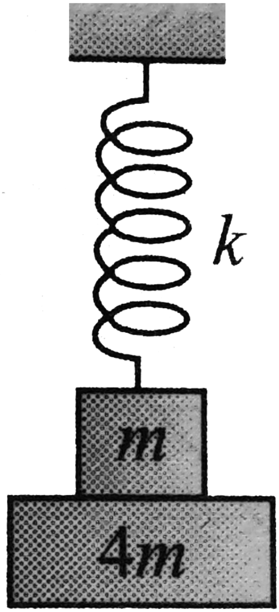
14. Find how much mass m will rise if $4m$ falls away. Blocks are at rest and in equilibrium.



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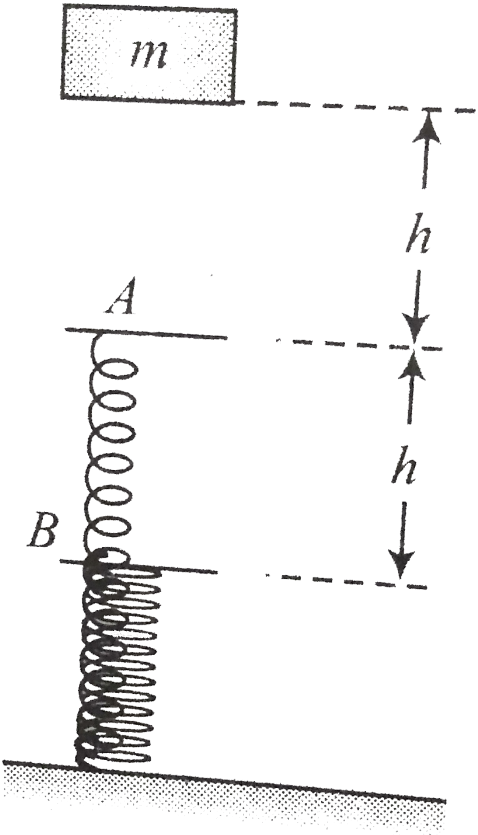
15. A block of mass m is released from rest onto a spring. A having stiffness $k_A = mg/2h$ as shown in figure. If the block compresses spring B through a distance h, find the:



a. stiffness of the spring B

b. equilibrium position of the block

c. maximum velocity of the block

d. maximum acceleration of the block

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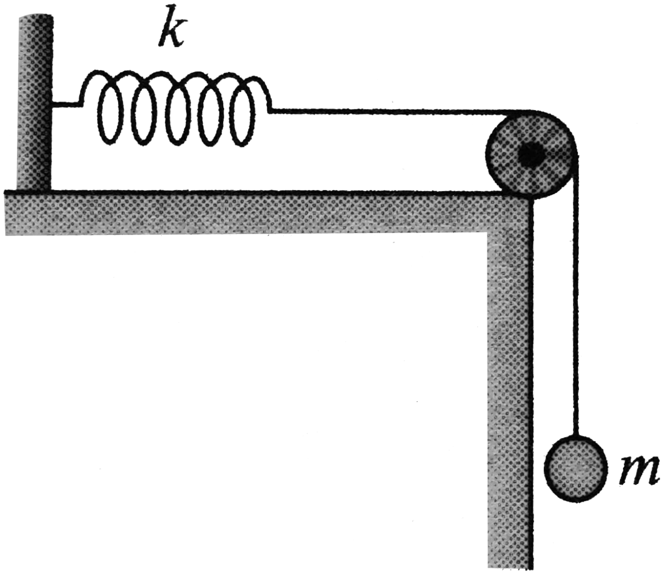
16. In figure, the light spring is of force constant k and is on a smooth horizontal surface. Initially the spring is relaxed. Calculate the work done by an external agent to lower the hanging body of mass M slowly, till it remains in equilibrium.



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17. A vehicle of mass m starts moving along a horizontal circle of radius R such that its speed varies with distance s covered by the vehicle as

$c = K\sqrt{s}$, where K is a constant. Calculate:

a. Tangential and normal force on vehicle as fucntion of s.

b. Distance s in terms of time t.

c. Work done by the resultant force in first t seconds after the beginning of motion.

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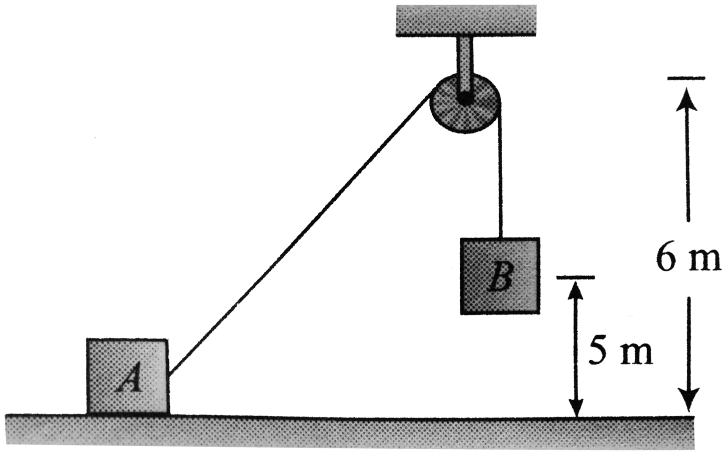
18. A block A of mass m is held at rest on a smooth horizontal floor. A light frictionless, small pulley is fixed at a height of $6m$ from the floor. A light inextensible string of length $16m$, connected with A passes over the pulley and another identical block B is hung from the string. Initial height of B is $5m$ from the floor as shown in figure



When the system is released from rest, B starts to move vertically downwards and A slides on the floor towards right.

a. If at an instant string makes an angle θ with horizontal, calculate relation between velocity u of A and v of B.

b. Calculate v when B strikes the floor. ($g = 10ms^{-2}$).

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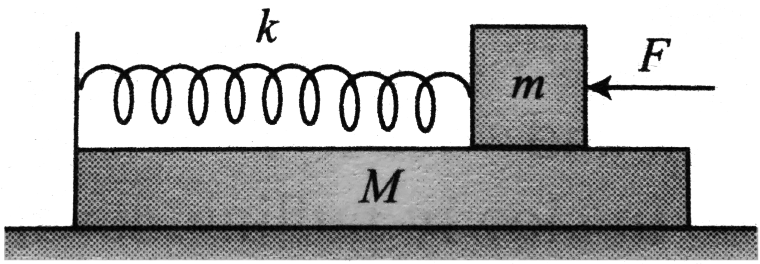
19. A constant force F pushes the block m till the wedge M starts sliding. If the stiffness of the light spring connecting M and m is K, coefficient of friction between block and wedge is μ_1 and between the wedge and ground is μ_2, find the value of the force F



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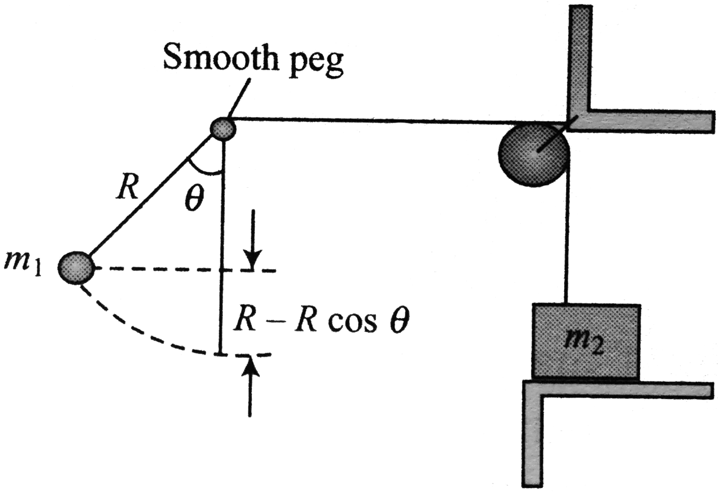
20. Two blocks are connected by a massless string that passes over a frictionless peg as shown in figure. One end of the string is attached to a mass $m_1 = 3kg$, i.e., a distance $R = 1.20m$ from the peg. The other end of the string is connected to a block of mass $m_2 = 6kg$ resting on a table. From what angle θ, measured from the vertical, must the $3 - kg$

block be released in order to just lift the $6kg$ block off the table?



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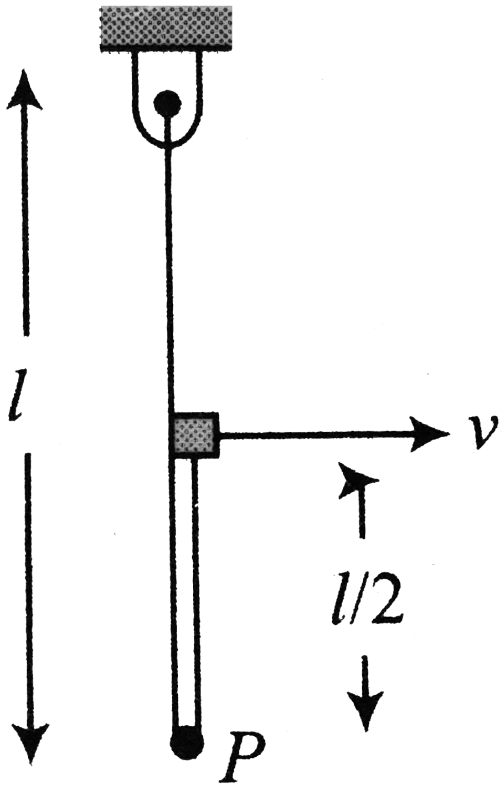
21. A bob of mass m is projected with a horizontal velocity $v = \sqrt{\frac{gl}{2}}$ as shown in figure. In consequence, it moves in a circular path in a vertical plane by the inextensible string which passes over the smooth fixed peg.

Find the maximum angle that the bob swings in the left hand side.



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22. A block is projected with a speed v_0 such that it strikes the point of projection after describing the path as shown by the dotted line. If friction exists for the parth of length d and the vertical circular path is smooth, assuming μ=coefficient of friction,

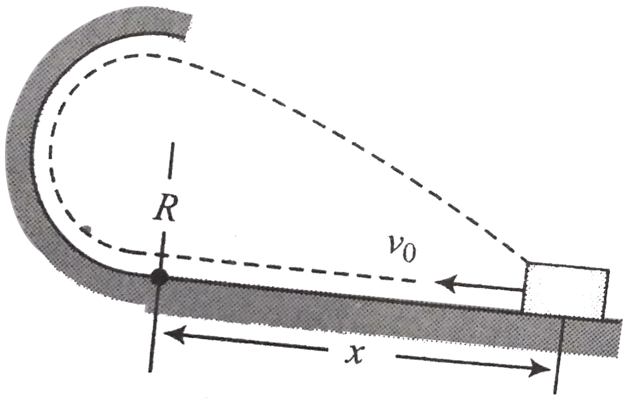

Fig. 8.225

a. Find v_0.

b. What is the minimum value of v_0?

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23. A small ball is suspended from point O by a thread of length l. A nail is driven into the wall at a distance of $l/2$ below O, at A. The ball is drawn aside so that the thread takes up a horizontal position at the level of point O and then released. Find

a. At what angle from the vertical of the ball's trajectory, will the tension in the thread disappear?

b. What will be the highest point from the lowermost point of circular track, to which it will rise?

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Single Correct

1. The displacement x in meter of a particle of mass mkg moving in one dimenstion under the action of a force is related to the time t in second by the equation $x = (t - 3)^2$. The work done by the force (in joules) in first six seconds is

A. (a) $18m$

B. (b) Zero

C. (c) $9m/2$

D. (d) $36m$

Answer: B

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2. A mass M is lowered with the help of a string by a distance h at a distance acceleration $g/2$. The work done by the string will be

A. (a) $\frac{Mgh}{2}$

B. (b) $-\frac{Mgh}{2}$

C. (c) $\frac{3Mgh}{2}$

D. (d) $-\frac{3Mgh}{2}$

Answer: B

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3. A force of $\overrightarrow{F} = 2x\hat{i} + 2\hat{j} + 3z^2\hat{k}N$ is acting on a particle. Find the work done by this force in displacing the body from $(1, 2, 3)m$ to $(3, 6, 1)m$.

A. (a) $-10J$

B. (b) $100J$

C. (c) $10J$

D. (d) $1J$

Answer: A

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4. Two identical $5kg$ blocks are moving with same speed of $2ms^{-1}$ towards each other along a frictionless horizontal surface. The two blocks collide, stick together, and come to rest. Consider the two blocks as a system. The works done by external and internal forces are, respectively,

A. 0, 0

B. (b) 0, 20J

C. (c) 0, -20J

D. (d) 20J, -20J

Answer: C

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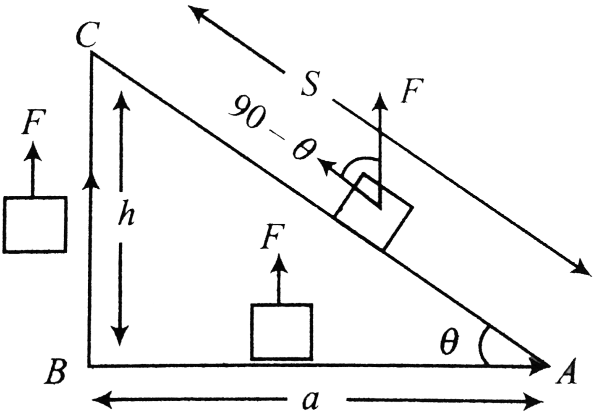
5. If we shift a body in equilibrium from A to C in a gravitational field via path AC or ABC,



A. (a) The work done by the force $\vec{F}$ for both paths will be same

B. (b) $W_{AC} > W_{ABC}$

C. (c) $W_{AC} < W_{ABC}$

D. (d) None of the above

Answer: A

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6. In which of the following cases can the work done increase the potential energy?

A. (a) Both conservative and non-conservative forces

B. (b) Conservative force only

C. (c) Non-conservative force only

D. (d) Neither conservative nor non-conservative forces.

Answer: B

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7. Work done by the conservative force on a system is equal to :

A. (a) The change in kinetic energy of the system

B. (b) The change in potential energy of the system

C. (c) The change in total mechanical energy of the system

D. (d) None of the above

Answer: B

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8. Which of the following statements is correct?

A. (a) Kinetic energy of a system can be changed without changing its momentum.

B. (b) Kinetic energy of a system cannot be changed without changing its momentum.

C. (c) Momentum of a system cannot be changed without changing its kinetic energy.

D. (d) A system cannot have energy without having momentum.

Answer: A

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9. A man M_1 of mass $80kg$ runs up a staircase in $15s$. Another man M_2 also of mass $80kg$ runs up the same staircase in $20s$. The ratio of the power development by then will be:

A. (a) 1

B. (b) $\frac{4}{3}$

C. (c) $\frac{16}{9}$

D. (d) None of the above

Answer: B

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10. An engine pumps up $100kg$ water through a height of $10m$ in $5s$. If efficiency of the engine is 60%. What is the power of the engine? $Take g = 10ms^2$.

A. (a) $33kW$

B. (b) $3.3kW$

C. (c) $0.33kW$

D. (d) $0.033kW$

Answer: B

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11. A pump motor is used to deliver water at a certain rate from a given pipe. To obtain 'n' times water from the same pipe in the same time by what amount (a) the force and (b) power of the motor should be increased ?

A. (a) n^2 times

B. (b) n^3 times

C. (c) n times

D. (d) $n^{3/2}$ times

Answer: B

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12. An engine pumps water continously through a hose. Water leave the hose with a velocity v and m is the mass per unit length of the Water jet. What is the rate at Which kinetic energy is imparted to water?

A. (a) $\frac{1}{2}kv^2$

B. (b) $\frac{1}{2}kv^3$

C. (c) $\frac{v^2}{2k}$

D. (d) $\frac{v^3}{2k}$

Answer: B

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13. A bus can be stopped by applying a retarding force F when it is moving with speed v on a level road. The distance covered by it before coming to rest is s. If the load of the bus increase by 50% because of passengers, for the same speed and same retarding force, the distance covered by the bus to come to rest shall be

A. $1.5s$

B. $2s$

C. $1s$

D. $2.5s$

Answer: A

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14. A heavy weight is suspended from a spring . A person raises the weight till the spring becomes slack . The done by him is W. The energy stored in the stretched spring was E . What will be the gain in gravitational potential energy?

A. (a) W

B. (b) E

C. (c) $W + E$

D. (d) $W - E$

Answer: C

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15. The speed v reached by a car of mass m in travelling a distance x, driven with constant power P, is given by

A. (a) $v = \frac{3xP}{m}$

B. (b) $v = \left(\frac{3xP}{m}\right)^{1/2}$

C. (c) $v = \left(\frac{3xP}{m}\right)^{1/3}$

D. (d) $v = \left(\frac{3xP}{m}\right)^{2}$

Answer: C

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16. Power supplied to a mass $2kg$ varies with time as $P = \frac{3t^2}{2}$ watt. Here t is in second . If velocity of particle at $t = 0$ is $v = 0$, the velocity of particle at time $t = 2s$ will be:

A. (a) $1ms^{-1}$

B. (b) $4ms^{-1}$

C. (c) $2ms^{-1}$

D. (d) $2\sqrt{2}ms^{-1}$

Answer: C

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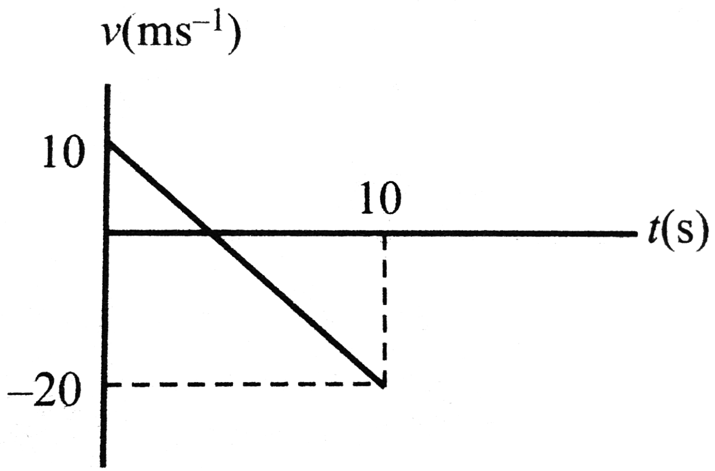
17. The velocity-time graph of a particle moving in a straight line is shown in figure. The mass of the particle is $2kg$. Work done by all the forces acting on the particle in time interval between $t = 0$ to $t = 10s$ is



A. (a) $300J$

B. (b) $-300J$

C. (c) $400J$

D. (d) $-400J$

Answer: A

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18. A body is moved along a straight line by a machine delivering constant power . The distance moved by the body is time t is proptional to

A. (a) $\sqrt{t}$

B. (b) $t^{3/4}$

C. (c) $t^{3/2}$

D. (d) t^2

Answer: C

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19. A car drives along a straight level frictionless road by an engine delivering constant power. Then velocity is directly proportional to

A. (a) $\sqrt{t}$

B. (b) $\frac{1}{\sqrt{t}}$

C. (c) $\sqrt{t}$

D. (d) None of the above

Answer: C

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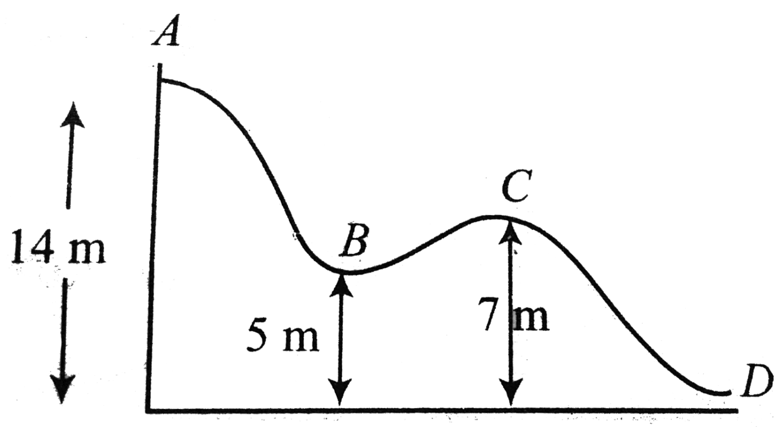
20. Figure shows the vertical section of a frictionless surface. A block of mass $2kg$ is released from rest from position A, its KE as it reaches position C is $(g = 10ms^{-2})$



A. (a) $140J$

B. (b) $180J$

C. (c) $120J$

D. (d) $280J$

Answer: A

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21. The kinetic energy K of a particle moving along a circle of radius R depends upon the distance s as $K = as^2$. The force acting on the particle is

A. (a) $2a\frac{s^2}{R}$

B. (b) $2as\left[1 + \frac{s^2}{R}\right]^{1/2}$

C. (c) $2as$

D. (d) $2a$

Answer: B

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22. A particle of mass in is moving in a circular with of constant radius r such that its contripetal accelenation a_c is varying with time t as $a_c = K^2 r t^2$ where K` is a constant . The power delivered to the particles by the force action on it is

A. (a) zero

B. (b) $mk^2 r^2 t^2$

C. (c) $mk^2 r^2 t$

D. (d) $mk^2 r t$

Answer: C

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23. An object of mass m slides down a hill of arbitrary shape and after travelling a certain horizontal path stops because of friction. The total vertical height descended is h. The friction coefficient is different for different segments for the entire path but is independent of the velocity and direction of motion. The work that a tangerial force must perform to return the object to its initial position along the same path is

A. (a) mgh

B. (b) $-mgh$

C. (c) $-2mgh$

D. (d) $2mgh$

Answer: D

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24. A toy gun a spring of force constant k. When changed before being triggered in the upward direction, the spring is compressed by a distance

x. If the mass of the shot is m, on the being triggered it will go up to a height of

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

B. $\frac{x^2}{Kmg}$

C. $\frac{Kx^2}{2mg}$

D. $\frac{K^2x^2}{mg}$

Answer: C

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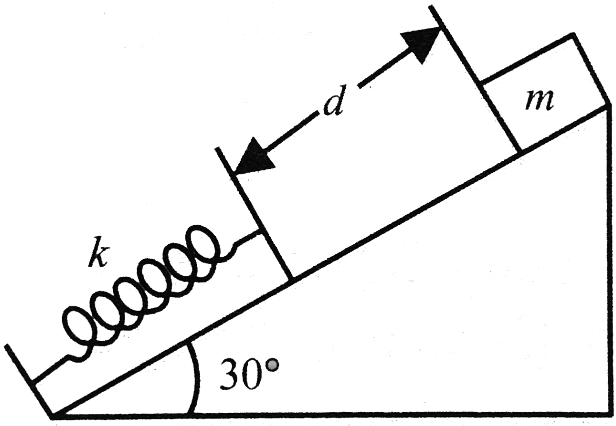
25. A block of $4kg$ mass starts at rest and slides a distance d down a friction less incline (angle 30°) where it runs into a spring of negligible mass. The block slides an additional $25m$ before it is brought to rest momentarily by compressing the spring. The force constant of the spring is $400 Nm^{-1}$. The value of d is (take $g = 10 ms^{-2}$)



A. (a) $25 cm$

B. (b) $37.5 cm$

C. (c) $62.5 cm$

D. (d) None of the above

Answer: B

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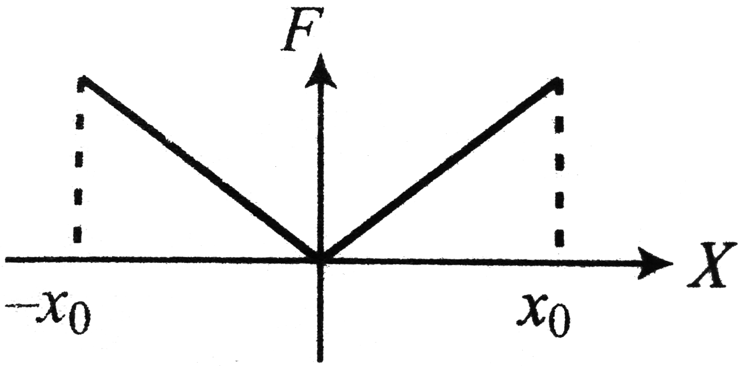
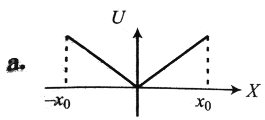
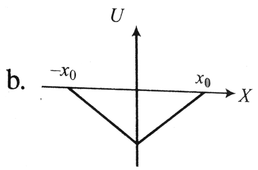
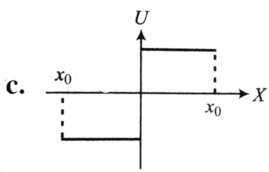
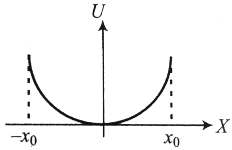
26. Figure shows a plot of the conservative force F in a unidimensional field. The plot representing the function corresponding to the potential energy (U) in the field is



A. 

B. 

C. 

D. d. 

Answer: D

Watch Video Solution

27. A spring is compressed between two toy carts to masses m_1 and m_2. When the toy carts are released, the spring exerts on each toy cart equal and opposite forces for the same small time t. If the coefficients of friction μ between the ground and the toy carts are equal, then the magnitude of displacements of the toy carts are in the ratio

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

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

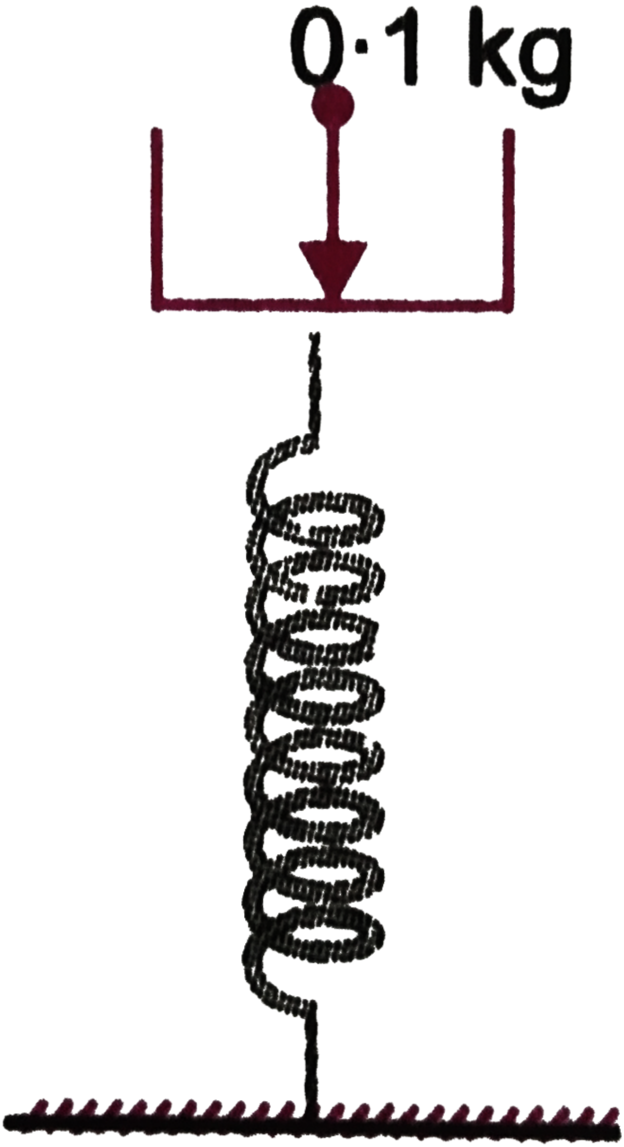
C. (c) $\frac{S_1}{S_2} = \left(\frac{m_2}{m_1}\right)^2$

D. (d) $\frac{S_1}{S_2} = \left(\frac{m_1}{m_2}\right)^2$

Answer: C

Watch Video Solution

28. A massless platform is kept on a light elastic spring as shown in figure. When a small stone of mass 0.1 kg is dropped on the pan from a height of 0.24 m, the spring compresses by 0.01m. From what height should the stone be droppped to cause a compression of 0.04m in the spring ?



A. $0.96m$

B. $2.96m$

C. $3.96m$

D. $0.48m$

Answer: C

Watch Video Solution

29. A partical is realeased from the top of two inclined rought surface of height h each. The angle of inclination of the two planes are 30° and 60° respectively. All other factors (e.g. coefficient of friction , mass of the block etc) are same in both the cases. Let $K_1 \text{ and } K_2$ be the kinetic energy of the partical at the bottom of the plane in two cases. Then

A. (a) $K_1 = K_2$

B. (b) $K_1 > K_2$

C. (c) $K_1 < K_2$

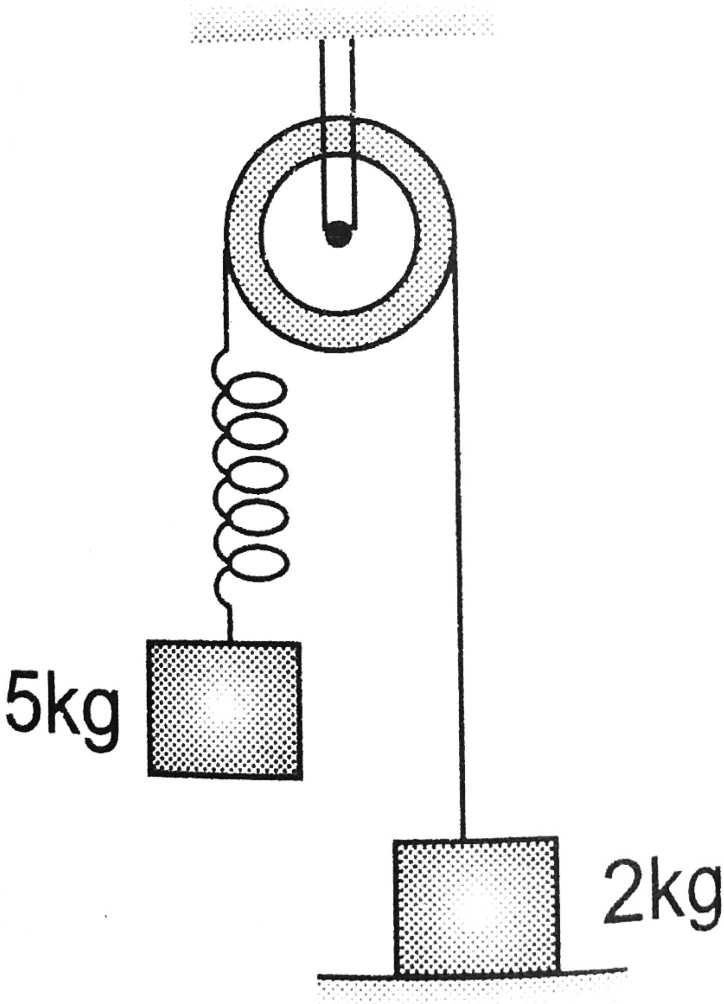
D. (d) Data insufficient

Answer: C

Watch Video Solution

30. System shown in figure is released from rest . Pulley and spring is mass less and friction is absent everywhere. The speed of $5kg$ block when $2kg$ block leaves the constant of with ground is (force constant of spring

$k = 40N/m$ and $g = 10m/s^2$)



A. (a) $\sqrt{2}ms^{-1}$

B. (b) $2\sqrt{2}ms^{-1}$

C. (c) $2ms^{-1}$

D. (d) $\sqrt{2}ms^{-1}$

Answer: B

Watch Video Solution

31. When a person stands on a weighing balance, working on the principle of Hooke's law, it shows a reading of $60kg$ after a long time and the spring gets compressed by $2.5cm$. If the person jumps on the balance from a height of $10cm$, the maximum reading of the balance will be

A. (a) $60kg$

B. (b) $120kg$

C. (c) $180kg$

D. (d) $240kg$

Answer: D

Watch Video Solution

32. A particle of mass m is projected at an angle α to the horizontal with an initial velocity u. The work done by gravity during the time it reaches its highest point is

A. (a) $u^2 \sin^2 \alpha$

B. (b) $\frac{mu^2 \cos^2 \alpha}{2}$

C. (c) $\frac{mu^2 \sin^2 \alpha}{2}$

D. (d) $-\frac{mu^2 \sin^2 \alpha}{2}$

Answer: D

Watch Video Solution

33. In the above question, the average power delivered by gravity is

A. (a) $-mgu \cos \alpha$

B. (b) $-mgu \sin \alpha$

C. (c) $-\frac{mgu \cos \alpha}{2}$

D. (d) $-\frac{mgu\sin\alpha}{2}$

Answer: D

Watch Video Solution

34. A person of mass $70kg$ jumps from a stationary helicopter with the parachute open. As he falls through $50m$ height, he gains a speed of $20ms^{-1}$. The work done by the viscous air drag is

A. $21000J$

B. $-21000J$

C. $-14000J$

D. $14000J$

Answer: B

Watch Video Solution

35. A particle located in a one-dimensional potential field has its potential energy function as $U(x) = \frac{a}{x^4} - \frac{b}{x^2}$, where a and b are positive constants. The position of equilibrium x corresponds to

A. (a) $\frac{b}{2a}$

B. (b) $\sqrt{\frac{2a}{b}}$

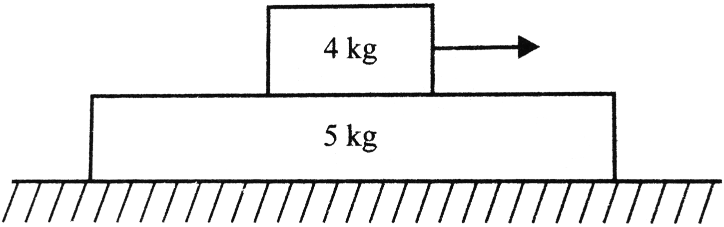
C. (c) $\sqrt{\frac{2b}{a}}$

D. (d) $\frac{a}{2a}$

Answer: B

Watch Video Solution

36. A large slab of mass $5kg$ lies on a smooth horizontal surface, with a block of mass $4kg$ lying on the top of it. The coefficient of friction between the block and the slab is 0.25. If the block is pulled horizontally by a force of F $= 6N$, the work done by the force of friction on the slab, between the instants $t = 2s$ and $t = 3s$, is $\left(g = 10ms^{-2}\right)$



A. (a) $2.4J$

B. (b) $5.55J$

C. (c) $4.44J$

D. (d) $10J$

Answer: B

Watch Video Solution

37. A small block of mass $2kg$ is kept on a rough inclined surface of inclination $\theta = 30^{\circ}$ fixed in a lift. The lift goes up with a uniform speed of $1ms^{-1}$ and the block does not slide relative to the inclined surface. The work done by the force of friction on the block in a time interval of $2s$ is

A. Zero

B. $9.8J$

C. $29.4J$

D. $16.9J$

Answer: B

Watch Video Solution

38. A particle of mass m moves with a variable velocity v, which changes with distance covered x along a straight line as $v = k\sqrt{x}$, where k is a positive constant. The work done by all the forces acting on the particle, during the first t seconds is

A. (a) $\frac{mk^4}{t^2}$

B. (b) $\frac{mk^4t^2}{4}$

C. (c) $\frac{mk^4t^2}{8}$

D. (d) $\frac{mk^4t^2}{16}$

Answer: C

Watch Video Solution

39. A particle of mass m moves along a circular path of radius r with a centripetal acceleration a_n changing with time t as $a_n = kt^2$, where k is a positive constant. The average power developed by all the forces acting on the particle during the first t_0 seconds is

A. (a) $mkrt_0$

B. (b) $\frac{mkrt_0^2}{2}$

C. (c) $\frac{mkrt_0}{2}$

D. (d) $\frac{mkrt_0}{4}$

Answer: C

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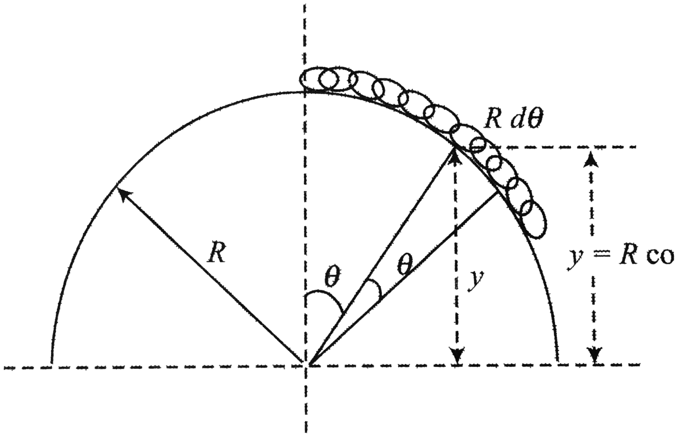
40. A chain of length l and mass m lies of the surface of a smooth hemisphere of radius $R > l$ with one end tied to the top of the hemisphere. Taking base of the hemisphere as reference line, find the gravitational potential energy of the chain.



A. (a) $\frac{mR^2 g}{l}\left(\frac{l}{R} - \frac{\sin l}{R}\right)$

B. (b) $\frac{mR^2 g}{2l}\left(\frac{l}{R} - sin\frac{l}{R}\right)$

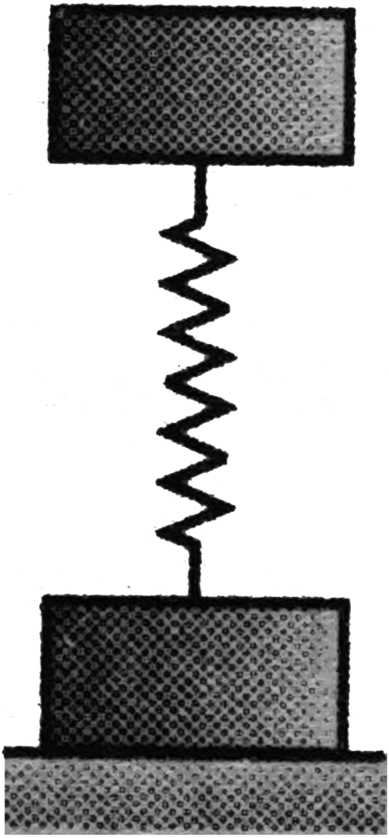
C. (c) $\frac{mR^2 g}{2l}\left(sin\frac{l}{R} - \frac{l}{R}\right)$

D. (d) $\frac{mR^2g}{l}\left(sin\frac{l}{R}-\frac{l}{R}\right)$

Answer: D

Watch Video Solution

41. Two discs, each having mass m, are attached rigidly to the ends of a vertical spring. One of the discs rests on a horizontal surface and the other produces a compression x_0 on the spring when it is in equilibrium. How much further must the spring be compressed so that when the force causing compression is removed, the extension of the spring will be able to lift the lower disc off the table?



A. (a) x_0

B. (b) $2x_0$

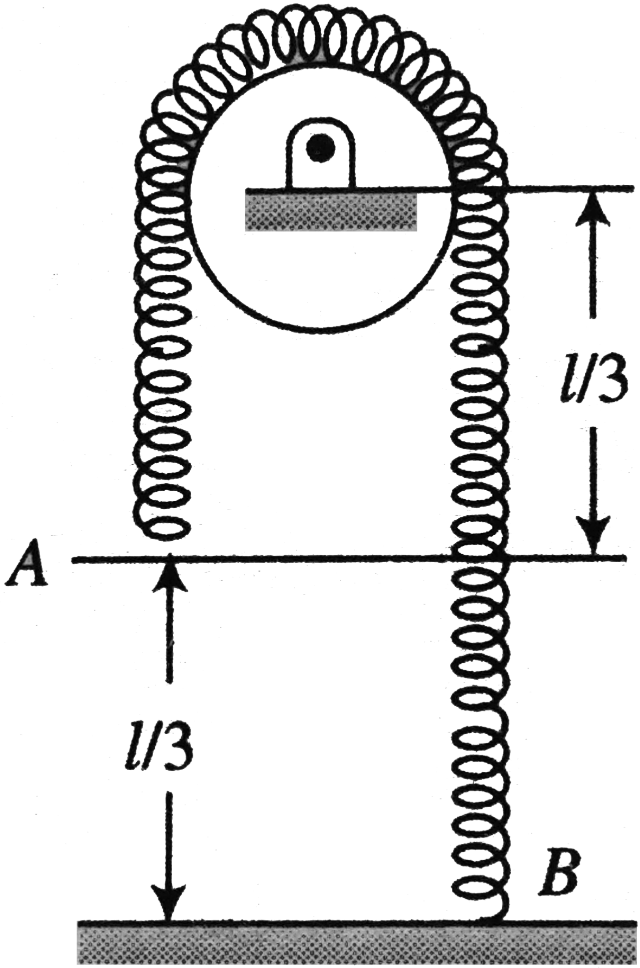
C. (c) $3x_0$

D. (d) $1.5x_0$

Answer: B

Watch Video Solution

42. Two ends A and B of a smooth chain of mass m and length l are situated as shown in figure. If an external agent pulls A till it comes to same level of B, work done by external agent is



A. (a) $\frac{mgl}{36}$

B. (b) $\frac{mgl}{15}$

C. (c) $\frac{mgl}{9}$

D. (d) None of the above

Answer: A

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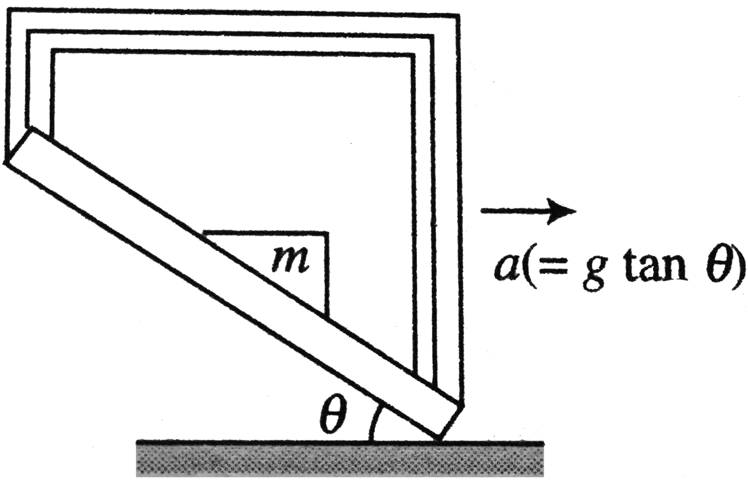
43. A block m is kept stationary on the surface of an accelerating cage as shown in figure. At the given instant, study the following statetments regarding the block.



i. Normal reaction performs positive work on the block.

ii. Frictional work done on the block is negative.

iii. No net work is done by normal reaction and friction on the block.

Now mark the correct answer.

A. (a) Only statement (i) is correct.

B. (b) Only statement (ii) is correct.

C. (c) Only statement (iii) is correct.

D. (d) All the statements are correct.

Answer: A

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44. A man places a chain (of mass m and length l) on a table slowly. Initially, the lower end of the chain just touches the table. The man brings down the chain by length $l/2$. Work done by the man in this process is

A. (a) $-mg\frac{1}{2}$

B. (b) $-\frac{mgl}{4}$

C. (c) $\frac{-3mgl}{8}$

D. (d) $-\frac{mgl}{8}$

Answer: C

Watch Video Solution

45. The potential energy of a particle of mass m free to move along the x-axis is given by $U = (1/2)kx^2$ for $x < 0$ and $U = 0$ for $x \geq 0$ (x denotes the x-coordinate of the particle and k is a positive constant). If the total mechanical energy of the particle is E, then its speed at $x = -\sqrt{2E/k}$ is

A. (a) Zero

B. (b) $\sqrt{\frac{2E}{m}}$

C. (c) $\sqrt{\frac{E}{m}}$

D. (d) $\sqrt{\frac{3E}{2m}}$

Answer: A

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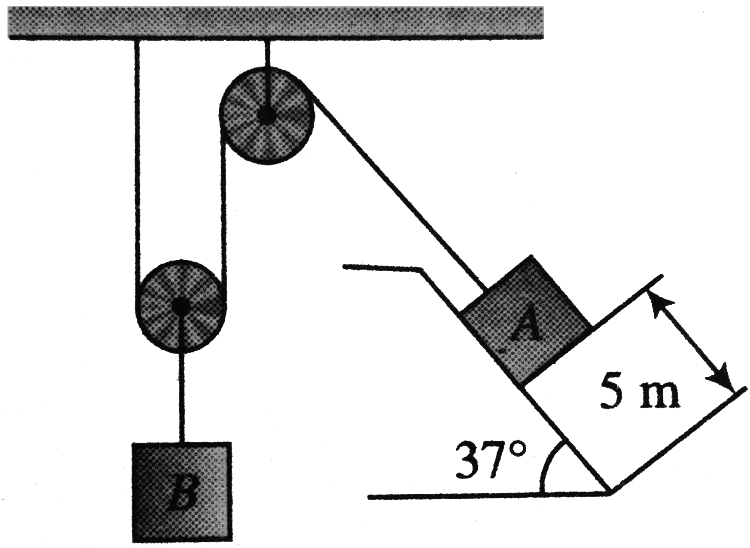
46. The blocks A and B shown in figure have masses $M_A = 5kg$ and $M_B = 4kg$. The system is released from rest. The speed of B after A has travelled a distance $1m$ along the incline is



A. (a) $\frac{\sqrt{3}}{2}\sqrt{g}$

B. (b) $\frac{\sqrt{3}}{4}\sqrt{g}$

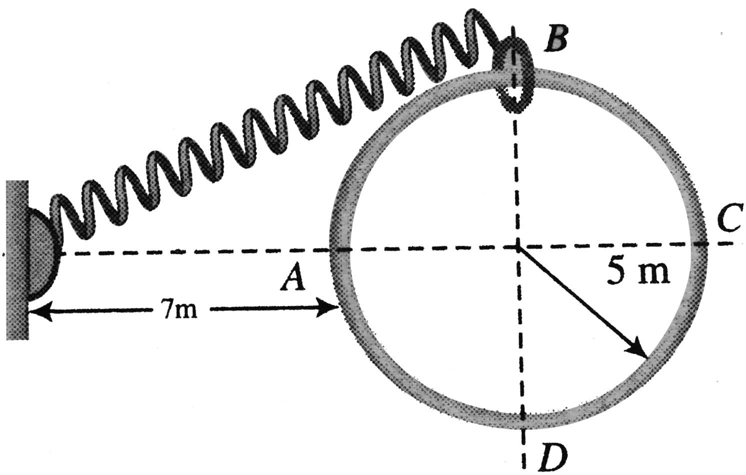
C. (c) $\frac{\sqrt{g}}{2\sqrt{3}}$

D. (d) $\frac{\sqrt{g}}{2}$

Answer: C

Watch Video Solution

47. A collar B of mass $2kg$ is constrained to move along a horizontal smooth and fixed circular track of radius $5m$. The spring lying in the plane of the circular track and having spring constant $200Nm^{-1}$ is underformed when the collar is at A. If the collar starts from rest at B, the normal reaction exerted by the track on the collar when it passes through A is



A. (a) $360N$

B. (b) $720N$

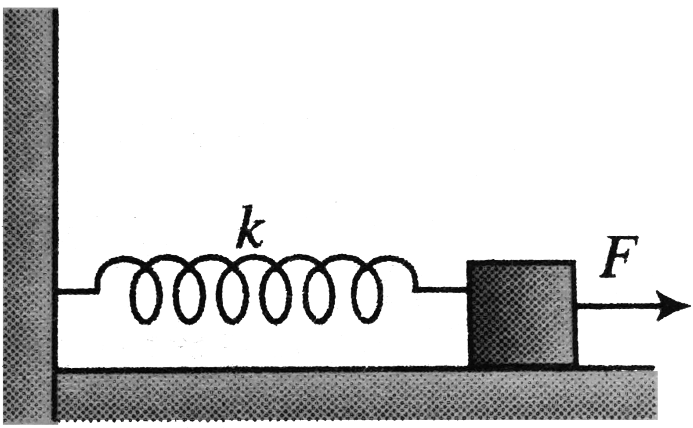
C. (c) $1440N$

D. (d) $2880N$

Answer: C

Watch Video Solution

48. A block attached to a spring, pulled by a constant horizontal force, is kept on a smooth surface as shown in figure. Initially, the spring is in the natural length state. Then the maximum positive work that the applied force F can do is (give that string does not break)



A. (a) $\frac{F^2}{k}$

B. (b) $\frac{2F^2}{k}$

C. (c) ∞

D. (d) $\frac{F^2}{2k}$

Answer: B

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49. A particle is projected along a horizontal field whose coefficient of friction varies as $\mu = A/r^2$, where r is the distance from the origin in meters and A is a positive constant. The initial distance of the particle is $1m$ from the origin and its velocity is radially outwards. The minimum initial velocity at this point so the particle never stops is

A. (a) ∞

B. (b) $2\sqrt{gA}$

C. (c) $\sqrt{2gA}$

D. (d) $4\sqrt{gA}$

Answer: C

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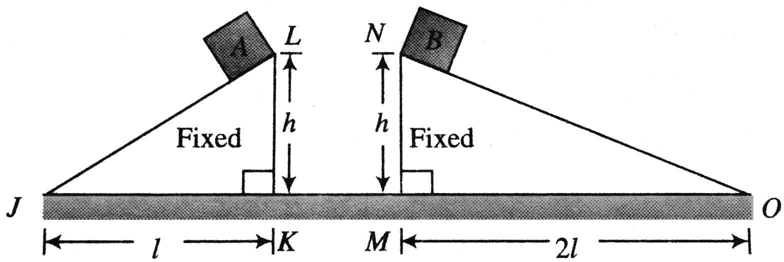
50. Two identical blocks A and B are placed on two inclined planes as shown in figure. Neglect resistance and other friction.



Read the following statements and choose options.

Statement I: The kinetic energy of A on sliding to J will be greater than the kinetic of B on sliding to O.

Statement II: The acceleration of A will be greater than acceleration of B when both are released on the inclined plane.

Statement III: The work done by external agent to move the block slowly from position B to O is negative.

A. (a) Only statement I is true

B. (b) Only statement II is true

C. (c) Only I and III are true

D. (d) Only II and III are true

Answer: D

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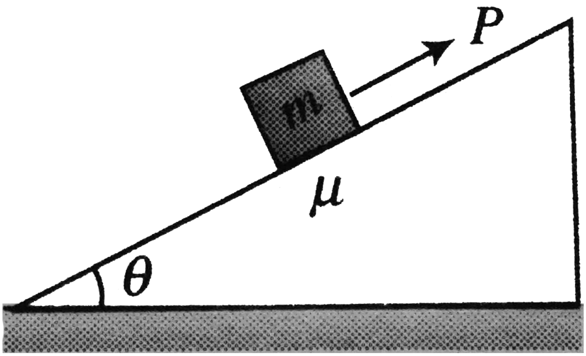
51. A block of mass m is being pulled up a rough incline by an agent delivering constant power P. The coefficient of friction between the block and the incline is μ. The maximum speed of the block during the course of ascent is



A. (a) $\dfrac{P}{mg\sin\theta+\mu mg\cos\theta}$

B. (b) $\dfrac{P}{mg\sin\theta-\mu mg\cos\theta}$

C. (c) $\dfrac{2P}{mg\sin\theta-\mu mg\cos\theta}$

D. (d) $\dfrac{3P}{mg\sin\theta-\mu mg\cos\theta}$

Answer: A

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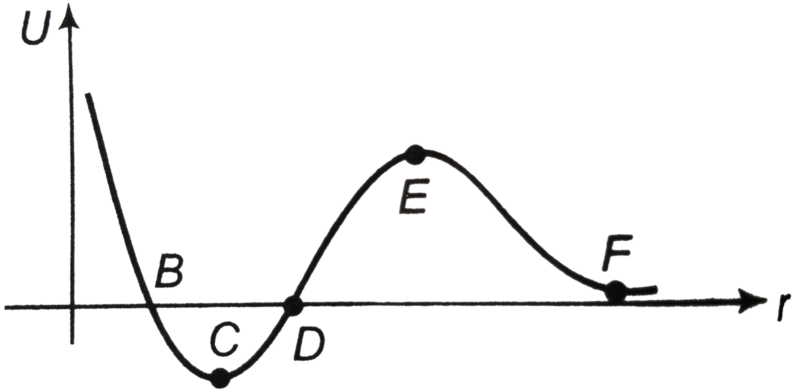
52. The given plot shows the variation of U, the potential energy of interaction between two particles with the distance separating them r,



A. (a) 1 and 3

B. (b) 1 and 4

C. (c) 2 and 4

D. (d) 2 and 3

Answer: C

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53. One end of an unstretched vertical spring is attached to the ceiling and an object attached to the other end is slowly lowered to its equilibrium position. If S is the gain in spring energy and G is the loss in gravitational potential energy in the process, then

A. (a) $S = G$

B. (b) $S = 2G$

C. (c) $G = 2S$

D. (d) None of the above

Answer: C

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54. The potential energy function associated with the force $\vec{F} = 4xy\hat{i} + 2x^2\hat{j}$ is

A. (a) $U = -2x^2y$

B. (b) $U = -2x^2y + constant$

C. (c) $U = 2x^2y + constant$

D. (d) Not defined

Answer: B

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55. The potential energy for a force filed $\overrightarrow{F}$ is given by $U(x, y) = \cos(x + y)$. The force acting on a particle at position given by coordinates $(0, \pi/4)$ is

A. (a) $-\frac{1}{\sqrt{2}}\left(\hat{i} + \hat{j}\right)$

B. (b) $\frac{1}{\sqrt{2}}\left(\hat{i} + \hat{j}\right)$

C. (c) $\left(\frac{1}{2}\hat{i} + \frac{\sqrt{3}}{2}\hat{j}\right)$

D. (d) $\left(\frac{1}{2}\hat{i} - \frac{\sqrt{3}}{2}\hat{j}\right)$

Answer: B

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56. A particle is projected with a velocity u making an angle θ with the horizontal. The instantaneous power of the gravitational force

A. (a) Varies linearly with time

B. (b) Is constant throughout

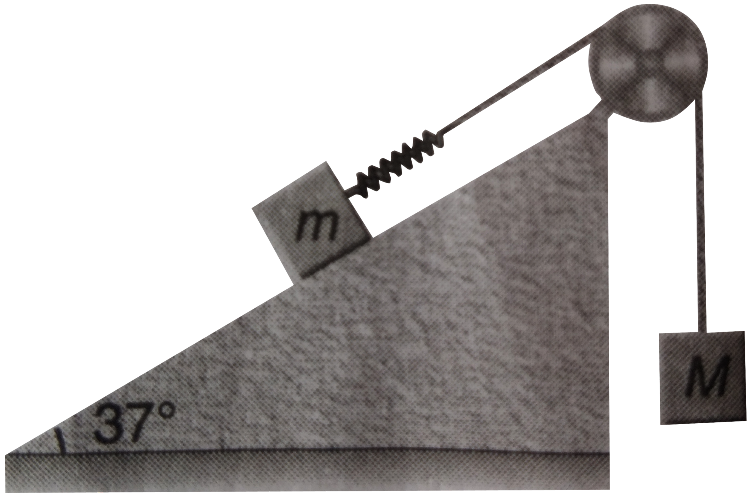
C. (c) Is negative for complete path

D. (d) None of the above

Answer: A

Watch Video Solution

57. A block of mass m is attached with a massless spring of force constant K. the block is placed over a rough inclined surface for which the coefficient of friction is $\mu = \frac{3}{4}$ find the minimum value of M required to move the block up the place. (Neglect mass of string and pulley. Ignore friction in pulley).



A. $\frac{3}{5}m$

B. $\frac{4}{5}m$

C. $\frac{6}{5}m$

D. $\frac{3}{2}m$

Answer: A

Watch Video Solution

58. In the above question, the maximum power delivered by the agent in pulling up the rope is

A. λ/gv

B. (b) $\lambda/gv+\frac{v^3\lambda}{2}$

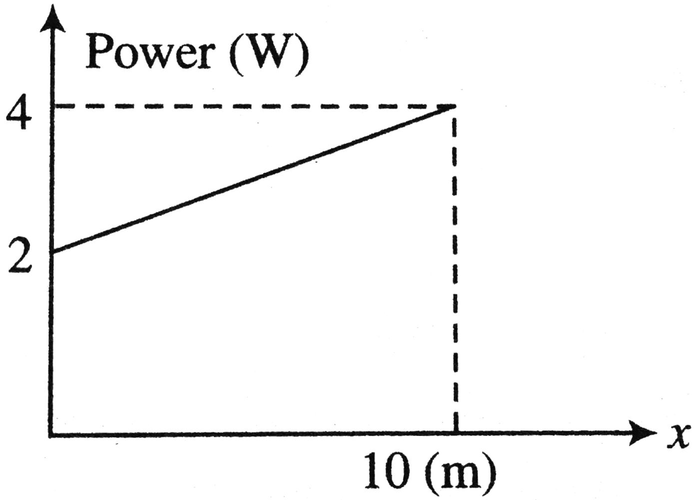
C. (c) $\lambda/gv+v^3\lambda$

D. (d) $\frac{llgv}{2}+\frac{\lambda v^3}{2}$

Answer: C

View Text Solution

59. A particle A of mass $10/7kg$ is moving in the positive direction of $x-a\xi s$. At initial position $x=0$, its velocity is $1ms^{-1}$, then its velocity at $x = 10m$ is (use the graph given)



A. (a) $4ms^{-1}$

B. (b) $2ms^{-1}$

C. (c) $3\sqrt{2}ms^{-1}$

D. (d) $\frac{100}{3}ms^{-1}$

Answer: A

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60. A particle is projected vertically upwards with a speed of $16ms^{-1}$. After some time, when it again passes through the point of projection, its speed is found to be $8ms^{-1}$. It is known that the work done by air resistance is same during upward and downward motion. Then the maximum height attained by the particle is (take $g = 10ms^{-2}$)

A. (a) $8m$

B. (b) $4.8m$

C. (c) $17.6m$

D. (d) $12.8m$

Answer: A

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61. An engine can pull four coaches at a maximum speed of $20ms^{-1}$. The mass of the engine is twice the mass of every coach. Assuming resistive forces to be proportional to the weight, approximate maximum speeds of the engine, when it pulls 12 and 6 coaches, are

A. (a) $8.5ms^{-1}$ and $15ms^{-1}$, respectively

B. (b) $6.5ms^{-1}$ and $8ms^{-1}$, respectively

C. (c) $8.5ms^{-1}$ and $13ms^{-1}$ respectively

D. (d) $10.5ms^{-1}$ and $15ms^{-1}$, respectively

Answer: A

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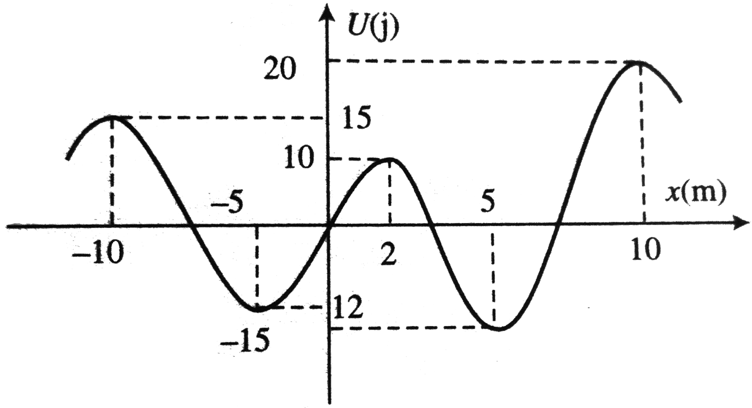
62. In figure, the variation of potential energy of a particle of mass $m = 2kg$ is represented w.r.t its x-coordinate. The particle moves under the effect of the conservative force along the x-axis. Which of the following statements is incorrect about the particle?



A. (a) If it is released at the origin, it will move in negative x-axis.

B. (b) If it is released at $x = 2 + \Delta$, where $\Delta \to 0$, then its maximum speed will be $5ms^{-1}$ and it will perform oscillatory motion.

C. (c) If initially $x = -10$ and $\vec{u} = \sqrt{6}\hat{i}$, then it will cross $x = 10$.

D. (d) $x = -5$ and $x = +5$ are unstable equilibrium positions of the particle.

Answer: D

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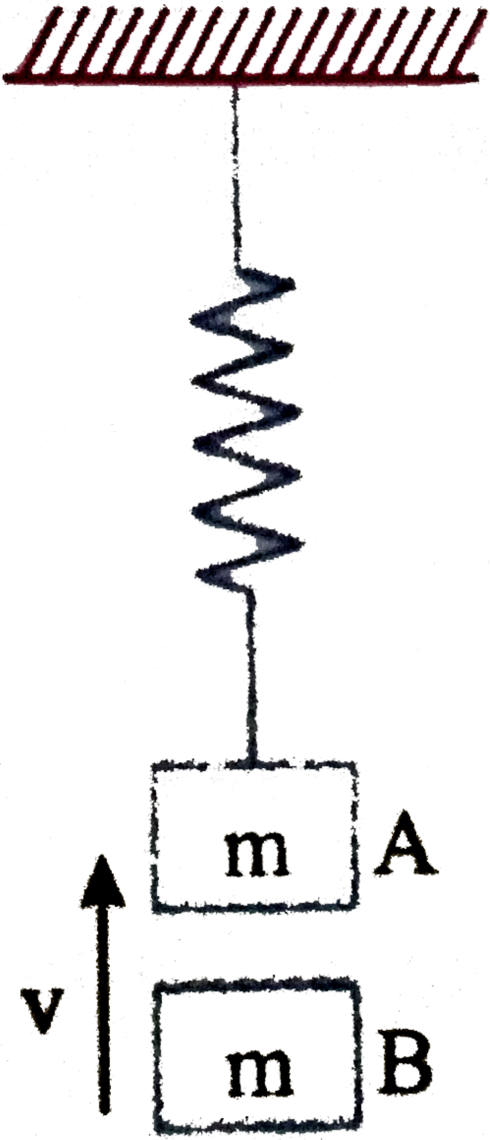
63. Block A is hanging from vertical spring of spring constant K and is rest. Block B strikes block A with velocity v and sticks to it. Then the value of v for which the spring just attains natural length is



A. (a) $\sqrt{\frac{60mg^2}{k}}$

B. (b) $\sqrt{\frac{6mg^2}{k}}$

C. (c) $\sqrt{\frac{10mg^2}{k}}$

D. (d) None of the above

Answer: B

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64. A machine delivers power to a body which is proportional to velocity of the body. If the body starts with a velocity which is almost negligible, then the distance covered by the body is proportional to

A. (a) $\sqrt{v}$

B. (b) $\sqrt[3]{\frac{v}{2}}$

C. (c) $v^{5/3}$

D. (d) v^2

Answer: D

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65. The kinetic energy acquired by a mass m travelling a certain distance d, starting from rest, under the action of a force F such that the force F is directly proportional to t is

A. (a) Directly proportional to t^2

B. (b) Independent of t

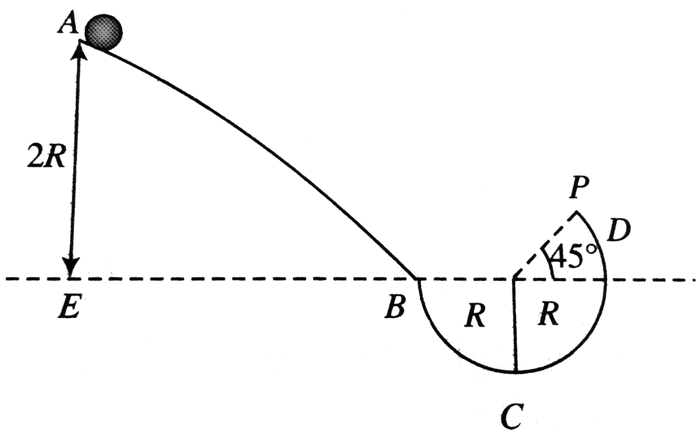
C. (c) Directly proportional to t^4

D. (d) Directly proportional to t

Answer: C

Watch Video Solution

66. A particle of mass m slides on a frictionaless surface ABCD, starting from rest as shown in figure. The part BCD is a circular arc. If it looses contact at point P, the maximum height attained by the particle from point C is



A. (a) $R\left[2+\frac{1}{2\sqrt{2}}\right]$

B. (b) $R\left[1+\frac{1}{2\sqrt{2}}\right]R$

C. (c) $3R$

D. (d) None of these

Answer: A

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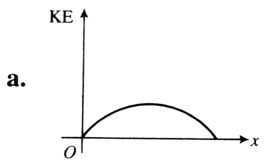
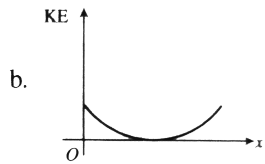
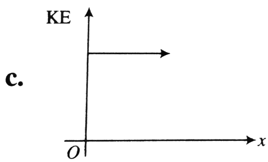
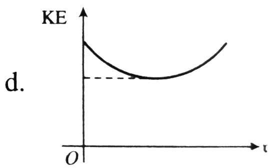
67. A projectile is fired with some velocity making certain angle with the horizontal. Which of the following graphs is the best representation for the kinetic energy of a projectile (KE) versus its horizontal displacement(x)?

A. 

B. 

C. 

D. 

Answer: D

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68. Two constant forces $\vec{F}_1$ and $\vec{F}_2$ act on a body of mass $8kg$. These forces displace the body from point $P(1, -2, 3)$ to $Q(2, 3, 7)$ in $2s$ starting from rest. Force $\vec{F}_1$ is of magnitude $9N$ and is acting along vector $\left(2\hat{i} - 2\hat{j} + \hat{k}\right)$. Work done by the force $\vec{F}_2$ is

A. (a) $80J$

B. (b) $-80J$

C. (c) $-180J$

D. (d) $180J$

Answer: D

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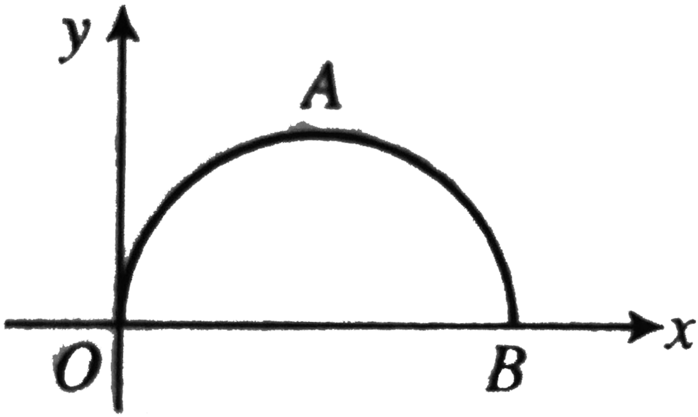
69. Given $\vec{F} = (xy^2)\hat{i} + (x^2y)\hat{j}N$. The work done by $\vec{F}$ when a particle is taken along the semicircular path OAB where the coordinates of B are

$(4, 0)$ is



A. (a) $\frac{65}{3}J$

B. (b) $\frac{75}{2}J$

C. (c) $\frac{73}{4}J$

D. (d) Zero

Answer: D

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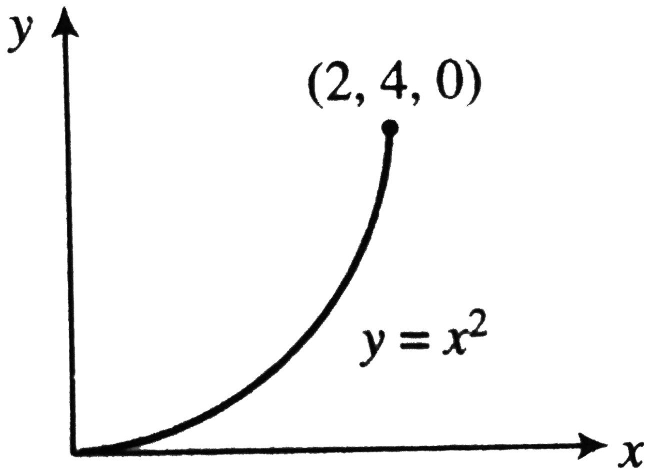
70. A force $\overrightarrow{F} = (3xy - 5z)\hat{j} + 4z\hat{k}$ is applied on a particle. The work done by the force when the particle moves from point $(0, 0, 0)$ to point $(2, 4, 0)$ as shown in figure.



A. (a) $\frac{280}{5} units$

B. (b) $\frac{140}{5} units$

C. (c) $\frac{232}{5} units$

D. (d) $\frac{192}{5} units$

Answer: D

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71. The potential energy of a particle is determined by the expression $U = \alpha(x^2 + y^2)$, where α is a positive constant. The particle begins to move from a point with coordinates $(3, 3)$, only under the action of potential field force. Then its kinetic energy T at the instant when the particle is at a point with the coordinates $(1, 1)$ is

A. (a) 8α

B. (b) 24α

C. (c) 16α

D. (d) Zero

Answer: C

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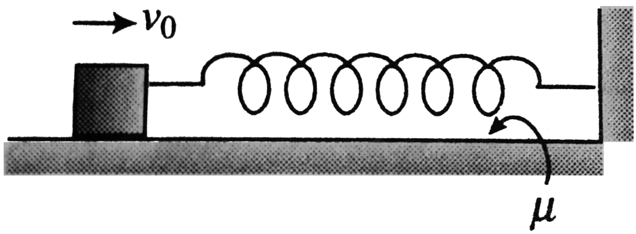
72. In the position shown in figure, the spring is at its natural length. The block of mass m is given a velocity v_0 towards the vertical support at

$t = 0$. The coefficient of friction between the block and the surface is given by $\mu = \alpha x$, where α is a positive constant and x is the position of the block from its starting position. The block comes to rest for the first time at x, which is



A. (a) $v_0\sqrt{\dfrac{m}{k + \alpha mg}}$

B. (b) $v_0\sqrt{\dfrac{m}{k}}$

C. (c) $v_0\sqrt{\dfrac{m}{\alpha g}}$

D. (d) None of these

Answer: A

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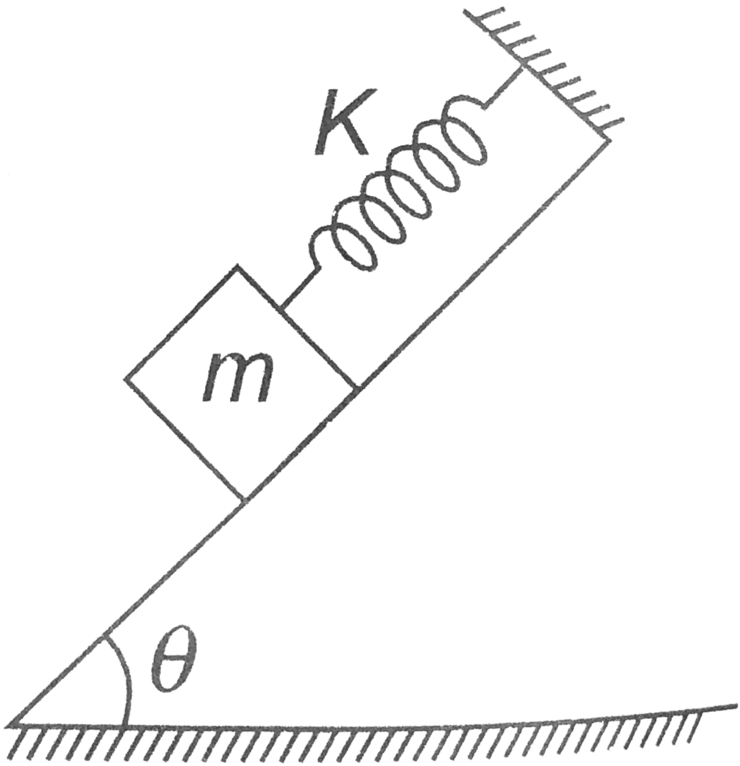
73. In the figure shown, a spring of spring constant K is fixed at on end and the other end is attached to the mass 'm' . The coefficient of friction between block and the inclined plane is μ. The block is released when the spring is in tis natural length. Assuming that the $\theta > \mu$, the maximum speed of the block during the motion is.



A. $(\sin\theta + \mu\cos\theta) g\sqrt{\frac{m}{k}}$

B. $(\sin\theta - \mu\cos\theta) g\sqrt{\frac{m}{k}}$

C. $(\cos\theta - \mu\sin\theta)g\sqrt{\frac{m}{k}}$

D. $(\cos\theta + \mu\sin\theta)g\sqrt{\frac{m}{k}}$

Answer: B

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74. Let r be the distance of a particle from a fixed point to which it is attracted by an inverse square law force given by $F = k/r^2$ (k=constant). Let m be the mass of the particle and L be its angular momentum with respect to the fixed point. Which of the following formulae is correct about the total energy of the system?

A. (a) $\frac{1}{2}m\left(\frac{dr}{dt}\right)^2 - \frac{k}{r} + \frac{L}{2mr^2} = Cons\tan t$

B. (b) $\frac{1}{2}m\left(\frac{dr}{dt}\right)^2 - \frac{k}{r} = Constant$

C. (c) $\frac{1}{2}m\left(\frac{dr}{dt}\right)^2 + \frac{k}{r} + \frac{L^2}{2mr^2} = Constant$

D. (d) None

Answer: A

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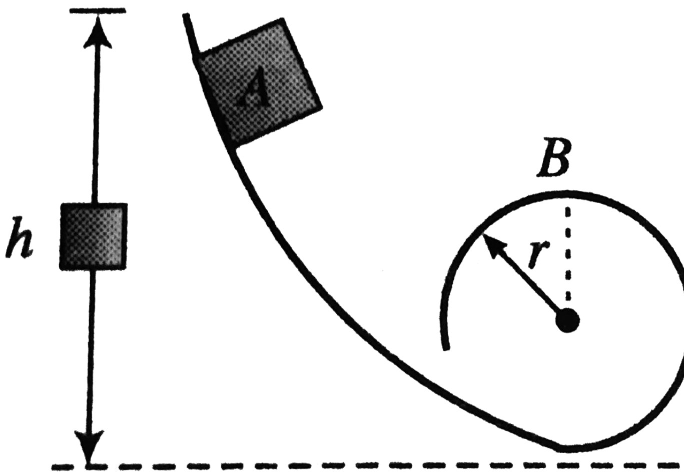
75. A mass m starting from A reaches B of a frictionless track. On reaching B, it pushes the track with a force equal to x times its weight, then the applicable relation is



A. (a) $h = \frac{(x+5)}{2} r$

B. (b) $h = \frac{x}{2} r$

C. (c) $h = r$

D. (d) $h = \left(\frac{x+1}{2}\right)r$

Answer: A

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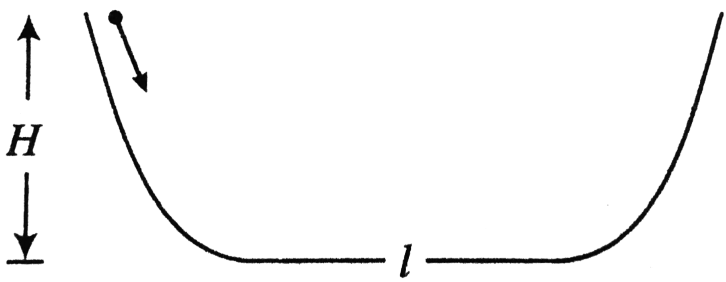
76. A particle of mass m slides along a curved-flat-curved track. The curved portions of the track are smooth. If the particle is released at the top of one of the curved portions, the particle comes to rest at flat portion of length l and of $\mu = \mu_{kinetic}$ after covering a distance of



A. (a) $\frac{l}{3\mu}$

B. (b) $\frac{H}{2\mu_{kinetic}}$

C. (c) $\frac{l}{6}$

D. (d) $\dfrac{H}{\mu_{kinetic}}$

Answer: D

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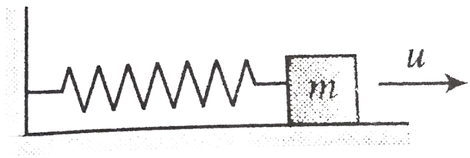
77. A block of mass m has initial velocity u having direction towards $+x$ axis. The block stops after covering a distnce S causing similar extension in the spring of constant K holding it. If μ is the kinetic friction between the block and the surface on which it was moving, the distance S is given



A. (a) $\dfrac{1}{K}\mu^2 m^2 g^2$

B. (b) $\dfrac{1}{K}\left(mKu^2 - \mu^2 m^2 g^2\right)^{1/2}$

C. (c) $\frac{1}{K}\left(\mu^2 m^2 g^2 + mK\mu^2 + \mu mg\right)^{1/2}$

D. (d) $\frac{-\mu mg + \sqrt{\mu^2 m^2 g^2 + mu^2 k}}{k}$

Answer: D

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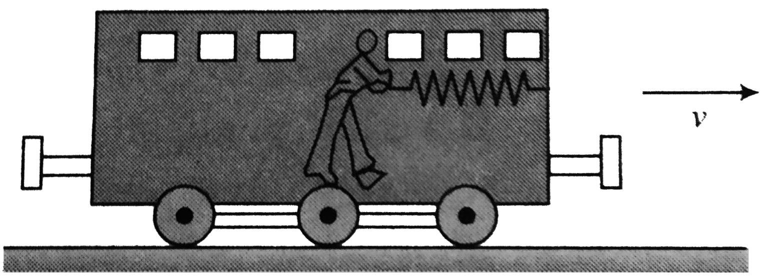
78. A moving railway compartment has a spring of constant k fixed to its front wall. A boy stretches this spring by distance x and in the mean time the compartment moves by a distance s. The work done by boy w.r.t. earth is



A. (a) $\frac{1}{2}kx^2$

B. (b) $\frac{1}{2}(kx)(s + x)$

C. (c) $\frac{1}{2}kxs$

D. (d) $\frac{1}{2}kx(s+x+s)$

Answer: A

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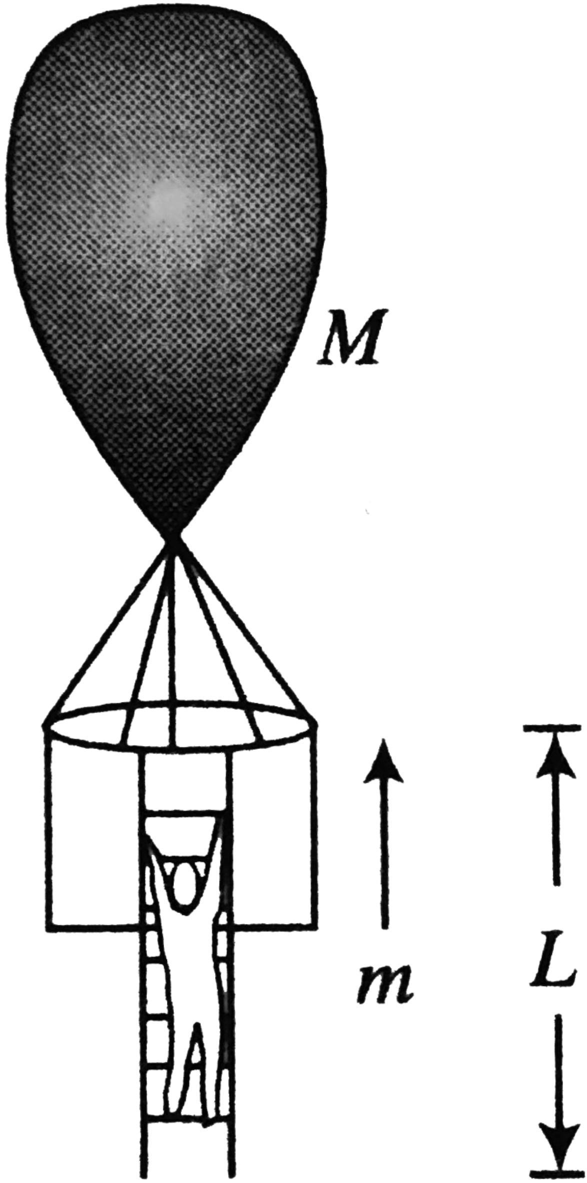
79. A rope ladder of length L is attached to a balloon of mass M. As the man of mass m climbs the ladder into the balloon basket, the balloon comes down by a vertical distance s. Then the increase in potential energy of man divided by the increase in potential energy of balloon is



A. $\frac{L-s}{s}$

B. $\frac{L}{s}$

C. $\frac{s}{L-s}$

D. $L-s$

Answer: A

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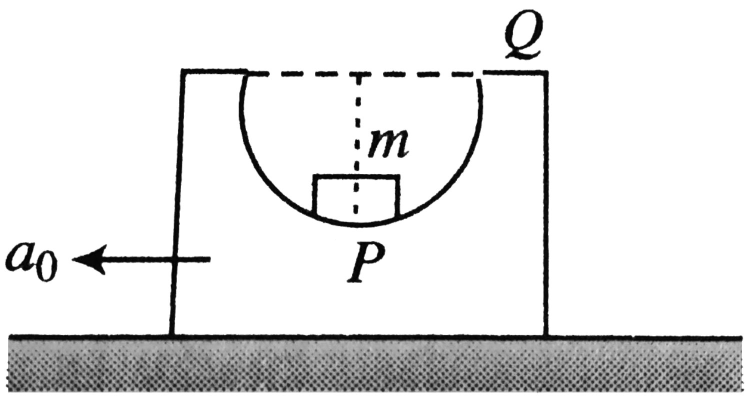
80. A block of mass m is lying at rest at point P of a wedge having a smooth semi-circular track of radius R. What should be the minimum value of a_0 so that the mass can just reach point Q



A. (a) $\frac{g}{2}$

B. (b) $\sqrt{g}$

C. (c) g

D. (d) Not possible

Answer: C

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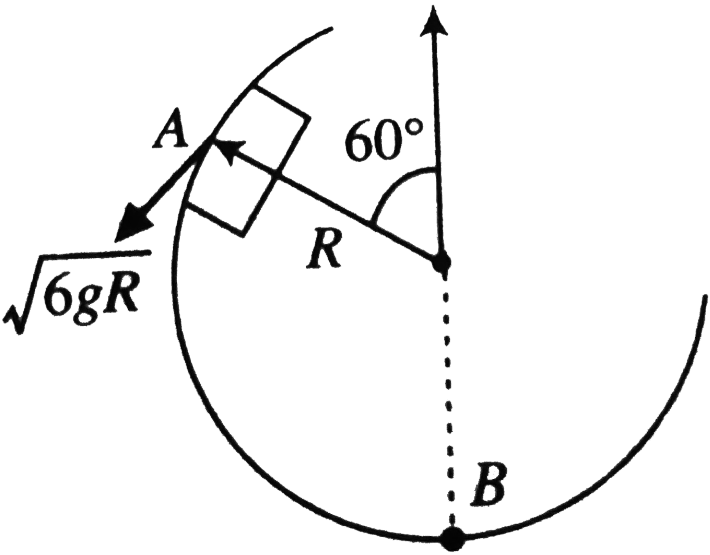
81. Figure shows a smooth vertical circular track AB of radius R. A block slides along the surface AB when it is given a velocity equal to $\sqrt{6gR}$ at point A. The ratio of the force exerted by the track on the block at point A to that at point B is



A. 0.25

B. 0.35

C. 0.45

D. 0.55

Answer: D

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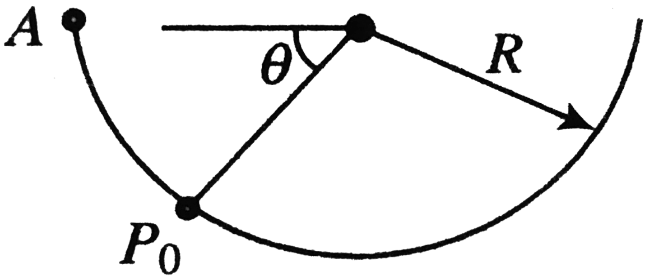
82. A bead of mass m is released from rest at A to move along the fixed smooth circular track as shown in figure. The ratio of magnitudes of centripetal force and normal reaction by the track on the bead at any point P_0 described by the angle $\theta(\neq 0)$ would



A. (a) Increase with θ

B. (b) Decrease with θ

C. (c) Remain constant

D. (d) First increase with θ and then decrease

Answer: C

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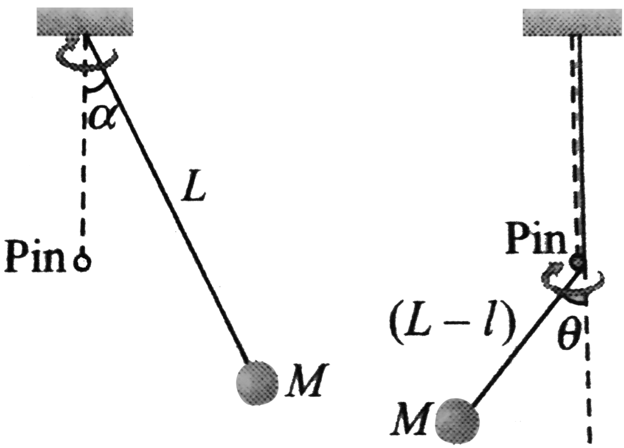
83. A simple pendulum consisting of a mass M attached to a string of length L is released from rest at an angle α. A pin is located at a distance l below the pivot point. When the pendulum swings down, the string hits the pin as shown in figure. The maximum angle θ which the string makes with the vertical after hitting the pin is



A. (a) $\cos^{-1}\left[\frac{L\cos\alpha + l}{L + l}\right]$

B. (b) $\cos^{-1}\left[\frac{L\cos\alpha + l}{L - l}\right]$

C. (c) $\cos^{-1}\left[\frac{L\cos\alpha - 1}{L - l}\right]$

D. (d) $\cos^{-1}\left[\frac{L\cos\alpha - 1}{L + l}\right]$

Answer: C

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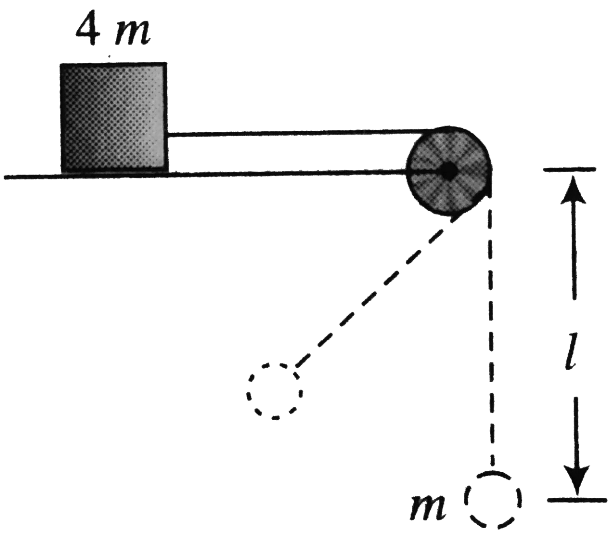
84. Two bodies of masses m and $4m$ are attached to a light string as shown in figure. A body of mass m hanging from string is executing oscillations with angular amplitude 60°, while other body is at rest on a horizontal surface. The minimum coefficient of friction between mass $4m$ and the horizontal surface is (here pulley is light and smooth)



A. (a) $\frac{1}{4}$

B. (b) $\frac{3}{4}$

C. (c) $\frac{1}{2}$

D. (d) $\frac{1}{8}$

Answer: C

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85. A $500 - kg$ car, moving with a velocity of $36kmh^{-1}$ on a straight road unidirectionally, doubles its velocity in $1 \min$. The average power delivered by the engine for doubling the velocity is

A. (a) $750W$

B. (b) $1050W$

C. (c) $1150W$

D. (d) $1250W$

Answer: D

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86. Two spring P and Q having stiffness constants k_1 and $k_2(< k_1)$, respectively are stretched equally. Then

A. (a) More work is done on Q

B. (b) More work is done on P

C. (c) Their force constants will become equal

D. (d) Equal work is done on both the springs

Answer: B

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87. In the above question, if equal forces are applied on two springs, then

A. (a) More work is done on Q

B. (b) More work is done on P

C. (c) Heir force constants will become equal

D. (d) Equal work is done on both the springs

Answer: A

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88. Water is drawn from a well in a $5kg$ drum of capacity $55L$ by two ropes connected to the top of the drum. The linear mass density of each rope is $0.5kgm^{-1}$. The work done in lifting water to the ground from the surface of water in the well $20m$ below is

$[g = 10ms^{-2}]$

A. $1.4 \times 10^4 J$

B. $1.5 \times 10^4 J$

C. $9.8 \times 10 \times 6J$

D. $18J$

Answer: A

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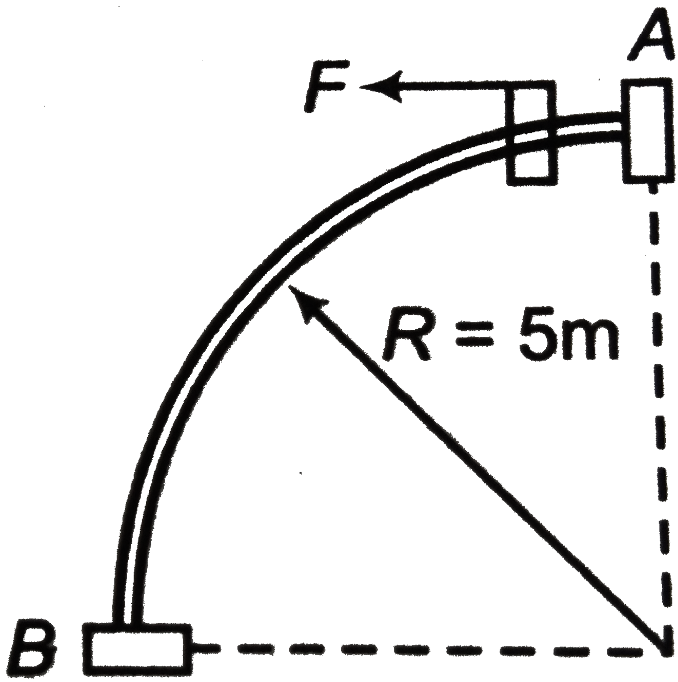
89. A bead of mass $\frac{1}{2}kg$ starts from rest from A to move in a vertical place along a smooth fixed quarter ring of radius $5m$, under the action of a constant horizontal force $f = 5N$ as shown. The speed of bead as it reaches the point (B) is [Take $g = 10ms^{-2}$]



A. $14.14ms^{-1}$

B. $7.07ms^{-1}$

C. $5ms^{-1}$

D. $25ms^{-1}$

Answer: A

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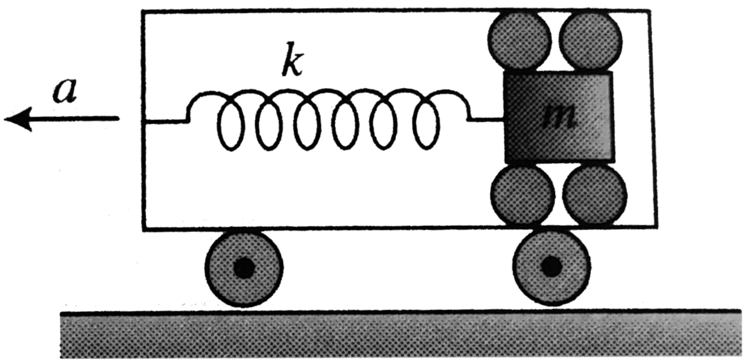
90. A block of mass m is connected to a spring of spring constant k as shown in figure. The frame in which the block is placed is given an acceleration a towards left. Neglect friction between the block and the frame walls. The maximum velocity of the block relative to the frame is



A. (a) $\sqrt{\frac{m}{k}}$

B. (b) $\alpha\sqrt{\frac{m}{k}}$

C. (c) $\alpha\sqrt{\frac{m}{2k}}$

D. (d) $2\alpha\sqrt{\frac{m}{k}}$

Answer: B

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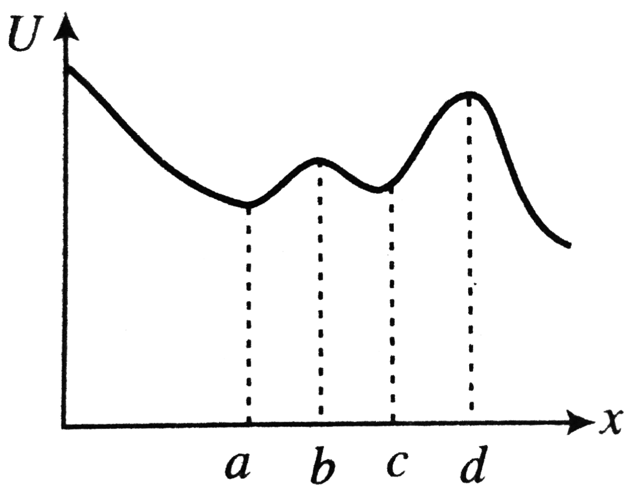
91. Figure shows a plot of the potential energy as a function of x for a particle moving along the x-axis. Which of the following statement(s) is/are true?



A. a, c, and d are points of equilibrium

B. a is a point of stable equilibrium

C. b is a unstable equilibrium point

D. All of the above

Answer: D

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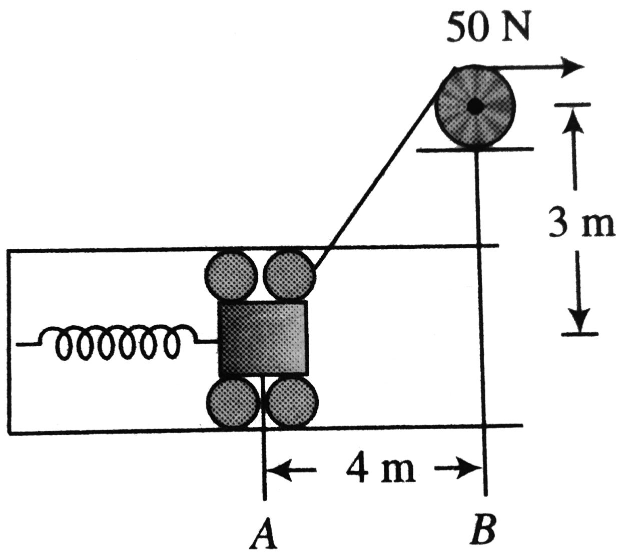
92. A $20 - kg$ block attached to a spring of spring constant $5Nm^{-1}$ is released from rest at A. The spring at this instant is having an elongation of $1m$. The block is allowed to move in smooth horizontal slot with the help of a constant force $50N$ in the rope as shown. The velocity of the block as it reaches B is (assume the rope to be light)



A. (a) $4ms^{-1}$

B. (b) $2ms^{-1}$

C. (c) $1ms^{-1}$

D. (d) $3ms^{-1}$

Answer: B

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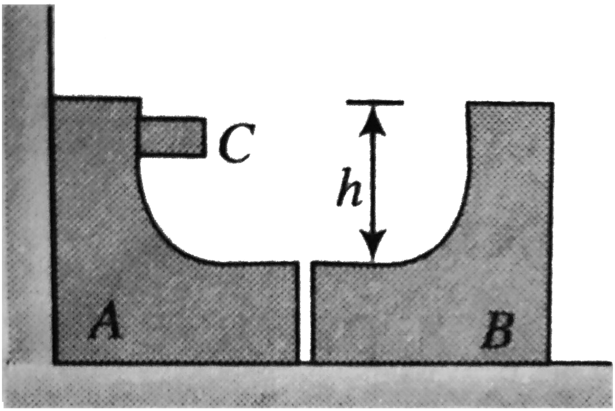
93. Two identical blocks, each having mass M, are placed as shown in figure. These two blocks A and B are smoothly conjugated, so that when another block C of mass m passes from A to B there is no jerk. All the surfaces are frictionless, and all three blocks are free to move. Block C is released from rest, then



A. Block C will move for a very small duration.

B. Block A will move for a very small duration.

C. Block B will acquire maximum speed when C is at the lowest point on B and moving towards left

D. Block B will acquire maximum speed when C is at the topmost point of B

Answer: C

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94. A $1kg$ stone at the end of $1m$ long string is whirled in a vertical circle at a constant speed of $4m/s$. The tension in the string is $6N$, when the stone is at $(g = 10m/s^2)$

A. (a) At the top of the circle

B. (b) At the bottom of the circle

C. (c) Half way down

D. (d) None of the above

Answer: A

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95. A stone at the end of $1m$ long string is whirled in a vertical circle at a constant speed of $4ms^{-1}$. The tension in the string is $6N$ when the stone is

A. (a) $10ms^{-1}$

B. (b) $5\sqrt{3}ms^{-1}$

C. (c) $10\sqrt{3}ms^{-1}$

D. (d) $20ms^{-1}$

Answer: A

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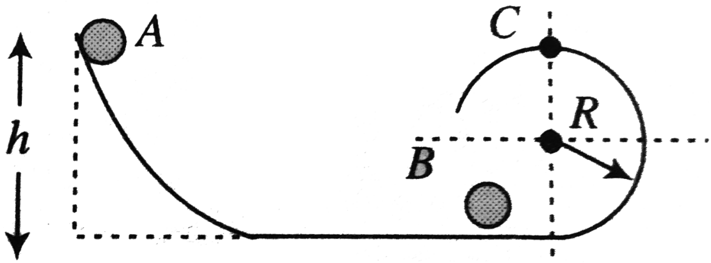
96. Ball A of mass m, after sliding from an inclined plane, strikes elastically another ball B of same mass at rest. Find the minimum heihgt h so that ball B just completes the circular motion of the surface at C. (All surfaces are smooth).



A. (a) $h=\frac{5}{2}R$

B. (b) $h=2R$

C. (c) $h=\frac{2}{5}R$

D. (d) $h=3R$

Answer: A

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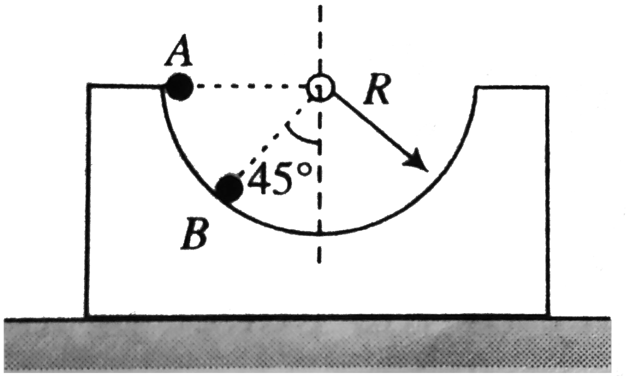
97. A ball of mass m is released from A inside a smooth wedge of mass m as shown in figure. What is the speed of the wedge when the ball reaches point B?



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

B. (b) $\sqrt{2gR}$

C. (c) $\left(\frac{5gR}{2\sqrt{3}}\right)^{1/2}$

D. (d) $\sqrt{\frac{3}{2}gR}$

Answer: A

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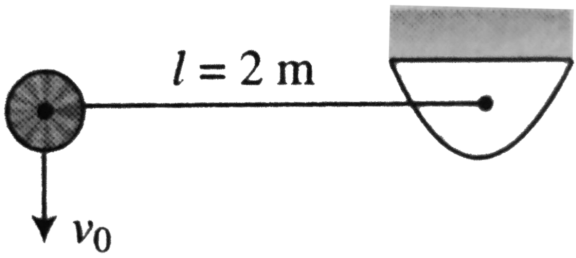
98. A small sphere is given vertical velocity of magnitude $v_0 = 5ms^{-1}$ and it swings in a vertical plane about the end of a massless string. The angle θ with the vertical at which string will break, knowing that it can withstand a maximum tension equal to twice the weight of the sphere, is



A. (a) $cos^{-1}\frac{2}{3}$

B. (b) $\cos^{-1}\left(\frac{1}{4}\right)$

C. (c) 60°

D. (d) 30°

Answer: B

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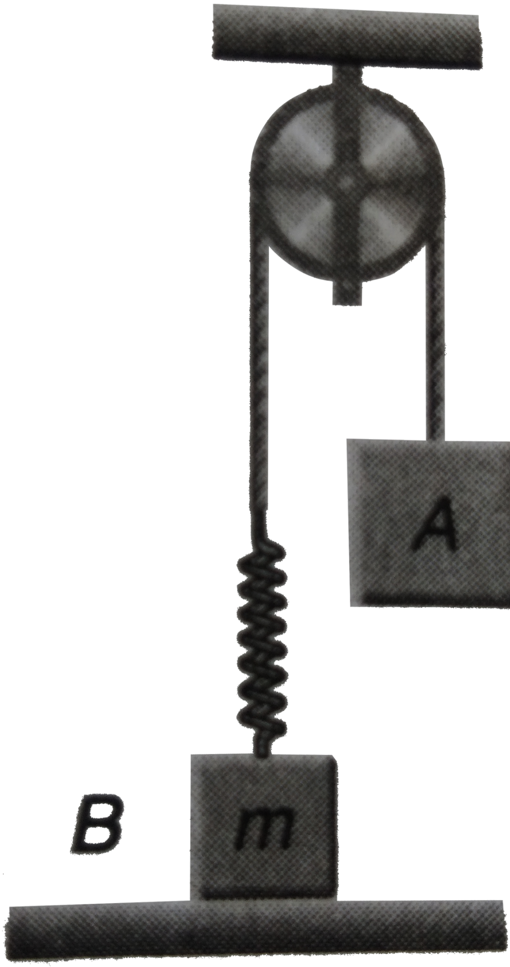
99. In the figure, block A is released from rest when the spring is its natural length for the block B of mass m to leave contact with the ground at some stage what should be the minimum mass of block A?



A. (a) $2M$

B. (b) M

C. (c) $M/2$

D. (d) $M/4$

Answer: C

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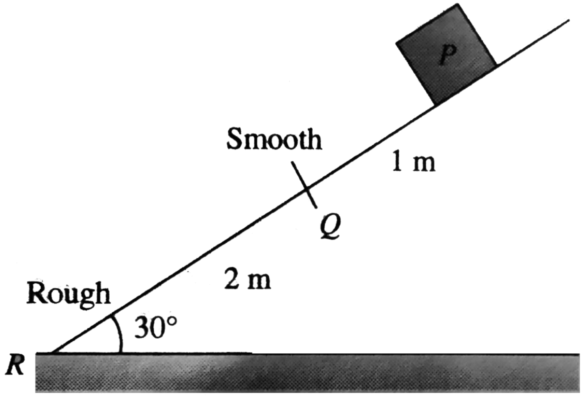
100. A block of mass $5.0kg$ slides down from the top of an inclined plane of length $3m$. The first $1m$ of the plane is smooth and the next $2m$ is rough. The block is released from rest and again comes to rest at the bottom of the plane. If the plane is inclined at 30° with the horizontal, find the coefficient of friction on the rough portion.



A. (a) $\frac{2}{\sqrt{3}}$

B. (b) $\frac{\sqrt{3}}{2}$

C. (c) $\frac{\sqrt{3}}{4}$

D. (d) $\frac{\sqrt{3}}{5}$

Answer: B

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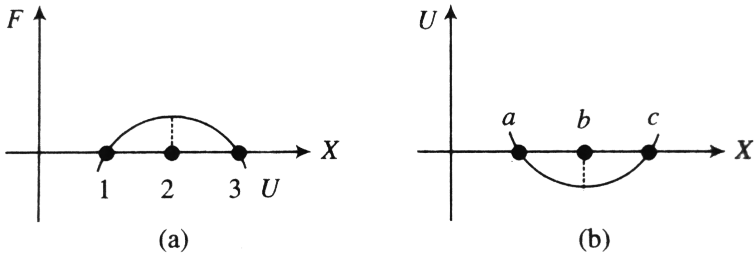
Multiple Correct

1. Referring the graphs, which of the following is/are correc?



A. (a) The particle has stable equilibrium at point 3 and b.

B. (b) The particle is in neutral equilibrium at point b and 2.

C. (c) No power is delivered by the force on the particle at point 1, 3, and b.

D. (d) The particle has least kinetic energy at position 1.

Answer: A::C::D

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2. Which of the following is//are conservative force (s) ?

A. (a) $\overrightarrow{F} = 2r^3\overrightarrow{r}$

B. (b) $\overrightarrow{F} = -\frac{5}{r}\hat{r}$

C. (c) $\overrightarrow{F} = \frac{3\left(x\hat{i} + y\hat{j}\right)}{\left(x^2 + y^2\right)^{3/2}}$

D. (d) $\overrightarrow{F} = \frac{3\left(y\hat{i} + x\hat{j}\right)}{\left(x^2 + y^2\right)^{3/2}}$

Answer: A::C

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3. One of the forces acting on the particle is conservative, then

A. (a) Its work is zero when the particle moves exactly once around any closed path.

B. (b) Its work equals the change in the kinetic energy of the particle.

C. (c) It does not obey Newton's second law.

D. (d) Its work depends on the end points of the motion, not on the path in between.

Answer: A::D

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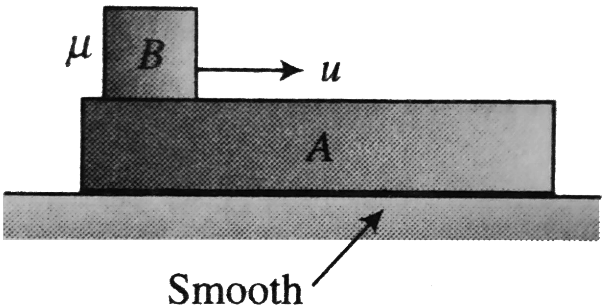
4. A long block A is at rest on a smooth horizontal surface. A small block B whose mass is half of mass of A is placed on A at one end and is given an initial velocity u as shown in figure. The coefficient of friction between the blocks is μ.



A. (a) Finally both move with a common velocity $2u/3$.

B. (b) Acceleration of B relative to A initially is $3\mu g/2$ towards left.

C. (c) Magnitude of total work done by friction is equal to the final kinetic energy of the system.

D. (d) The ratio of initial to final momentum of the system is 1.

Answer: B::D

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5. Choose the correct statement(s) from the following.

A. (a) Force acting on a particle for equal time intervals can produce the same change in momentum but different change in kinetic energy.

B. (b) Force acting on a particle for equal displacemenets can produce same change in kinetic energy but different change in momentum.

C. (c) Force acting on a particle for equal time intervals can produce different change in momentum but same change in kinetic energy.

D. (d) Force acting on a particle for equal displacements can produce different change in kinetic energy but same change in momentum.

Answer: A::B

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6. Mark the correct statement(s).

A. (a) The work-energy theorem is valid only for particles

B. (b) The work-energy theorem is an invariant law of physics.

C. (c) The work-energy theorem is valid only in inertial frames of reference.

D. (d) The work-energy theorem can be applied in non-inertial frames of reference too.

Answer: B::D

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7. Mark the correct statement(s).

A. (a) Total work done by internal forces of a system on the system is always zero.

B. (b) Total work done by internal forces of a system on the system is sometimes zero.

C. (c) Total work done by internal forces acting between the particles of a rigid body is always zero.

D. (d) Total work done by internal forces acting between the particles of a rigid body is sometimes zero.

Answer: B::C

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8. Select the correct option(s).

A. (a) A single external force acting on a particle necessarily changes its momentum and kinetic energy.

B. (b) A single external force acting on a particle necessarily changes its momentum.

C. (c) The work-energy theorem is valid for all types of forces: internal, external, conservative as well as non-conservative.

D. (d) The kinetic energy of the system can be increased without applying any external force on the system.

Answer: B::C::D

Watch Video Solution

9. When two blocks connected by a spring move towards each other under mutual interaction,

A. (a) Their velocities are equal and opposite

B. (b) Their accelerations are equal and opposite

C. (c) The forces acting on them are equal and opposite

D. (d) Their momenta are equal and opposite

Answer: C::D

Watch Video Solution

10. When a bullet is fired from a gun

A. (a) The kinetic energy of the bullet is more than that of the gum

B. (b) The acceleration of the bullet is more than that of the gun

C. (c) The momentum of the bullet is more than that of the gun

D. (d) The velocity of the bullet is more than that of the gun

Answer: A::B::D

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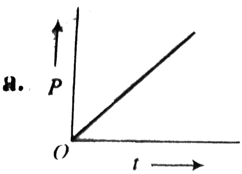
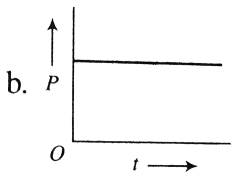
11. A vehicle is driven along a straight horizontal track by a motor which exerts a constant driving force. The vehicle starts from rest at $t = 0$ and the effects of friction and air resistance are negligible. If the kinetic eneryg of the vehicle at time t is E and power developed by the motor is P, which of the following graphs are correct?

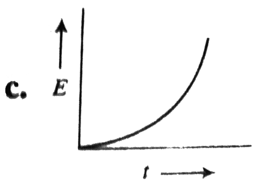
A. (a)



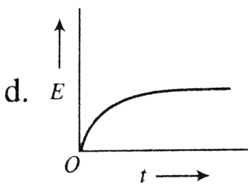
B. (b)



C. (c)



D. (d)



Answer: A::C

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12. A block hangs freely from the end of a spring. A boy then slowly pushes the block upwards so that the spring becomes strain free. The gain in gravitational potential energy of the block during this process is not equal to

A. (a) The work done by the boy against the gravitational force acting on the block

B. (b) The loss of energy stored in the spring minus the work done by the tension in the spring

C. (c) The work done on the block by the boy plus the loss of energy stored in the spring

D. (d) The work done on the block by the boy minus the work done by the tension in the spring plus the loss of energy stored in the spring

(e) The work done on the block by the boy minus the work done by the tension in the spring

Answer: A::B::D

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13. A charged particle X moves directly towards another charged particle Y. For the X plus Y system, the total momentum is p and the total energy is E.

A. (a) p and E are conserved if both X and Y are free to move.

B. (b) (a) is true only if X and Y have similar charges.

C. (c) If Y is fixed, E is conserved but not P.

D. (d) If Y is fixed, neither E nor P is conserved.

Answer: A::C

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14. The potential energy φ, in joule, of a particle of mass $1kg$, moving in the x-y plane, obeys the law $\varphi = 3x + 4y$, where (x, y) are the coordinates of the particle in metre. If the particle is at rest at $(6, 4)$ at time $t = 0$, then

A. (a) The particle has constant acceleration.

B. (b) The work done by the external forces, the position of rest of the particle and the instant of the particle crossing the x-axis is $25J$.

C. (c) The speed of the particle when it crosses the y-axis is $10m^{-1}$.

D. (d) The coordinates of the particle at time $t = 4s$ are $(\,-18,\,-28)$

.

Answer: A::B::C::D

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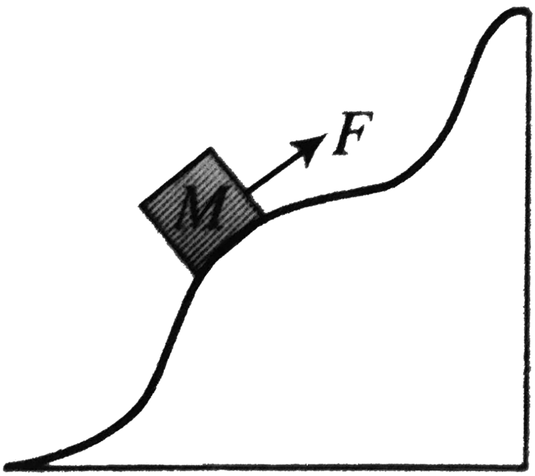
15. A body of mass M was slowly hauled up a rough hill by a force F which at each point was directed along a tangent to the hill. Work done by the force



A. (a) Is independent of the shape of trajectory

B. (b) Depends upon the vertical component of displacement but is independent of horizontal component

C. (c) Depends upon both the components

D. (d) Does not depend upon the coefficient of friction

Answer: A::C

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16. A block is suspended by an ideal spring of force constant k. If the block is pulled down by applying a constant force F and if maximum displacement of the block from its initial position of rest is δ, then

A. (a) $\frac{F}{k} < \delta > \frac{2F}{k}$

B. (b) $\delta = \frac{2F}{k}$

C. (c) Work done by force F is equal to $F\delta$

D. (d) Increase in energy stored in the spring is $\frac{1}{2}k\delta^2$

Answer: B::C

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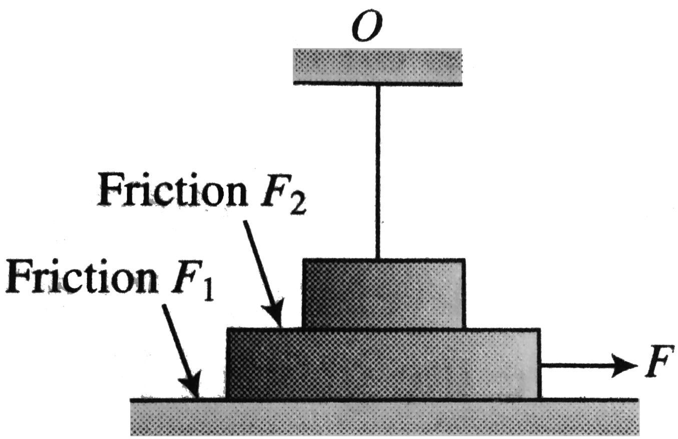
17. A horizontal plane supports a plank with a block placed on it. A light elastic string is attached to the block, which is attached to a fixed point O. Initially, the cord is unstretched and vertical. The plank is slowly shifted to right until the block starts sliding over it. It occurs at the moment when the cord deviates from vertical by an angle $\theta = 0^\circ$. Work done by the force F equals



A. (a) Energy lost against friction F_1 plus strain energy in cord

B. (b) Work done against total friction acting on the plank alone

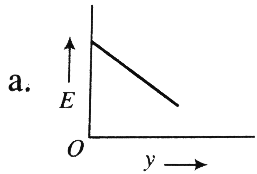
C. (c) Work done against total friction acting on the plank plus strain energy in the cord

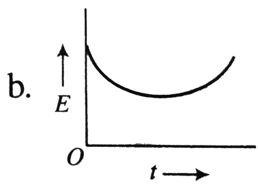
D. (d) Work done against total friction acting on the plank plus strain energy in the cord minus work done by friction acting on the block

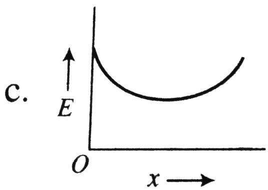
Answer: A::B::D

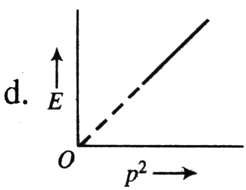
Watch Video Solution

18. A particle is projected from a point at an angle with the horizontal at $t=0$. At an instant t, if p is linear momentum, x is horizontal displacement, y is vertical displacement, and E is kinetic energy of the particle, then which of the following graphs are correct?

A. (a) 

B. (b) 

C. (c) 

D. (d) 

Answer: A::B::C::D

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19. In which of the following cases no work is done by the force?

A. (a) A man carrying a bucket of water, walking on a level road with a uniform velocity.

B. (b) A drop of rain falling vertically with a constant velocity.

C. (c) A man whirling a stone tied to a string in a circle with a cosntant speed.

D. (d) A man walking upon staircase

Answer: A::B::C

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20. A man of mass m is standing on a stationary flat car of mass M. The car can move without friction along horizontal rails. The man starts walking with velocity v relative to the car. Work done by him

A. (a) is greater than $\frac{1}{2}mv^2$ if he walks along rails.

B. (b) is less than $\frac{1}{2}mv^2$ is he walks along rails.

C. (c) is equal to $\frac{1}{2}mv^2$ is he walks normal to rails.

D. (d) can never be less than $\frac{1}{2}mv^2$

Answer: B::C

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21. The kinetic energy of a particle continuously icreses with time

A. (a) The resultant force on the particle must be parallel to the velocity at all instants

B. (b) The resultant force on the particle must be at an angle less than 90° with velocity all the times.

C. (c) Its height above the ground level must continuously decrease.

D. (d) The magnitude of its linear momentum is increasing continuously.

Answer: B::D

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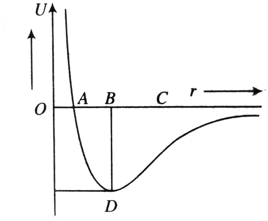
22. The potential energy curve for interaction between two molecules is shown in figure. Which of the following statements are true?

A. (a) The molecules have maximum attraction for $r = OA$.



B. (b) The molecules have maximum kinetic energy for $r = OB$.

C. (c) The intermolecular force is zero for $r = OB$.

D. (d) For the gaseous state, the depth BD of the potential energy curve is much smaller that KT.

Answer: B::C::D

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23. A particle is taken from point A to point B under the influence of a force field. Now it is taken back from B to A and it is observed that the work done in taking the particle from A to B is not equal to the work done in taking it from B to A. If W_{nc} and W_c are the work done by non-conservative and conservative forces present in the system, respectively, ΔU is the change in potential energy and Δk is the change in kinetic energy, then

A. (a) $W_{nc} - \Delta U = \Delta k$

B. (b) $W_c = -\Delta U$

C. (c) $W_{nc} + W_c = \Delta k$

D. (d) $W_{nc} - \Delta U = -\Delta k$

Answer: A::B::C

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24. Which of the following statements is/are correct about work?

A. (a) In a certain reference frame,

$$W_{\text{pseudo force}} + W_{\text{conservative force}} + W_{\text{non-conservative force}} + W_{\text{other forces}} =$$

B. (b) Work done by friction is always negative.

C. (c) Work done by a force is defined as the dot product of the force and the displacement of the point of application of force.

D. (d) Work done by conservative force in moving a body from A to B =potential energy of the body at A-potential energy of the body at B.

Answer: A::C::D

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25. A body of mass $1kg$ is taken from infinity to a point P. When the body reaches that point, it has a speed of $2ms^{-1}$. The work done by the conservative force is $-5J$. Which of the following is true (assuming non-conservative and pseudo-forces to be absent).

A. (a) Work done by the applied force is $+7J$

B. (b) The total energy possessed by the body at P is $+7J$

C. (c) The potential energy possessed by the body at P is $+5J$

D. (d) Work done by all forces together is equal to the change in kinetic energy.

Answer: A::B::C::D

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Linked Comprehension

1. Two unequal masses are ties together with a cord with a compressed spring in between.

When the cord is burnt with a match releasing the spring, the two masses fly apart with equal

A. (a) Kinetic energy

B. (b) Speed

C. (c) Momentum

D. (d) Acceleration

Answer: C

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2. Two unequal masses are ties together with a cord with a compressed spring in between.

Which one is correct?

A. (a) Both masses with have equal KE.

B. (b) Lighter block will have greater KE.

C. (c) Heavier block will have greater KE.

D. (d) None of above answers is correct.

Answer: B

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3. Two unequal masses are ties together with a cord with a compressed spring in between.

Which of the following energies is conserved for the system?

A. (a) Kinetic energy

B. (b) Potential energy

C. (c) Mechanical energy

D. (d) None of these

Answer: C

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4. A body of mass $2kg$ starts from rest and moves with uniform acceleration. It acquires a velocity $20ms^{-1}$ in $4s$.

The power exerted on the body at $2s$ is

A. (a) $50W$

B. (b) $100W$

C. (c) $150W$

D. (d) $200W$

Answer: B

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5. A body of mass $2kg$ starts from rest and moves with uniform acceleration. It acquires a velocity $20ms^{-1}$ in $4s$.

Find average power transferred to the body in first $2s$.

A. $50W$

B. $100W$

C. $150W$

D. $200W$

Answer: A

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6. Sand particles drop vertically at the rate of $2kgs^{-1}$ on a conveyor belt moving horizontally with a velocity of $0.2ms^{-1}$.

The extra force required to keep the belt moving is

A. (a) $0.4N$

B. (b) $0.08N$

C. (c) $0.04N$

D. (d) $0.2N$

Answer: A

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7. Sand particles drop vertically at the rate of $2kgs^{-1}$ on a conveyor belt moving horizontally with a velocity of $0.2ms^{-1}$.

The extra force required is

A. (a) $0.4W$

B. (b) $0.08W$

C. (c) $0.04W$

D. (d) $0.2W$

Answer: B

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8. Sand particles drop vertically at the rate of $2kgs^{-1}$ on a conveyor belt moving horizontally with a velocity of $0.2ms^{-1}$.

The time rate of change of kinetic energy of sand particles is

A. (a) $0.4Js^{-1}$

B. (b) $0.08Js^{-1}$

C. (c) $0.04Js^{-1}$

D. (d) $0.2Js^{-1}$

Answer: C

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9. A ladder of length l carrying a man of mass m at its end is attached to the basket of a balloon of mass M. The entire system is in equilibrium in the air. As the man climbs up the ladder into the balloon, the balloon descends by a height h.

The potential energy of the man

A. (a) Increases by $mg(l-h)$

B. (b) Increases by mgl

C. (c) Increases by mgh

D. (d) Increases by $mg(2l-h)$

Answer: A

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10. A ladder of length l carrying a man of mass m at its end is attached to the basket of a balloon of mass M. The entire system is in equilibrium in the air. As the man climbs up the ladder into the balloon, the balloon descends by a height h.

The potential energy of the balloon

A. (a) Decreases by mgh

B. (b) Increases by mgh

C. (c) Increases by $mgl(l-h)$

D. (d) Increases by mgl

Answer: B

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11. A ladder of length l carrying a man of mass m at its end is attached to the basket of a balloon of mass M. The entire system is in equilibrium in the air. As the man climbs up the ladder into the balloon, the balloon descends by a height h.

The work done by the man is

A. (a) mgl

B. (b) mgh

C. (c) mg

D. (d) $mg(l-h)$

Answer: A

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12. A single conservative force $F(x)$ acts on a $1.0 - kg$ particle that moves along the x-axis. The potential energy $U(x)$ is given by $U(x) = 20 + (x - 2)^2$ where x is in meters. At $x = 5.0m$, the particle has a kinetic energy of $20J$.

What is the mechanical energy of a system?

A. (a) $35J$

B. (b) $64J$

C. (c) $86J$

D. (d) $49J$

Answer: D

Watch Video Solution

13. A single conservative force $F(x)$ acts on a $1.0 - kg$ particle that moves along the x-axis. The potential energy $U(x)$ is given by $U(x) = 20 + (x - 2)^2$ where x is in meters. At $x = 5.0m$, the particle has a kinetic energy of $20J$.

The maximum and minimum values of x, respectively, are

A. $7.38m, \; - 3.38m$

B. $6.38m, \; - 4.38m$

C. $7.38m, \; - 2.83m$

D. $6.38m, \; - 2.38m$

Answer: A

Watch Video Solution

14. A single conservative force $F(x)$ acts on a $1.0 - kg$ particle that moves along the x-axis. The potential energy $U(x)$ is given by $U(x) = 20 + (x - 2)^2$ where x is in meters. At $x = 5.0m$, the particle has a kinetic energy of $20J$.

The maximum kinetic energy of the particle and the value of x at which maximum kinetic energy occurs are

A. (a) $29J, 0m$

B. (b) $49J, 0m$

C. (c) $49J, 2m$

D. (d) $29J, 2m$

Answer: D

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15. A single conservative force $F(x)$ acts on a $1.0 - kg$ particle that moves along the x-axis. The potential energy $U(x)$ is given by $U(x) = 20 + (x - 2)^2$ where x is in meters. At $x = 5.0m$, the particle has a kinetic energy of $20J$.

Determine the equation of $F(x)$ as a function of x.

A. (a) $F = 2 + x$

B. (b) $F = 2 + 3x$

C. (c) $F = 2(2 - x)$

D. (d) $F = 3 + 2x$

Answer: C

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16. A $1.5 - kg$ block is initially at rest on a horizontal frictionless surface when a horizontal force in the positive direction of x-axis is applied to the block. The force is given by $\vec{F} = (4 - x^2)\vec{i} N$, where x is in meter and the initial position of the block is $x = 0$.

The maximum kinetic energy of the block between $x = 0$ and $x = 2.0m$ is

A. (a) $2.33J$

B. (b) $8.67J$

C. (c) $5.33J$

D. (d) $6.67J$

Answer: C

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17. A $1.5-kg$ block is initially at rest on a horizontal frictionless surface when a horizontal force in the positive direction of x-axis is applied to the block. The force is given by $\overrightarrow{F}=(4-x^2)\overrightarrow{i}N$, where x is in meter and the initial position of the block is $x=0$.

The maximum positive displacement x is

A. (a) $2\sqrt{3}$

B. (b) $2m$

C. (c) $4m$

D. (d) $\sqrt{2}m$

Answer: A

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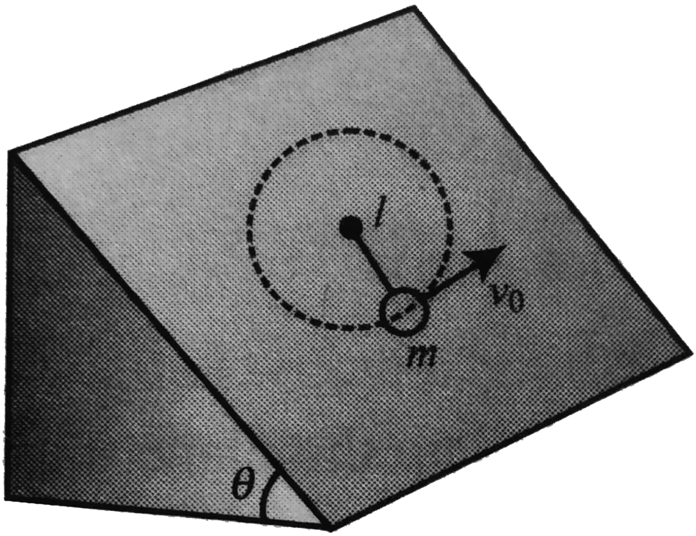
18. A pendulum bob swings along a circular path on a smooth inclined plane as shown in figure, where $m = 3kg$, $l = 0.75m$, $\theta = 37^\circ$. At the lowest point of the circle the tension in the string is $T = 274N$. Take $g = 10ms^{-2}$.



The speed of the bob at the lowest point is

A. $9.2ms^{-1}$

B. $9ms^{-1}$

C. $6.5ms^{-1}$

D. $8ms^{-1}$

Answer: D

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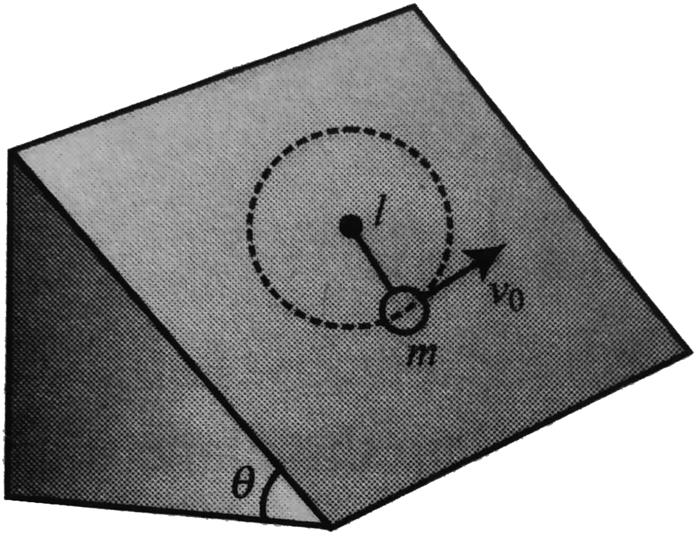
19. A pendulum bob swings along a circular path on a smooth inclined plane as shown in figure, where $m = 3kg$, $l = 0.75m$, $\theta = 37^{\circ}$. At the lowest point of the circle the tension in the string is $T = 274N$. Take $g = 10ms^{-2}$.



The speed of the bob at the highest point on the circle is

A. (a) $\sqrt{46}ms^{-1}$

B. (b) $\sqrt{26}ms^{-1}$

C. (c) $\sqrt{52}ms^{-1}$

D. (d) $\sqrt{35}ms^{-1}$

Answer: A

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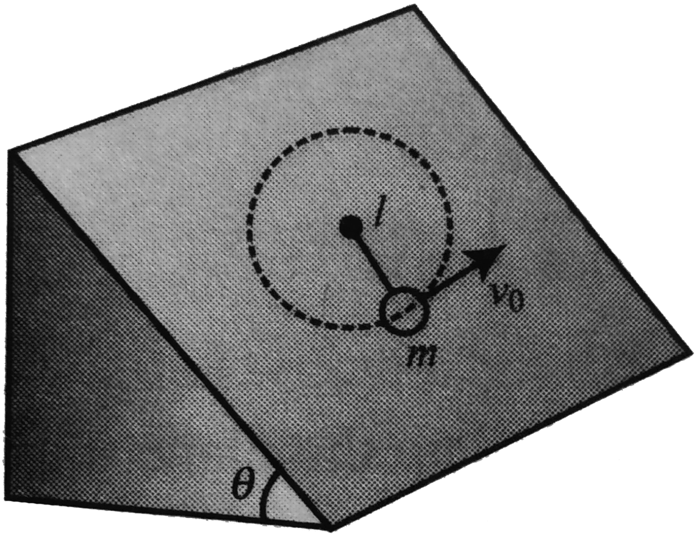
20. A pendulum bob swings along a circular path on a smooth inclined plane as shown in figure, where $m = 3kg$, $l = 0.75m$, $\theta = 37^\circ$. At the lowest point of the circle the tension in the string is $T = 274N$. Take $g = 10ms^{-2}$.



The tension in the string at the highest position is

A. (a) $166N$

B. (b) $67.66N$

C. (c) $68N$

D. (d) $152N$

Answer: A

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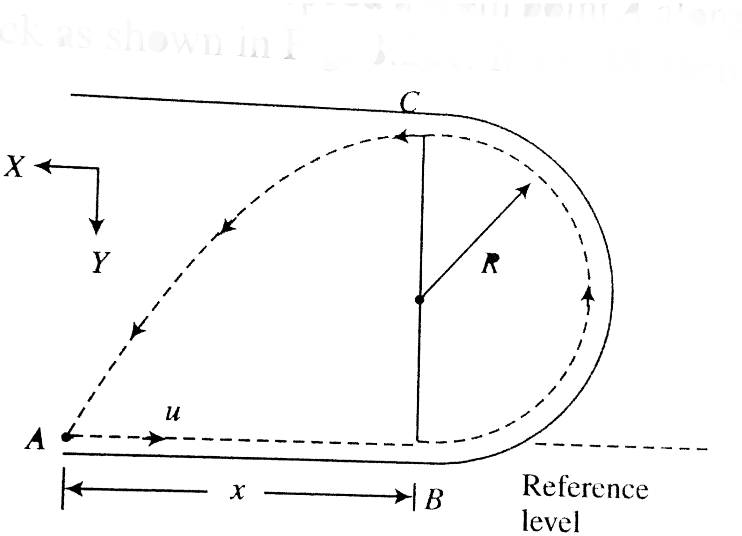
21. A small ball is rolled with speed u from piont A along a smooth circular track as shown in figure. If $x = 3R$, then



Determine the required speed u so that the ball returns to A, the point of projection after passing through C, the highest point.

A. (a) $\frac{3}{2}\sqrt{gR}$

B. (b) $\frac{1}{2}\sqrt{gR}$

C. (c) $\frac{5}{3}\sqrt{gR}$

D. (d) $\frac{5}{2}\sqrt{gR}$

Answer: D

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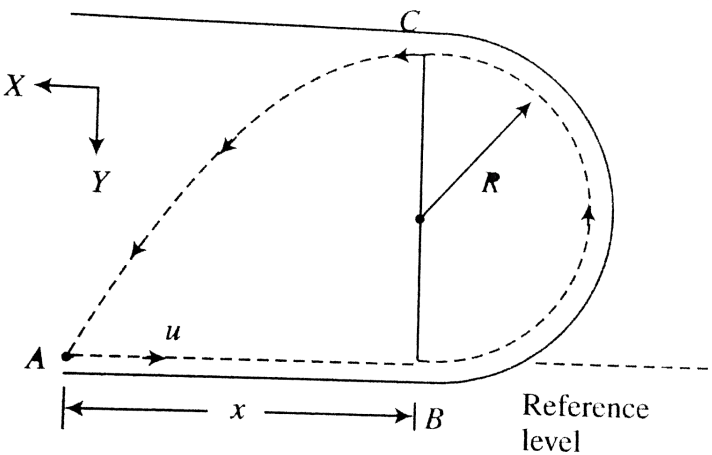
22. A small ball is rolled with speed u from point A along a smooth circular track as shown in figure. If $x = 3R$, then



`What is the minimum value of x for which the ball can reach the point of projection after reaching C?

A. $2R$

B. $5R$

C. $3R$

D. $\frac{5}{2}R$

Answer: A

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23. A man of mass m speeds up while running from rest to a speed v in a straight track along an inclined plane, after raising through a height h.

$W_{gravity} = \text{work done by gravity on the man}$

$W_{iction} = \text{work done by friction on the man}$

$W_{man} = \text{work done by man}$

Which of the following options is correct regarding the various work done?

A. (a) $W_{gravity} = -mgh$

B. (b) $W_{friction} > 0$

C. (c) $W_{man} = mgh + \frac{1}{2}mv^2$

D. (d) $W_{friction} = 0$

Answer: A::C::D

Watch Video Solution

24. A man of mass m speeds up while running from rest to a speed v in a straight track along an inclined plane, after raising through a height h.

$W_{gravity} = \text{work done by gravity on the man}$

$W_{iction} = \text{work done by friction on the man}$

$W_{man} = \text{work done by man}$

If instead of moving up the plane, the man increases his speed to the value v while moving down the inclined plane through the same vertical distance h, then

A. (a) $W_{friction} > 0$

B. (b) $W_{friction} = -mgh + \frac{1}{2}mv^2$

C. (c) Work done by the man can be positive, negative or zero

D. (d) $W_{friction} + W_{man} = -mgh + \frac{1}{2}mv^2$

Answer: C::D

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25. A man of mass m speeds up while running from rest to a speed v in a straight track along an inclined plane, after raising through a height h.

$W_{gravity} = \text{work done by gravity on the man}$

$W_{iction} = \text{work done by friction on the man}$

$W_{man} = \text{work done by man}$

If in the previous problem, we replace the man by a block of mass m and release it from top of the inclined plane, and let it gain a speed v, then

A. (a) $W_{friction} = -mgh + \frac{1}{2}mv^2$

B. (b) $W_{gravity} = -mgh$

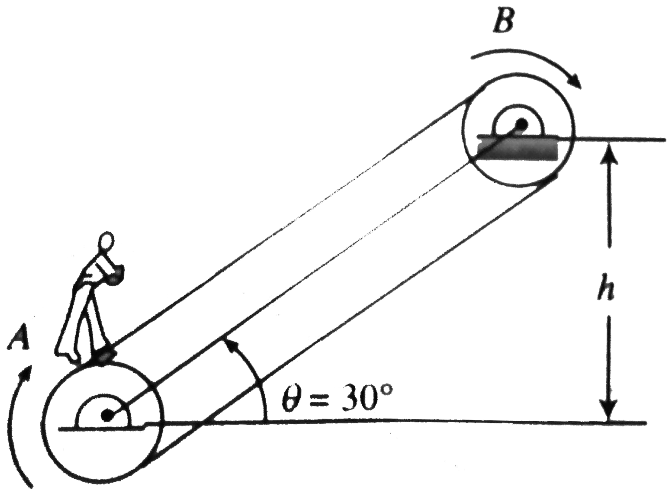
C. (c) $W_{friction} = 0$

D. (d) $W_{friction} = -\mu mgx$, where x is the horizontal distance covered and μ is the coefficient of friction between the block and the ground.

Answer: A::B::D

Watch Video Solution

26. A boy of mass m climbs up a conveyor belt with a constant acceleration. The speed of the belt is $v = \sqrt{gh/6}$ and the coefficient of friction between the body and conveyor belt is $\mu = \frac{5}{3\sqrt{3}}$. The boy starts from A and moves with the maximum possible acceleration till he reaches the highest point B.



The time taken by the boy to reach the height h is

A. (a) $\sqrt{\frac{2h}{g}}$

B. (b) $\sqrt{\frac{6h}{g}}$

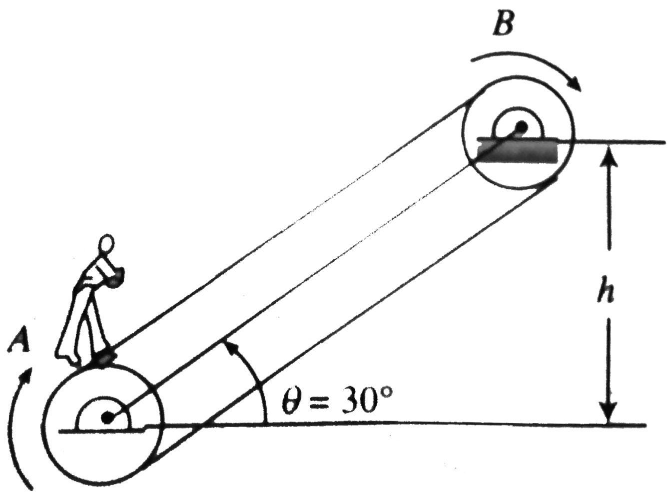
C. (c) $2\sqrt{\frac{h}{g}}$

D. (d) None of above

Answer: B

Watch Video Solution

27. A boy of mass m climbs up a conveyor belt with a constant acceleration. The speed of the belt is $v = \sqrt{gh/6}$ and the coefficient of friction between the body and conveyor belt is $\mu = \frac{5}{3\sqrt{3}}$. The boy starts from A and moves with the maximum possible acceleration till he reaches the highest point B.



Work done by gravity to w.r.t. the conveyor belt is

A. $-mgh$

B. $-\frac{1}{2}mgh$

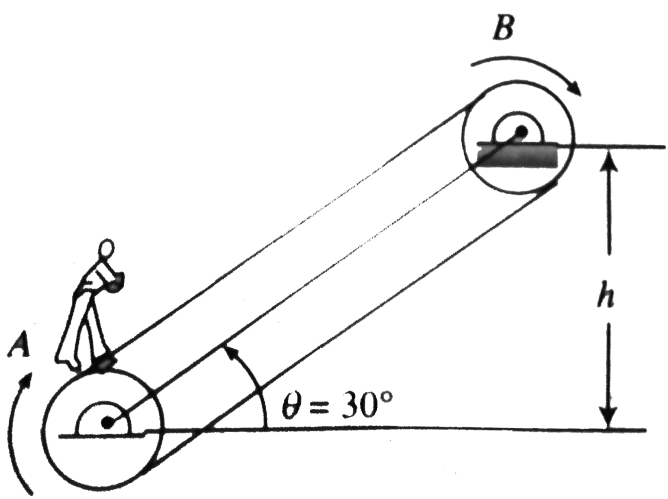
C. $\frac{1}{3}mgh$

D. None of above

Answer: B

Watch Video Solution

28. A boy of mass m climbs up a conveyor belt with a constant acceleration. The speed of the belt is $v = \sqrt{gh/6}$ and the coefficient of friction between the body and conveyor belt is $\mu = \frac{5}{3\sqrt{3}}$. The boy starts from A and moves with the maximum possible acceleration till he reaches the highest point B.



Work done by friction on the boy is

A. (a) Equal to work done by boy

B. (b) `Equal to work done by the motor in running the conveyor belt

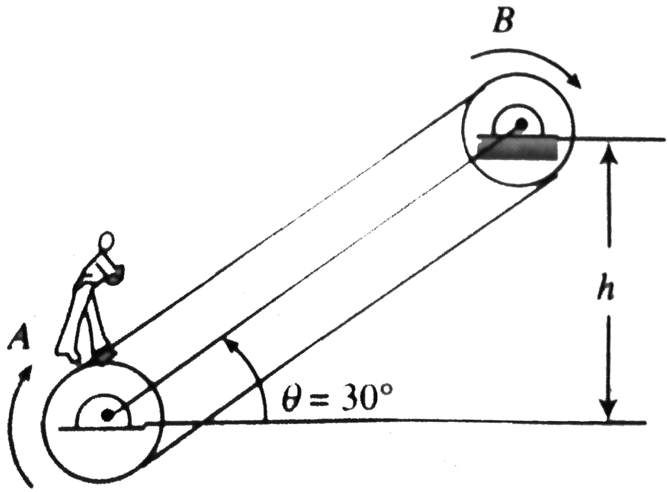
C. (c) Zero

D. (d) None of above

Answer: B

Watch Video Solution

29. A boy of mass m climbs up a conveyor belt with a constant acceleration. The speed of the belt is $v = \sqrt{gh/6}$ and the coefficient of friction between the body and conveyor belt is $\mu = \frac{5}{3\sqrt{3}}$. The boy starts from A and moves with the maximum possible acceleration till he reaches the highest point B.



Work done by the boy is

A. (a) $\frac{5}{6}mgh$

B. (b) $\frac{1}{4}mgh$

C. (c) $\frac{4}{3}mgh$

D. (d) None of above

Answer: A

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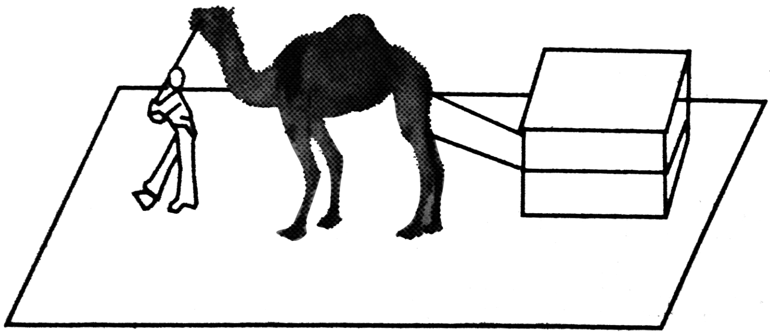
30. Ram and Ali have been fast friends since childhood. Ali neglected studies and now has no means to earn money other than a channel whereas Ram has become an engineer. Now both are working in the same factory. Ali uses camel to transport the load within the factory.



Due to low salary and degradation in health of camel, Ali becomes worried and meets his friend Ram and discusses his problems. Ram collected some data and with some assumptions concluded the following:

i. The load used in each trip is $1000kg$ and has friction coefficient $\mu_k = 0.1$ and $\mu_s = 0.2$.

ii. Mass of camel is $500kg$.

iii. Load is accelerated for first $50m$ with constant acceleration, then it is pulled at a constant speed of $5ms^{-1}$ for $2km$ and at last stopped with

constant retardation in $50m$.

iv. From biological data, the rate of consumption of energy of camel can be expressed as $P = 18 \times 10^3 v + 10^4 Js^{-1}$ where P is the power and v is the velocity of the camel. After calculations on different issues, Ram suggested proper food, speed of camel, etc. to his friend. For the welfare of Ali, Ram wrote a letter to the management to increase his salary.

(Assuming that the camel exerts a horizontal force on the load):

Sign of work done by the camel on the load during parts of motion, accelerated motion, uniform motion and retarded motion, respectively are

A. (a) +ve, +ve, +ve

B. (b) +ve, +ve, -ve

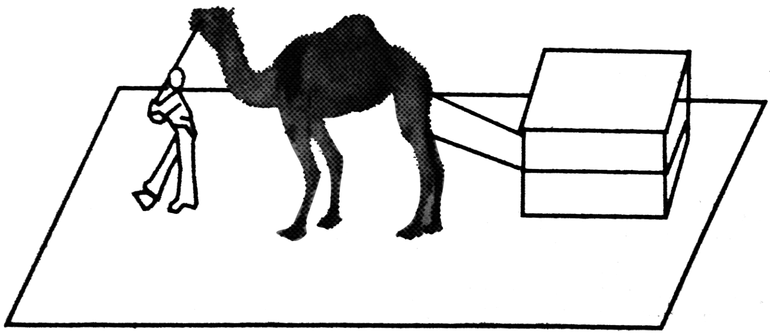
C. (c) +ve, zero, -ve

D. (d) +ve, zero, +ve

Answer: A

Watch Video Solution

31. Ram and Ali have been fast friends since childhood. Ali neglected studies and now has no means to earn money other than a channel whereas Ram has become an engineer. Now both are working in the same factory. Ali uses camel to transport the load within the factory.



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constant retardation in $50m$.

iv. From biological data, the rate of consumption of energy of camel can be expressed as $P = 18 \times 10^3 v + 10^4 Js^{-1}$ where P is the power and v is the velocity of the camel. After calculations on different issues, Ram suggested proper food, speed of camel, etc. to his friend. For the welfare of Ali, Ram wrote a letter to the management to increase his salary.

(Assuming that the camel exerts a horizontal force on the load):

The ratio of magnitude of work done by camel on the load during accelerated motion to retarded motion is

A. (a) $3:5$

B. (b) $2.2:1$

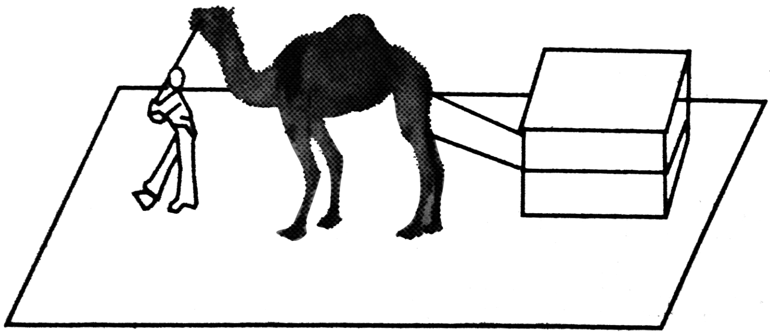
C. (c) $1:1$

D. (d) $5:3$

Answer: D

Watch Video Solution

32. Ram and Ali have been fast friends since childhood. Ali neglected studies and now has no means to earn money other than a channel whereas Ram has become an engineer. Now both are working in the same factory. Ali uses camel to transport the load within the factory.



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(Assuming that the camel exerts a horizontal force on the load):

Maximum power transmitted by the camel to load is

A. (a) $6250 Js^{-1}$

B. (b) $5000 Js^{-1}$

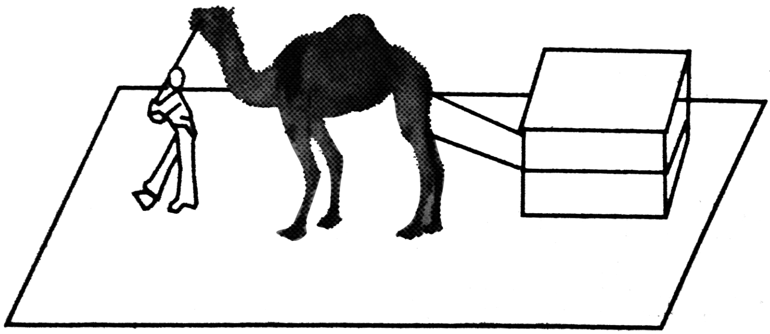
C. (c) $10^5 Js^{-1}$

D. (d) $1250 Js^{-1}$

Answer: A

Watch Video Solution

33. Ram and Ali have been fast friends since childhood. Ali neglected studies and now has no means to earn money other than a channel whereas Ram has become an engineer. Now both are working in the same factory. Ali uses camel to transport the load within the factory.



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(Assuming that the camel exerts a horizontal force on the load):

The ratio of the energy consumed by the camel during uniform motion for the two cases when it moves with speed $5ms^{-1}$ to the case when it moves with $10ms^{-1}$

A. (a) $\frac{19}{20}$

B. (b) $\frac{19}{10}$

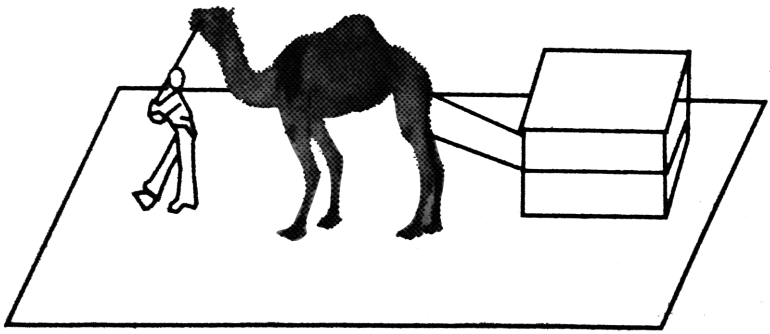
C. (c) $\frac{10}{19}$

D. (d) $\frac{20}{19}$

Answer: D

Watch Video Solution

34. Ram and Ali have been fast friends since childhood. Ali neglected studies and now has no means to earn money other than a channel whereas Ram has become an engineer. Now both are working in the same factory. Ali uses camel to transport the load within the factory.



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(Assuming that the camel exerts a horizontal force on the load):

The total energy consumed by the camel during the trip of $2100m$ is

A. (a) $2.1 \times 10^6 J$

B. (b) $4.22 \times 10^7 J$

C. (c) $2.22 \times 10^4 J$

D. (d) $4.22 \times 10^6 J$

Answer: B

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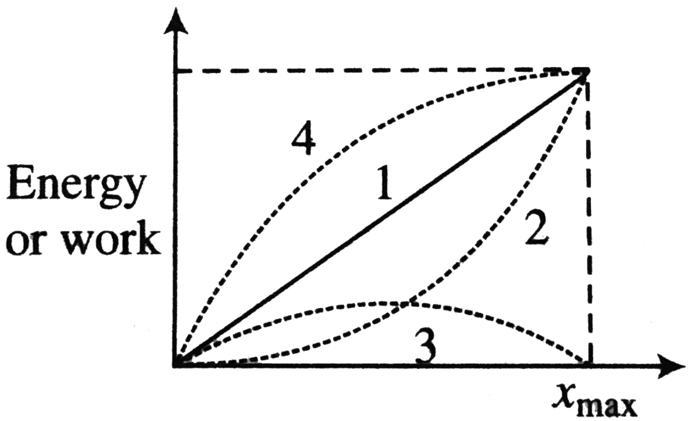
35. A srping lies along the x-axis attached to a wall at one end and a block at the other end. The block rests on a friction less surface at $x = 0$. A force of constant magnitude F is applied to the block that begins to compress the spring, until the block comes to a maximum displacement x_{max}.



During the displacement, which of the curves shown in the graph best represents the kinetic energy of the block?

A. (a) 1

B. (b) 2

C. (c) 3

D. (d) 4

Answer: C

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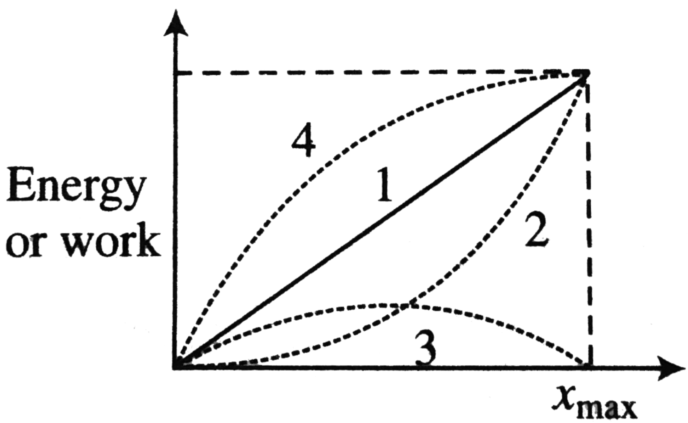
36. A srping lies along the x-axis attached to a wall at one end and a block at the other end. The block rests on a friction less surface at $x = 0$. A force of constant magnitude F is applied to the block that begins to compress the spring, until the block comes to a maximum displacement $x_{\max}$.



During the displacement, which of the curves shown in the graph best represents the work done on the spring block system by the applied force?

A. (a) 1

B. (b) 2

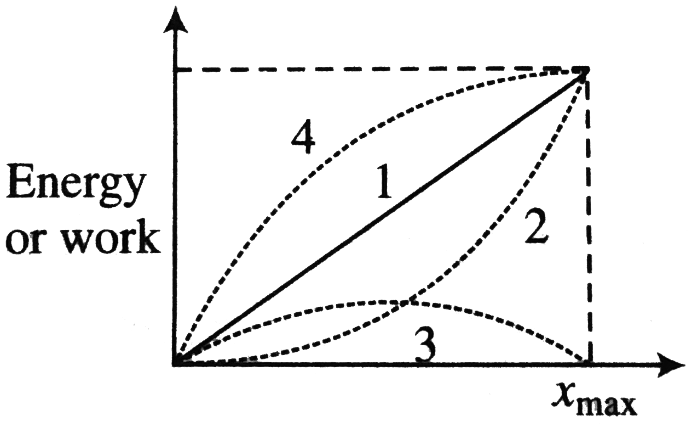
C. (c) 3

D. (d) 4

Answer: A

Watch Video Solution

37. A srping lies along the x-axis attached to a wall at one end and a block at the other end. The block rests on a friction less surface at $x = 0$. A force of constant magnitude F is applied to the block that begins to compress the spring, until the block comes to a maximum displacement $x_{\max}$.



During the first half of the motion, applied force transfers more energy to the

A. (a) Kinetic energy

B. (b) Potential energy

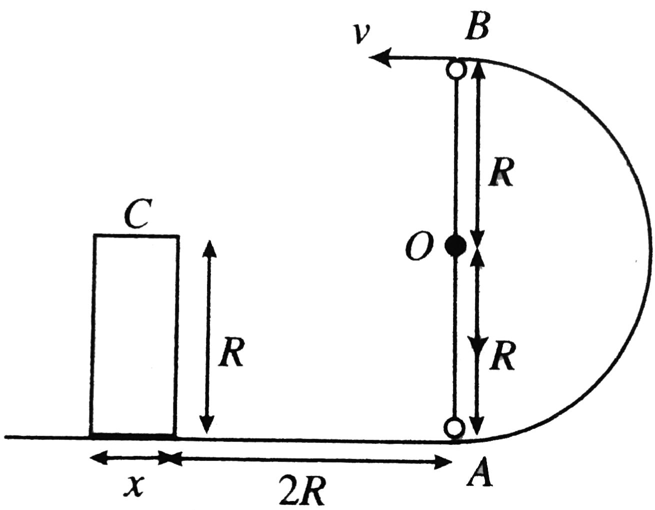
C. (c) Equal to both

D. (d) Depends upon mass of the block

Answer: C

Watch Video Solution

38. A small ball is given some velocity at point A towards right so that it moves on the semicircular track and does not leave contact up to the highest point B. After leaving the highest point B, it falls at the top of a building of height R and width $x(x < < 2R)$. (All the surfaces are frictionless).



The velocity given to the ball at point A so that it may hit the top of the building is

A. (a) $\sqrt{4gR}$

B. (b) $\sqrt{2gR}$

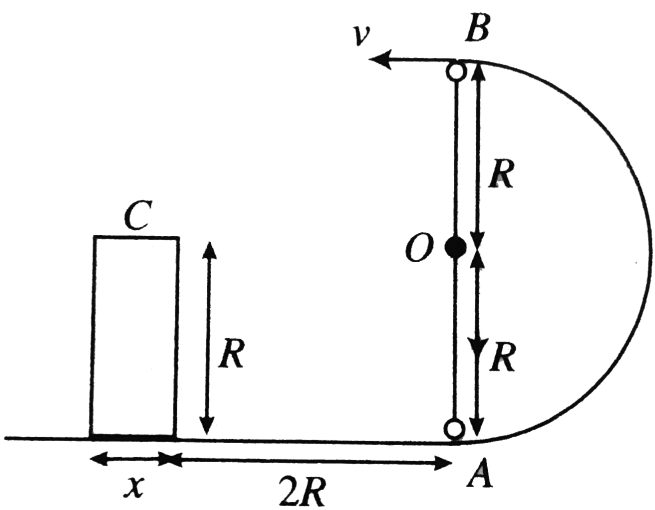
C. (c) $\sqrt{gR}$

D. (d) $\sqrt{6gR}$

Answer: D

Watch Video Solution

39. A small ball is given some velocity at point A towards right so that it moves on the semicircular track and does not leave contact up to the highest point B. After leaving the highest point B, it falls at the top of a building of height R and width $x(x < < 2R)$. (All the surfaces are frictionless).



If the collision of ball with the building is elastic, then the angle with the horizontal at which the ball will rebound from the top of the building is

A. (a) 60°

B. (b) 45°

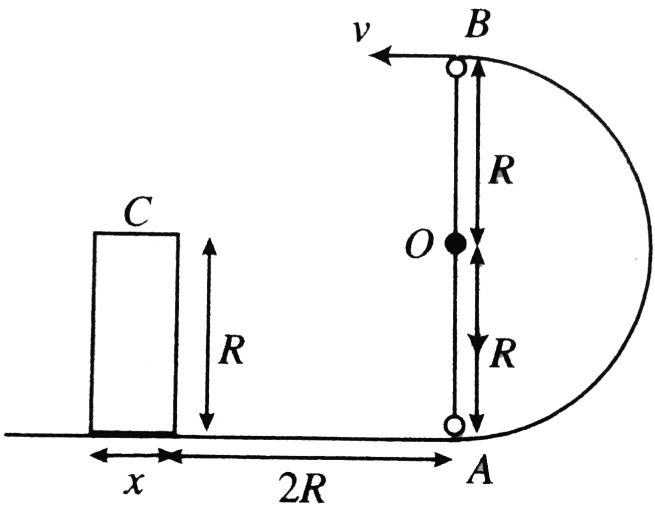
C. (c) 30°

D. (d) None

Answer: B

Watch Video Solution

40. A small ball is given some velocity at point A towards right so that it moves on the semicircular track and does not leave contact up to the highest point B. After leaving the highest point B, it falls at the top of a building of height R and width $x(x < < 2R)$. (All the surfaces are frictionless).



The horizontal distance of the ball from the foot of the builing where the ball strikes the horizontal ground will

A. (a) $\sqrt{2}R$

B. (b) $(1+\sqrt{2})R$

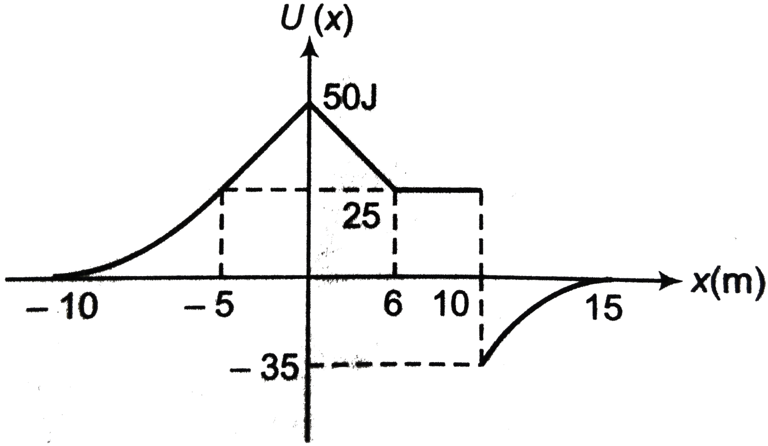
C. (c) $2(1+\sqrt{2})R$

D. (d) $12R$

Answer: C

Watch Video Solution

41. The figure shows the variation of potential energy of a particle as a function pf x, the x-coordination of the region. It has been assumed that potential energy depends only on x. For all other values x, U is zero. i.e. for$x < -10$ and $x > 15, U = 0$.



If total mechanical energy of the particle is $25J$, then it can found in the region

A. (a) $-10 < x < -5$ and $6 < x < 15$

B. (b) $-10 < x < 0$ and $6 < x < 10$

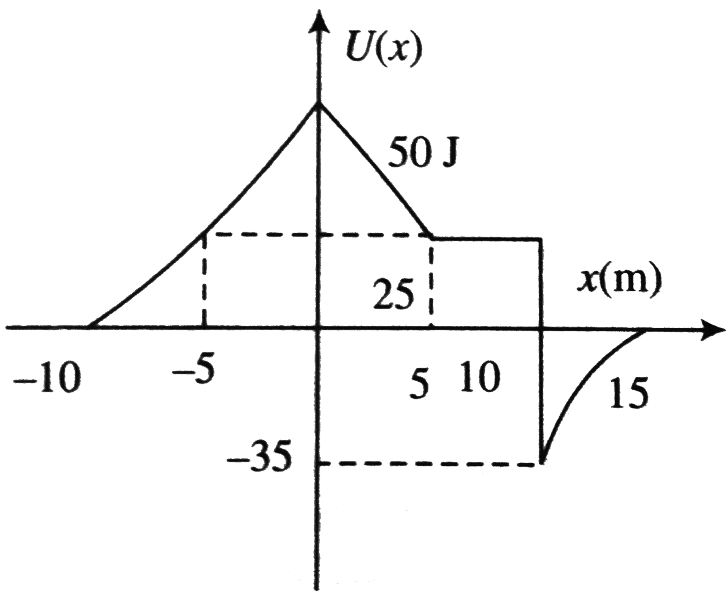
C. (c) $-5 < x < 6$

D. (d) $-10 < x < 10$

Answer: A

Watch Video Solution

42. Figure shows the variation of potential energy of a particle as a function of x, the x-coordinate of the region. It has been assumed that potential energy depends only on x. For all other values of x, U is zero, i.e., $x \leftarrow 10$ and $x > 15, U = 0$.



If the total mechanical energy of the particle is $-40J$, then it can be found in region

A. (a) $x \leftarrow 10$ and $x > 15$

B. (b) $-10 < x \leftarrow 5$ and $6 < x < 15$

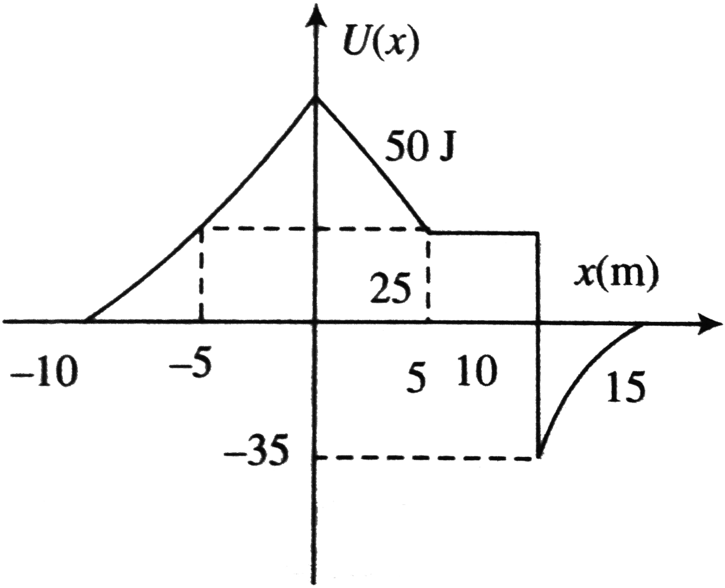
C. (c) $10 < x < 15$

D. (d) It is not possible

Answer: D

Watch Video Solution

43. Figure shows the variation of potential energy of a particle as a function of x, the x-coordinate of the region. It has been assumed that potential energy depends only on x. For all other values of x, U is zero, i.e., $x \leftarrow 10$ and $x > 15, U = 0$.



If the particle is isolated and its total mechanical energy is $60J$, then

A. (a) The particle can be found anywhere from $-\infty < x < \infty$.

B. (b) The particle's maximum kinetic energy is $95J$.

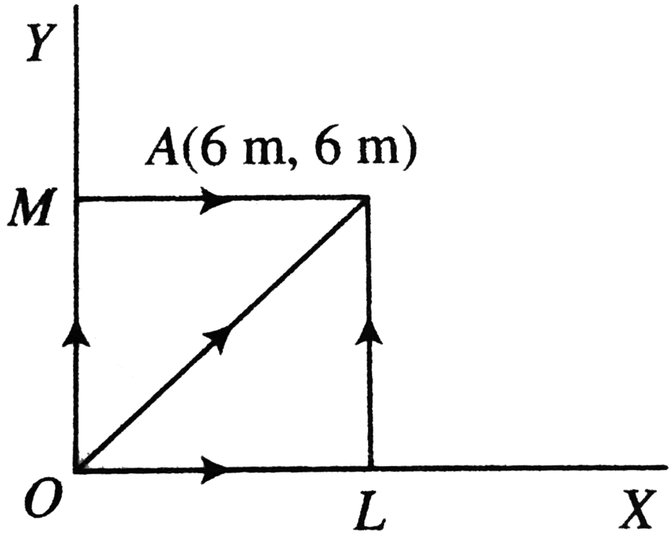
C. (c) The particle's kinetic energy is not getting zero

D. (d) All of the above

Answer: D

Watch Video Solution

44. Force acting on a particle moving in the x-y plane is $\vec{F} = \left(y^2\hat{i} + x\hat{j}\right)N$, x and y are in metre. As shown in figure, the particle moves from the origin O to point A $(6m, 6m)$. The figure shows three paths, OLA, OMA, and OA for the motion of the particle from O to A.



(A)

Which of the following is correct?

A. (a) There is equal probability for the force being conservative or non-conservative.

B. (b) Conservative or non-conservative nature of force cannot be predicted on the basis of given information.

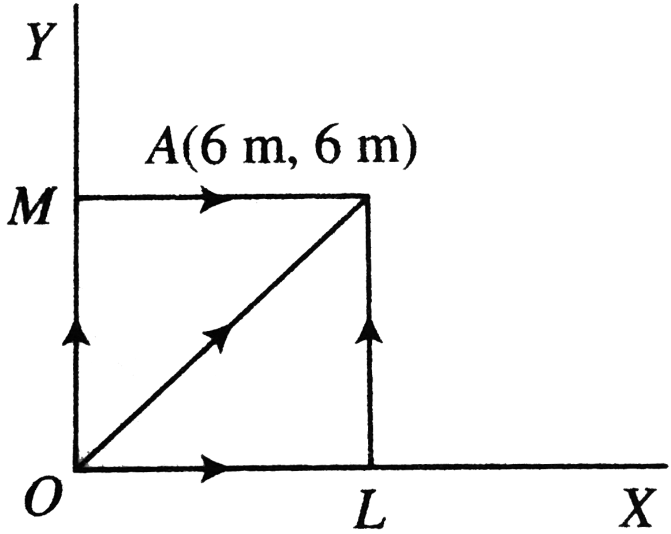
C. (c) The given force is non-conservative.

D. (d) The given force is conservative.

Answer: C

Watch Video Solution

45. Force acting on a particle moving in the x-y plane is $\vec{F} = \left(y^2\hat{i} + x\hat{j}\right)N$, x and y are in metre. As shown in figure, the particle moves from the origin O to point A $(6m, 6m)$. The figure shows three paths, OLA, OMA, and OA for the motion of the particle from O to A.



(A)

Which of the following is correct?

A. (a) OA

B. (b) OMA

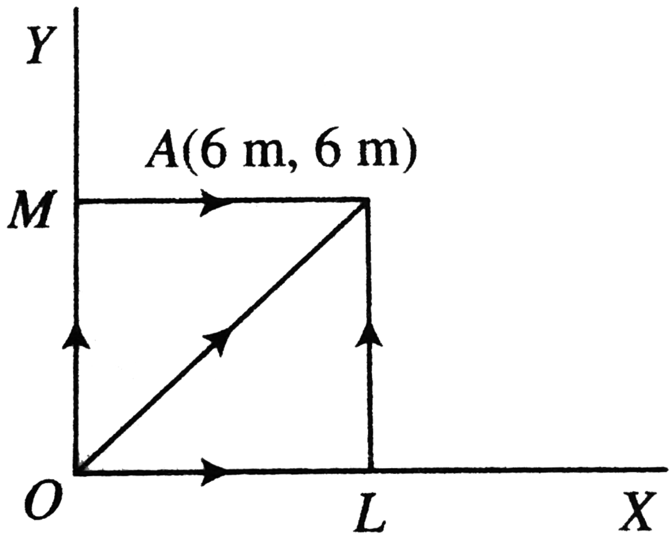
C. (c) OLA

D. (d) Work done has the same value for all the three paths.

Answer: B

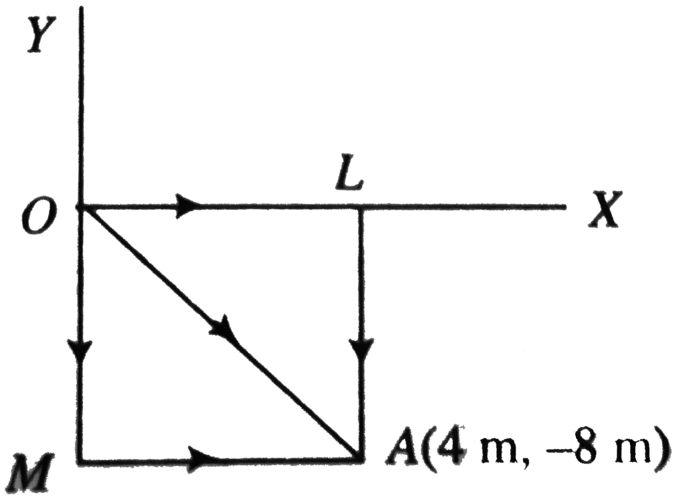
Watch Video Solution

46. Force acting on a particle moving in the x-y plane is $\vec{F} = \left(y^2\hat{i} + x\hat{j}\right)N$, x and y are in metre. As shown in figure, the particle moves from the origin O to point A $(6m, 6m)$. The figure shows three paths, OLA, OMA, and OA for the motion of the particle from O to A.



(A)

Work done for motion along path OA is nearly



(B)

A. (a) $383J$

B. (b) $90J$

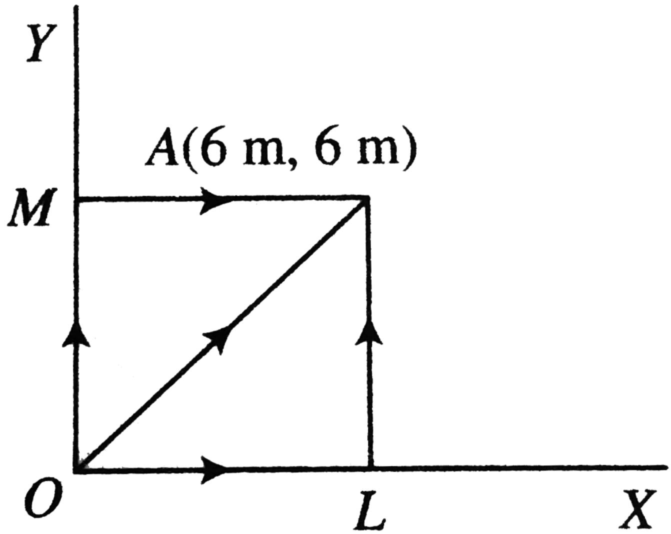
C. (c) $180J$

D. (d) None of these

Answer: B

Watch Video Solution

47. Force acting on a particle moving in the x-y plane is $\vec{F} = \left(y^2\hat{i} + x\hat{j}\right)N$, x and y are in metre. As shown in figure, the particle moves from the origin O to point A $(6m, 6m)$. The figure shows three paths, OLA, OMA, and OA for the motion of the particle from O to A.



(A)

Which of the following is correct?

A. (a) There is equal probability for the force being conservative or non-conservative.

B. (b) Conservative or non-conservative nature of the force cannot be predicted on the basis of the given information. z.

C. (c) The force is non-conservative

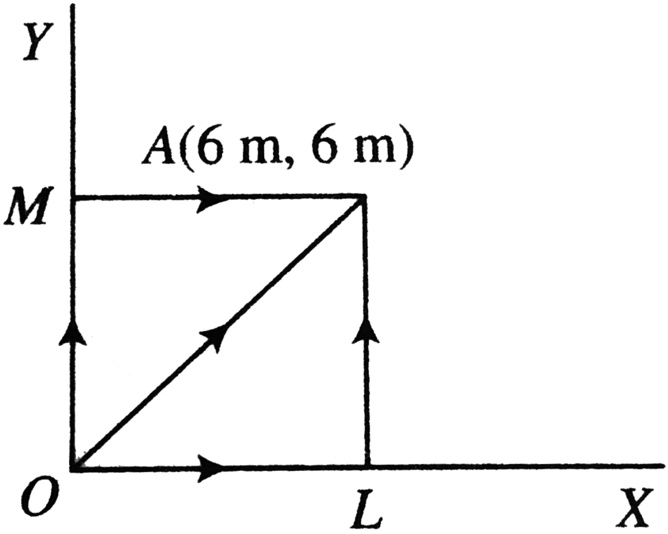
D. (d) The force is conservative.

Answer: D

Watch Video Solution

48. Force acting on a particle moving in the x-y plane is $\overrightarrow{F} = \left(y^2\hat{i} + x\hat{j}\right)N$, x and y are in metre. As shown in figure, the particle moves from the origin O to point A $(6m, 6m)$. The figure shows three paths, OLA, OMA, and OA for the motion of the particle from O to A.

Now consider another situation. A force $\overrightarrow{F} = \left(4\hat{i} + 3\hat{j}\right)N$ acts on a particle of mass $2kg$. The particle under the action of this force moves from the origin to a point A $(4m, -8m)$. Initial speed of the particle, i.e., its speed at the origin is $2\sqrt{6}ms^{-1}$. Figure shows three paths for the motion of the particle from O to A.



(A)

Speed of the particle at A will be nearly

A. (a) $4.0ms^{-1}$

B. (b) $2.8ms^{-1}$

C. (c) $3.6ms^{-1}$

D. (d) $5.6ms^{-1}$

Answer: A

Watch Video Solution

49. Force acting on a particle moving in the x-y plane is $\vec{F} = \left(y^2\hat{i} + x\hat{j}\right)N$, x and y are in metre. As shown in figure, the particle moves from the origin O to point A $(6m, 6m)$. The figure shows three paths, OLA, OMA, and OA for the motion of the particle from O to A.

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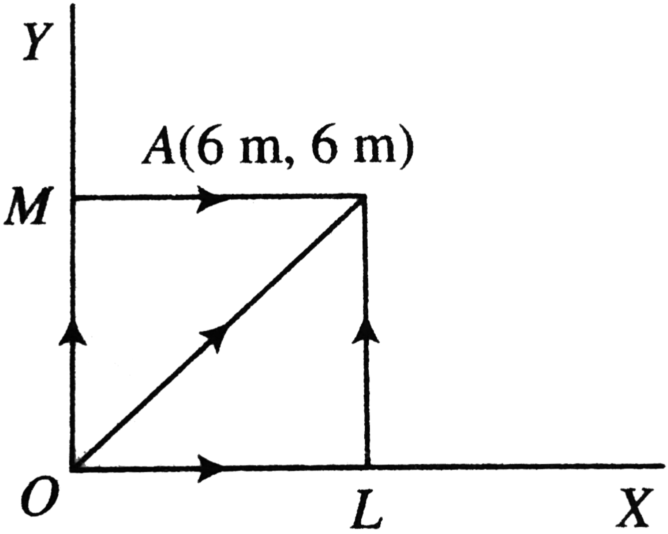


(A)

If the potential energy at O is $16J$, the potential energy at A will be

A. (a) $14.5J$

B. (b) $32J$

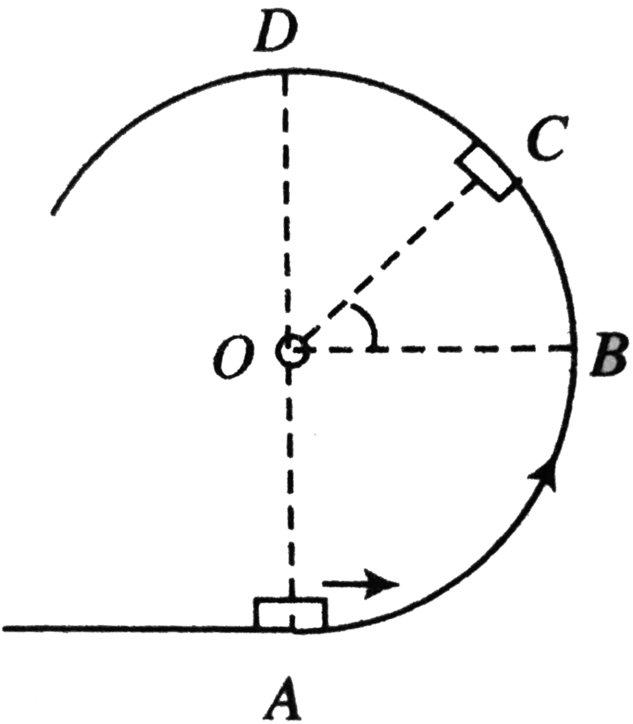
C. (c) $24J$

D. (d) $40J$

Answer: C

Watch Video Solution

50. A small block of mass m is pushed on a smooth track from position A with a velocity $2\sqrt{5}$ times the minimum velocity required to reach point D. The block will leave the contact with track at the point where normal force between them becomes zero.



At what angle θ with horizontal does the block gets separated from the track?

A. (a) $\sin^{-1}\left(\frac{1}{3}\right)$

B. (b) $\sin^{-1}\left(\frac{3}{4}\right)$

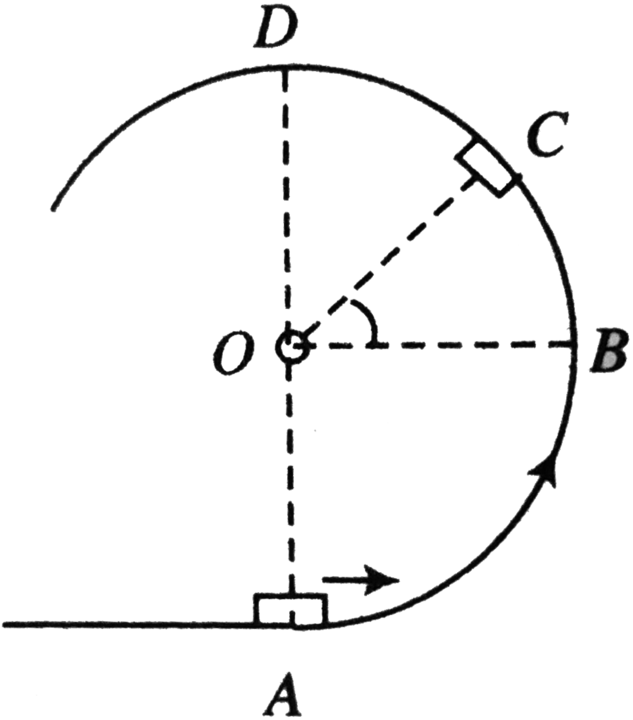
C. (c) $\sin^{-1}\left(\frac{2}{3}\right)$

D. (d) never leaves contact with the track

Answer: C

Watch Video Solution

51. A small block of mass m is pushed on a smooth track from position A with a velocity $2\sqrt{5}$ times the minimum velocity required to reach point D. The block will leave the contact with track at the point where normal force between them becomes zero.



At what angle θ with horizontal does the block gets separated from the track?

A. (a) $\tan^{-1}\left(\frac{1}{2}\right)$

B. (b) $\tan^{-1}(2)$

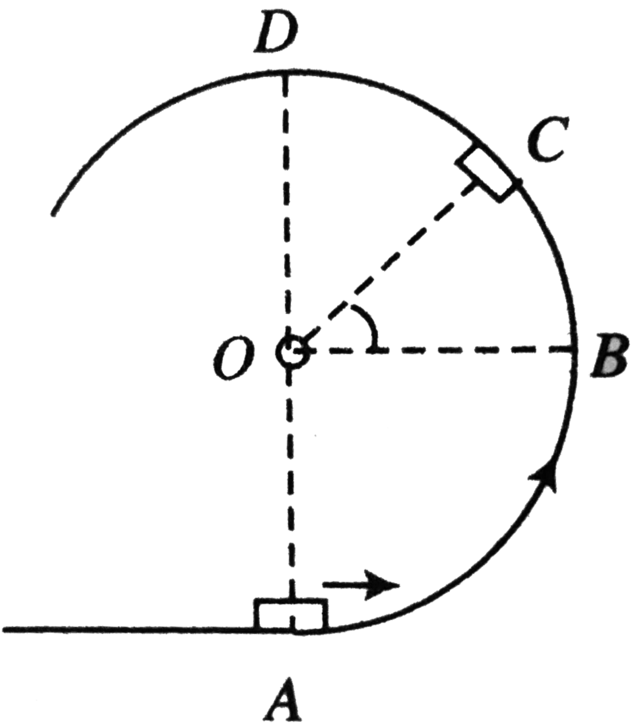
C. (c) $\sin^{-1}\left(\frac{2}{3}\right)$

D. (d) The block never reaches point B.

Answer: A

Watch Video Solution

52. A small block of mass m is pushed on a smooth track from position A with a velocity $2\sqrt{5}$ times the minimum velocity required to reach point D. The block will leave the contact with track at the point where normal force between them becomes zero.



Find where the maximum contact force occurs between the block and the track.

A. (a) At B

B. (b) At C

C. (c) Somewhere between A and B

D. (d) At A

Answer: D

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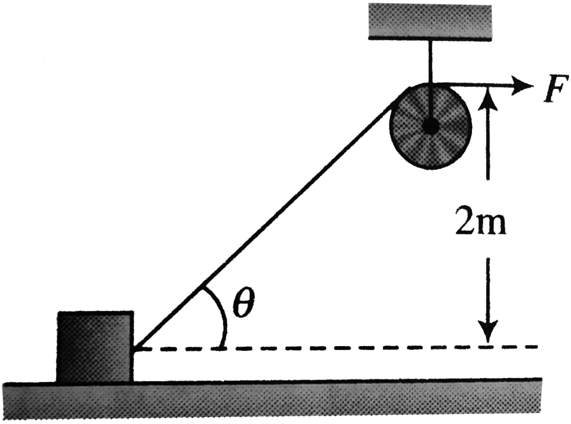
53. A force $F = 50N$ is applied at one end of a string, the other end of which is tied to a block of mass $10kg$. The block is free to move on a frictionless horizontal surface. Take initial instant as $\theta = 30^\circ$ and final instant as $\theta = 37^\circ$. For the time between these two instants, answer teh following questions?



Net work done by the force F on the block is

A. (a) $\frac{50}{3}J$

B. (b) $\frac{100}{3}J$

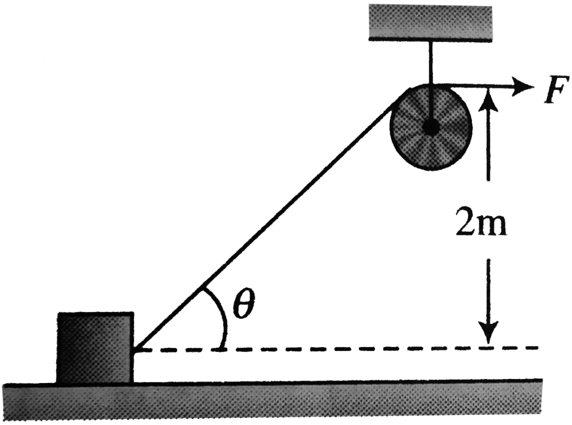
C. (c) $75J$

D. (d) None of these

Answer: B

Watch Video Solution

54. A force $F = 50N$ is applied at one end of a string, the other end of which is tied to a block of mass $10kg$. The block is free to move on a frictionless horizontal surface. Take initial instant as $\theta = 30^\circ$ and final instant as $\theta = 37^\circ$. For the time between these two instants, answer teh following questions?



What is the final velocity of the block if initially it was at rest?

A. (a) $\sqrt{\frac{25}{3}} ms^{-1}$

B. (b) $5ms^{-1}$

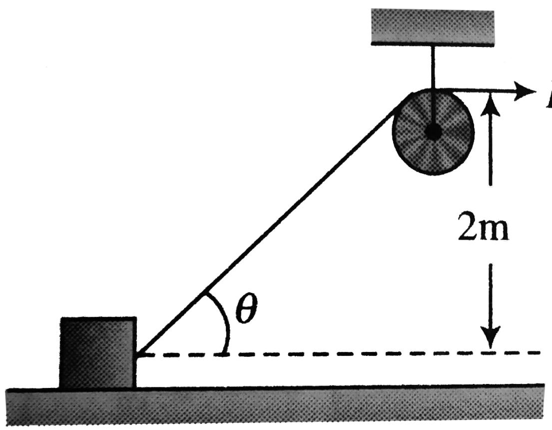
C. (c) $\sqrt{\frac{20}{3}} ms^{-1}$

D. (d) None of these

Answer: C

Watch Video Solution

55. A force $F = 50N$ is applied at one end of a string, the other end of which is tied to a block of mass $10kg$. The block is free to move on a frictionless horizontal surface. Take initial instant as $\theta = 30^\circ$ and final instant as $\theta = 37^\circ$. For the time between these two instants, answer teh following questions?



Find the ratio of initial acceleration to final acceleration of the block

A. $\dfrac{3\sqrt{5}}{8}$

B. $\frac{8\sqrt{3}}{5}$

C. $\frac{8\sqrt{5}}{3}$

D. $\frac{5\sqrt{3}}{8}$

Answer: D

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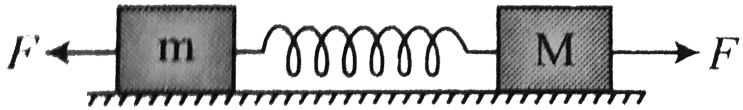
Integer

1. In the situation shown in figure all contact surfaces are smooth. The force constant of the spring is K. Two forces F are applied as shown. The maximum elongation produced in the spring is how many times of F/K (initially the spring is relaxed)?



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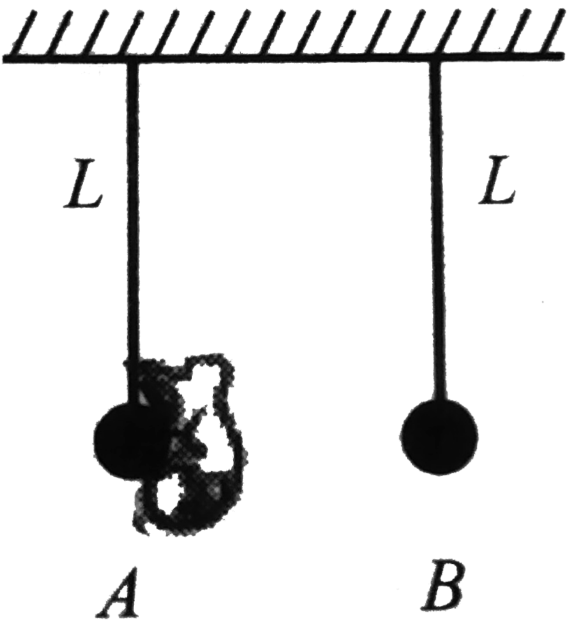
2. An insect jumps from ball A onto ball B, which are suspended from inextensible light strings each of length $L = 8cm$. The mass of each ball and insect is same. What should be the minimum relative velocity (in ms^{-1}) of jump of insect w.r.t. ball A, if both the balls manage to complete the full circle?



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3. The PE of a certain spring when streched from natural length through a distance $0.3m$ is $5.6J$. Find the amount of work in joule that must be done on this spring to stretch it through an additional distance $0.15m$.

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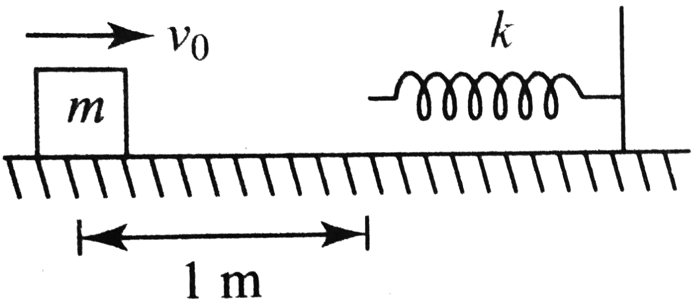
4. A block of mass $m = 0.14kg$ is moving with velocity v_0 towards a mass less unstretched spring of force constant $K = 10Nm^{-1}$. Coefficient of friction between the block and the ground is $\mu = 1/2$.



Find the maximum value of compression in the spring (in cm), so that after pressing the spring the block does not return back but stops there permanently.

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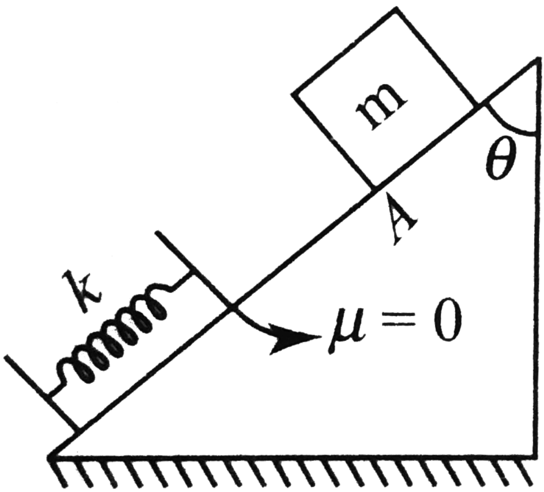
5. A block of mass m is released from rest at point A. The compression in spring (force constant k) when the speed of block is maximum is found to be $\frac{nmg\cos\theta}{4k}$. What should be the value of n?



A. 2

B. 3

C. 4

D. 1

Answer: C

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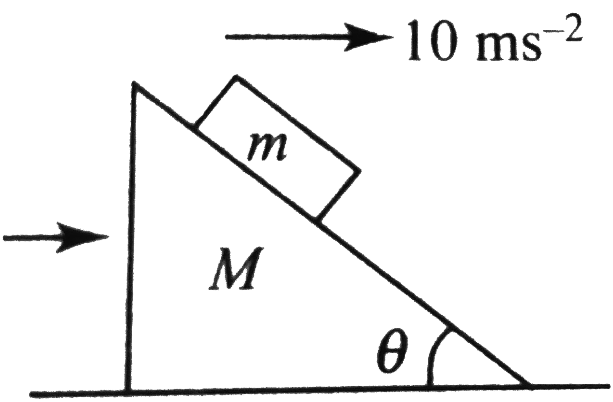
6. In figuer, shown all the surfaces are frictionless, and mass of the block is $m = 100g$. The block and the wedge are held initially at rest. Now the wedge is given a horizontal acceleration of $10ms^{-2}$ by applying a force on the wedge, so that the block does not slip on the wedge. Then find the work done in joules by the normal force in ground frame on the block in $1s$.



A. 5J

B. 2J

C. 10J

D. 15J

Answer: A

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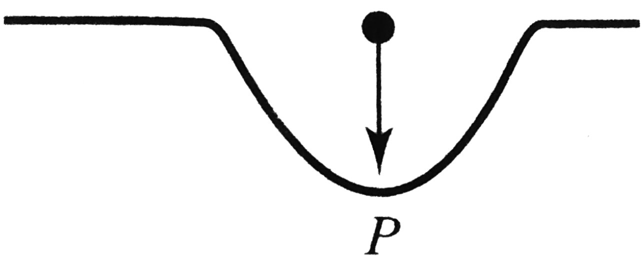
7. A car travelling on a smooth road passes through a curved portion of the road in the form of an arc of circle of radius $10m$. If the mass of car is $120kg$, find the reaction (in kN) on car at lowest point P where its speed is $20ms^{-1}$.



A. 2kN

B. 6kN

C. 10kN

D. 12kN

Answer: B

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8. A man slowly pulls a bucket of water from a well of depth $h = 20m$. The mass of the uniform rope and bucket full of water are $m = 200g$ and $M = 19.9kg$ respectively. Find the work done (in kJ) by the mean.

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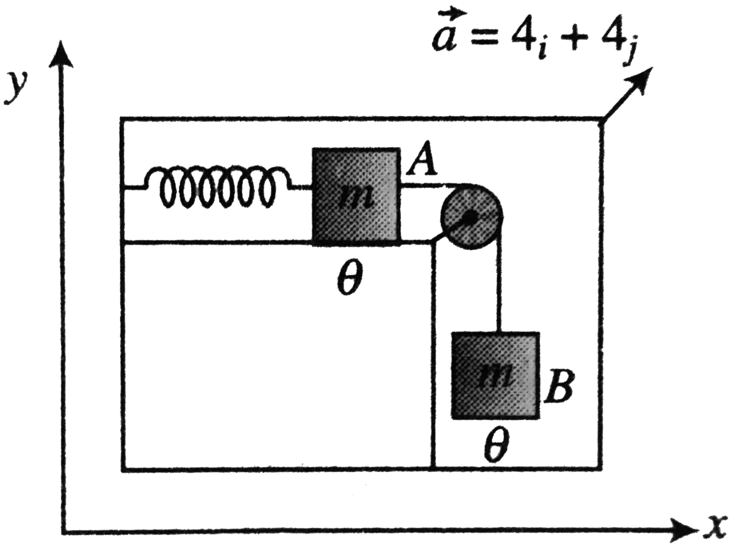
9. The arrangement shown in figure is at rest. An ideal spring of natural length l_0 having spring constant $k = 220Nm^{-1}$, is connected to block A. Blocks A and B are connected by an ideal string passing through a frictionless pulley. The mass of each block A and B is equal to $m = 2kg$

when the spring was in natural length, the whole system is given an acceleration $\vec{a}$ as shown. If coefficient of friction of both surfaces is $\mu = 0.25$, then find the maximum extension in (cm) of the spring. $(g = 10ms^{-2})$.



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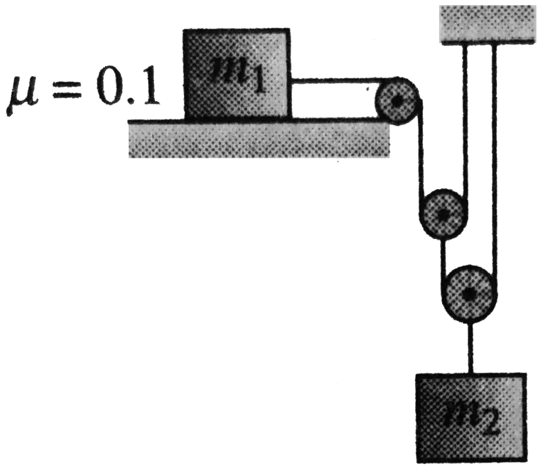
10. In figure, find the velocity of m_1 in ms^{-1} when m_2 falls by $9m$.



Given $m_1 = m, m_2 = 2m$ (take $g = 10ms^{-2}$).

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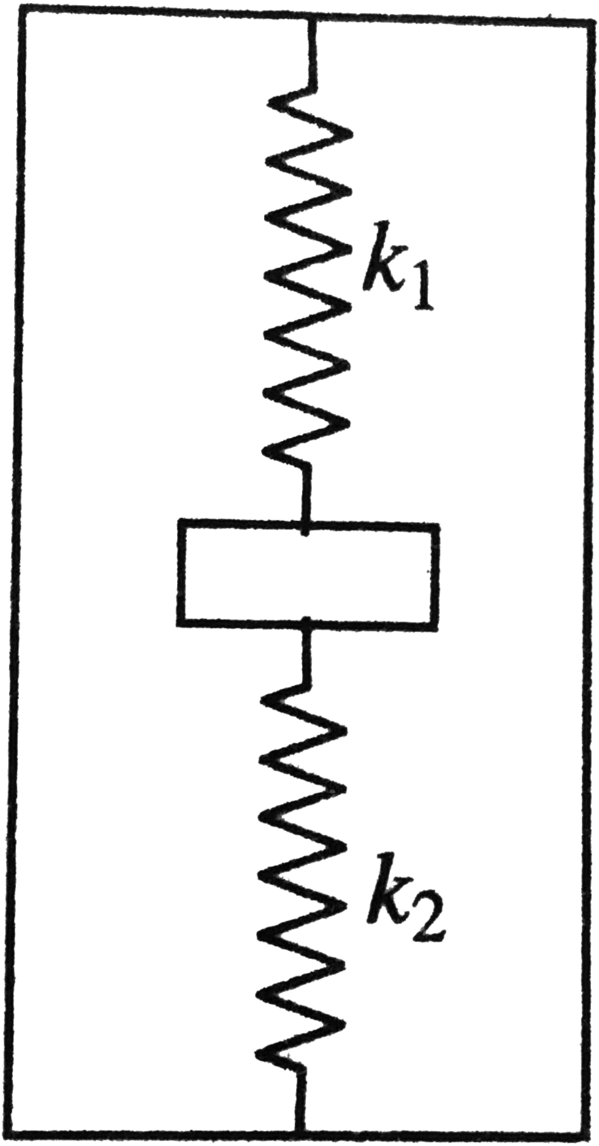
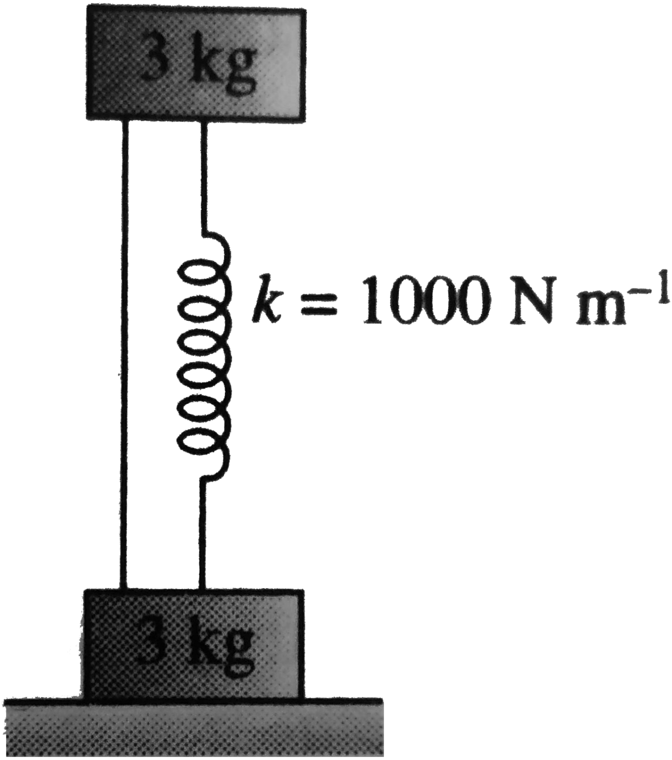
11. One end of a spring of force constant k_1 is attached to the ceiling of an elevator. A block of mass $1.5kg$ is attached to the other end. Another spring of force constant k_2 is attached to the bottom of the mass and to the floor of the elevator as shown in figure. At equilibrium, the deformation in both the spring is equal and is $40cm$. If the elevator moves with constant acceleration upward, the additional deformation in both the spring is $8cm$. Find the elevator's accelerationn ($g = 10ms^{-2}$).



12. A system consists of two identical cubes, each of mass $3kg$, linked together by a compressed weightless spring of force constant $1000Nm^{-1}$. The cubes are also connected by a thread which is burnt at a certain moment. At what minimum value of initial compression x_0 (in cm) of the spring will the lower cube bounce up after the thread is burnt together?



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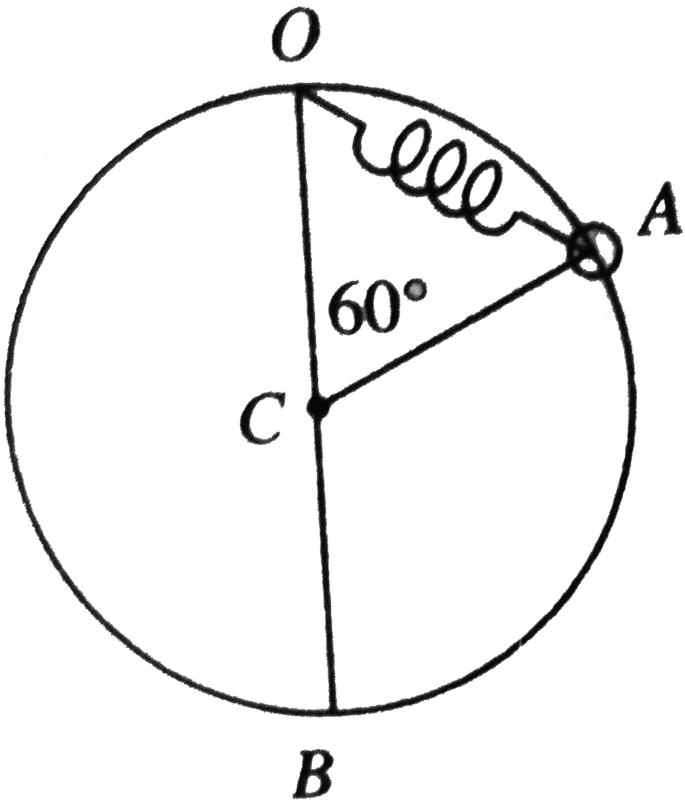
13. A particle of mass $5kg$ is free to slide on a smooth ring of radius $r = 20cm$ fixed in a vertical plane. The particle is attached to one end of a spring whose other end is fixed to the top point O of the ring. Initially, the particle is at rest at a point A of the ring such that $\angle OCA = 60^{\circ}$, C being the centre of the ring. The natural length of the spring is also equal to $r = 20 cm$. After the particle is released and slides down the ring, the contact force between the particle and the ring becomes zero when it reaches the lowest position B. Determine the force constant $(in \times 10^2 Nm^{-1})$ of the spring.



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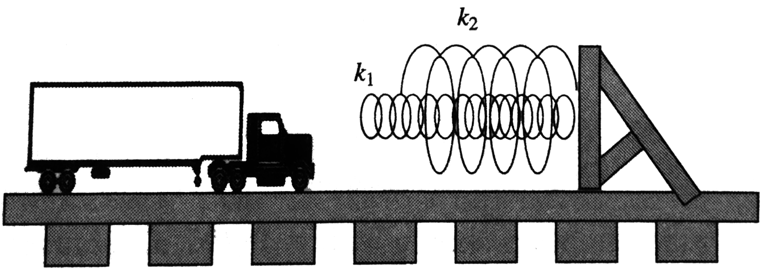
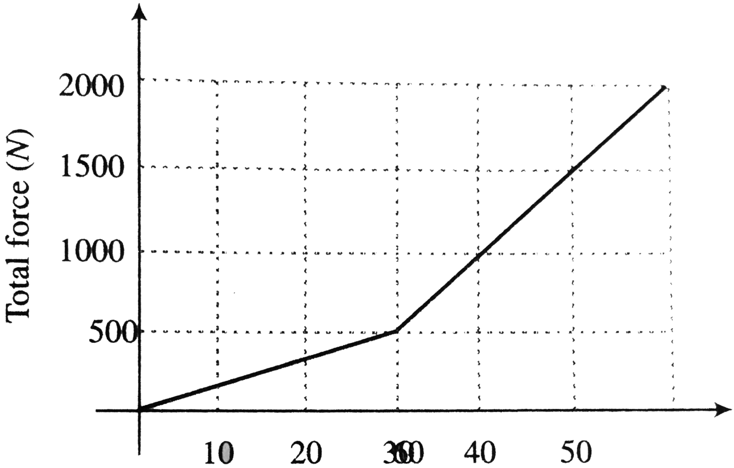
14. A $2144kg$ freight car roles along rails with negligible friction. The car is brought to rest by a combination of two coiled springs as illustrated in figure. Both springs are described by Hooke's law with $k_1 = 1600Nm^{-1}$ and $k_2 = 3400Nm^{-1}$. After the first spring compresses a distance of $30.0cm$, the second spring acts with the first to increase the force as additional compression occurs as shown in the graph in figure. The car comes to rest $50.0cm$ after first contracting the two-spring system. Find the car's initial speed $(in \times 10^{-1}Nm^{-1})$.





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Archives (sinble Correct)

1. If maching is lubricated with oil

A. (a) The mechanical advantage of the machine increases

B. (b) The mechanical efficiency of the machine increases

C. (c) Both its mechanical advantage and efficiency increase

D. (d) Its efficiency increases, but its mechanical advantage decreases

Answer: B

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2. Two masses of 1 g and 4g are moving with equal linear momenta. The ratio of their kinetic energies is :

A. (a) $4:1$

B. (b) $\sqrt{2}:1$

C. (c) $1:2$

D. (d) $1:16$

Answer: C

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3. A body is moved along a straight line by a machine delivering constant power . The distance moved by the body is time t is proptional to

A. (a) $t^{1/2}$

B. (b) $t^{3/4}$

C. (c) $t^{3/2}$

D. (d) t^2

Answer: C

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4. A particle of mass m is moving in a circular path of constant radius r, such that its centripetal force F_r varies with time t as $F_r = K^2 r t^2$, where k is a constant. What is the power delivered to the particle by the forces acting on it?

A. (a) $2\pi m k^2 r^2 t$

B. (b) $m k^2 r^2 t$

C. (c) $\frac{(m k^4 r^2 t 5)}{3}$

D. (d) zero

Answer: B

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5. A stone tied to a string of length L is whirled in a vertical circle with the other end of the string at the centre. At a certain instant of time the stone is at lowest position and has a speed u . Find the magnitude of the change in its velocity as it reaches a position, where the string is horizontal.

A. (a) $\sqrt{u^2 - 2gL}$

B. (b) $\sqrt{2gL}$

C. (c) $\sqrt{u^2 - gL}$

D. (d) $\sqrt{2(u^2 - gL)}$

Answer: D

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6. A force $F = -K\left(y\hat{i} + x\hat{j}\right)$ (where K is a positive constant) acts on a particle moving in the x-y plane. Starting from the origin, the particle is taken along the positive x-axis to the point $(a, 0)$, and then parallel to the y-axis to the point (a, a). The total work done by the force F on the particle is

A. $-2Ka^2$

B. $2Ka^2$

C. $-Ka^2$

D. Ka^2

Answer: C

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7. A spring of force constant k is cut into two pieces such that one piece is double the length of the other. Then the long piece will have a force constant of

A. (a) $\left(\frac{2}{3}\right)k$

B. (b) $\left(\frac{3}{2}\right)k$

C. (c) $3k$

D. (d) $6k$

Answer: B

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8. A wind - powered generator convets and energy into electrical energy . Assume that the generator convents a fixed fraction of the wind energy intercepited by to blades into electrical energy for wind speed V , the electrical power output will be propertional to

A. (a) V

B. (b) V^2

C. (c) V^3

D. (d) V^4

Answer: C

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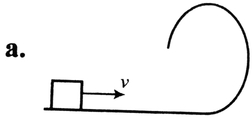
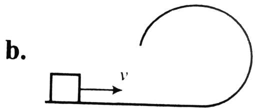
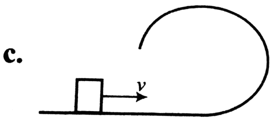
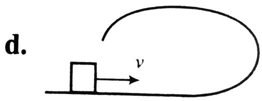
9. A small block is shot into each of the four tracks as shown below. Each of the tracks rises to the same height. The speed with which the block enters the track is the same in all cases. At the highest point of the track, the normal reaction is maximum in

A. (a)


B. (b)


C. (c)


D. (d)


Answer: A

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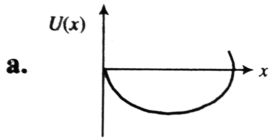
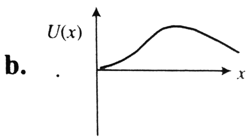
10. A particle, which is constrained to move along the x-axis, is subjected to a force from the origin as $F(x) = -kx + ax^3$.Here k and a are positive constants. For $x = 0$, the functional form of the potential energy $U(x)$ of particle is.

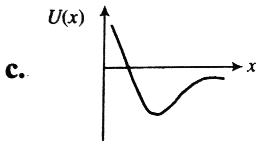
A. (a)



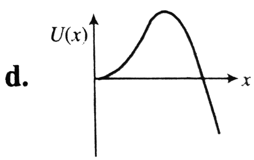
B. (b)



C. (c)



D. (d)



Answer: D

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11. An ideal spring with spring constant k is hung from the ceiling and a block of mass M is attached to its lower end. The mass is released with the spring initially unstretched. Then the maximum extension in the spring is

A. (a) $\frac{4Mg}{k}$

B. (b) $\frac{2Mg}{k}$

C. (c) $\frac{Mg}{k}$

D. (d) $\frac{Mg}{2k}$

Answer: B

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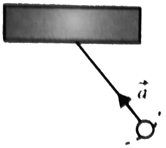
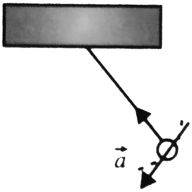
12. A simple pendulum is oscillating without damiping, When the displacement of the bob is less than maximum, its acceleration vector $\vec{a}$ is correctly show in:

a.



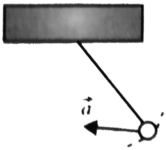
A. (a)

b.



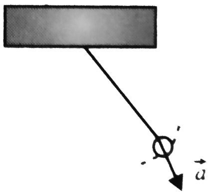
B. (b)

c.



C. (c)

d.



D. (d)

Answer: C

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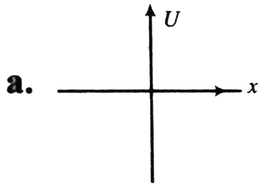
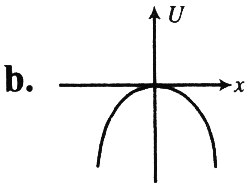
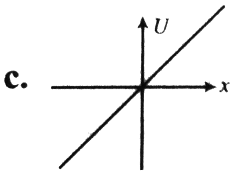
13. A particle is acted by x force $F = Kx$ where K is $a(+Ve)$ constant its potential mwrgy at $x = 0$ is zero . Which curve correctly represent the variation of putential energy of the block with repect to x



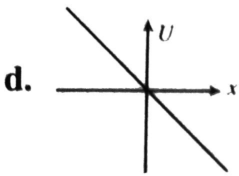
A. (a)



B. (b)



C. (c)



D. (d)

Answer: B

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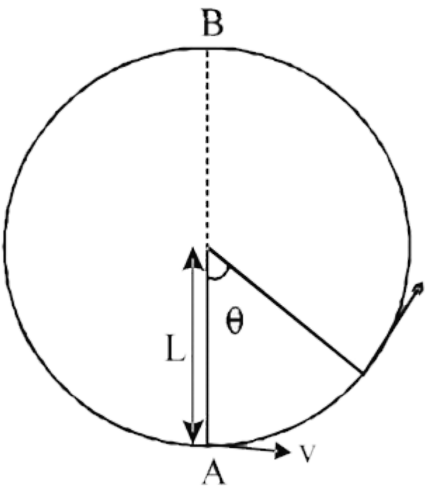
14. A bob of mass M is suspended by a massless string of length L. The horizonta velocity v at position A is just sufficient to make it reach the point B. The angle θ at which the speed of the bob is half of that at A, satisfies



A. (a) $\theta = \frac{\pi}{4}$

B. (b) $\frac{\pi}{4} < \theta < \frac{\pi}{4}$

C. (c) $\frac{\pi}{2} < \theta < \frac{3\pi}{4}$

D. (d) $\frac{3\pi}{4} < \theta < \pi$

Answer: D

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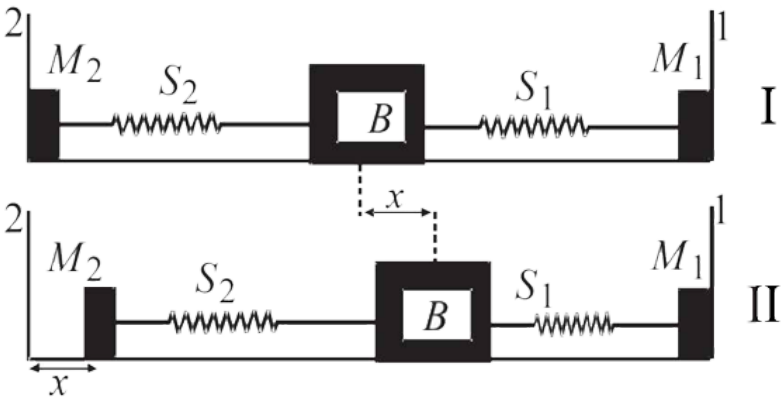
15. A block (B) is attached to two unstriched sprig S_1 and S_(2) with spring constant K and $4K$, respectively (see fig 1) The other ends are atteched in identical support M_1 and M_2 not attached in the walls . The springs and supports have negligible mass . There is no friction anywhere . The block B is displaced toword wall 1 by a small distance z (figure (ii)) and released . THe block return and moves a maximum displacements x and y are musured with reoact to the equalibrum of the block B and the ratio y/x is



A. 4

B. 2

C. (c) $\frac{1}{2}$

D. (d) $\frac{1}{4}$

Answer: C

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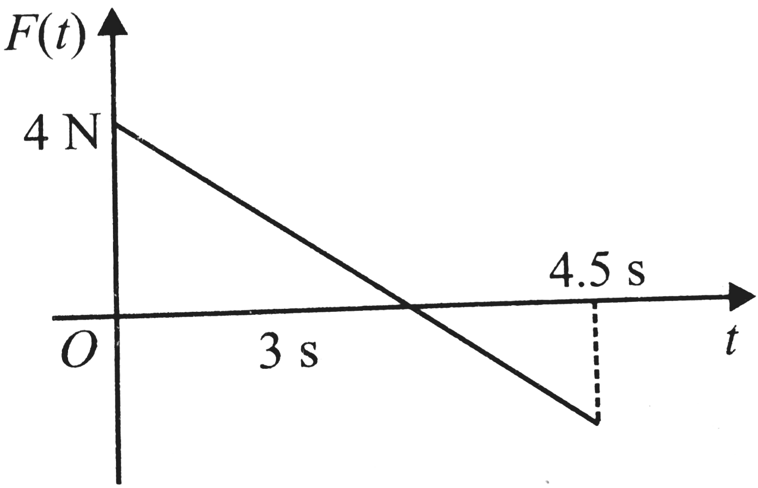
16. A block of mass $2kg$ is free to move along the x-axis. It at rest and from $t = 0$onwards it is subjected to a time-dependent force $F(t)$ in the x direction. The force $F(t)$ varies with t as shown in the figure. The kinetic energy of the block after 4.5 seconds is



A. $4.50J$

B. $7.50J$

C. $5.06J$

D. $14.06J$

Answer: C

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17. The work done an a particle of mass m by a force

$$K\left[\frac{x}{(x^2+y^2)^{3/2}}\hat{i}+\frac{y}{\left(x^2+y^{2^{3/2}}\right)\hat{j}}\right](Kbe \in gacons \tan tofap \propto riate \text{ di}$$

(a,0) $\rightarrow thep \oint$(0,a)` along a circular path of radius a about the origin in x - y plane is

A. (a) $\frac{2Kx}{a}$

B. (b) $\frac{Kx}{a}$

C. (c) $\frac{Kx}{2a}$

D. (d) 0

Answer: D

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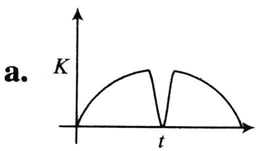
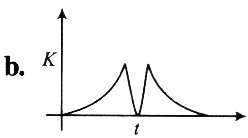
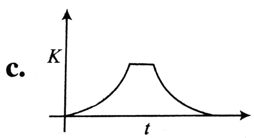
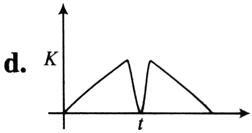
18. A tennis ball dropped on a barizoontal smooth surface , it because back to its original postion after hiting the surface the force on the bell during the collision is propertional to the length of compression of the bell . Which one of the following skethes desches discribe the variation of its kinetic energy K with time 1 mass apporiandly ? The figure as only illistrative and not to the scale .

A. (a) 

B. (b) 

C. (c) 

D. (d) 

Answer: B

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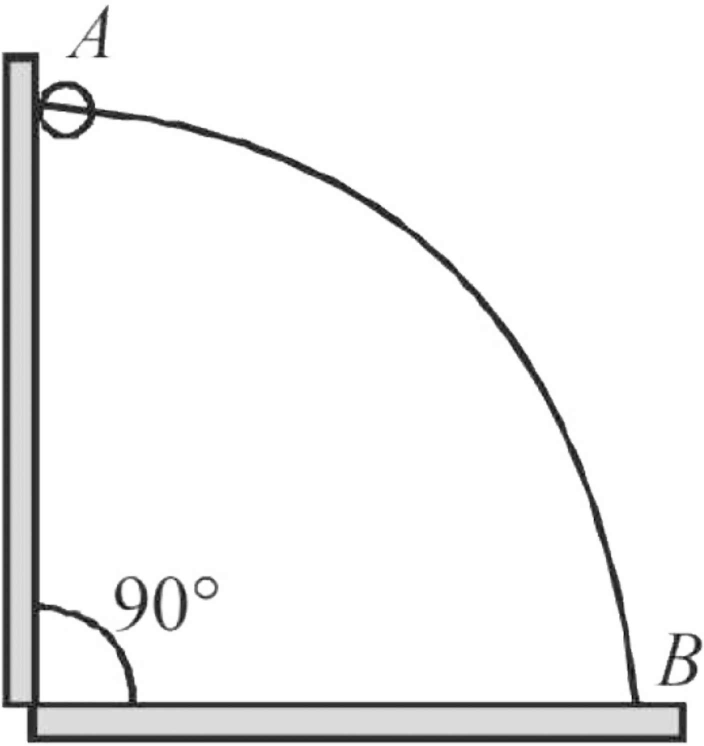
19. A wire, which passes through the hole in a small bead, is bent in the form of quarter of a circle. The wire is fixed vertically on ground as shown in the figure. The bead is released from near the top of the wire and it slides along the wire without friction. As the bead moves from A to B, the force it applies on the wire is



A. (a) always radially outwards.

B. (b) always radially inwards.

C. (c) radially outwards initially and radially inwards later.

D. (d) radially inwards initially and radially outwards later.

Answer: D

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Archives(multiple Correct)

1. A simple pendulum of length L and mass (bob) M is oscillating in a plane about a vertical line between angular limit $-\phi$ and $+\phi$. For an angular displacement $\theta(|\theta| < \phi)$, the tension in the string and the velocity of the bob are T and V respectively. The following relations hold good under the above conditions:

A. (a) $T\cos\theta = Mg$

B. (b) $T - Mg\cos\theta = \frac{MV^2}{L}$

C. (c) The magnitude of the tangential acceleration of the bob $a_T = g\sin\theta$

D. (d) $T = Mg\cos\theta$

Answer: B::C

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2. A particle is acted upon by a force of constant magnitude which is always is perpendicular to the velocity of the particle , the motion of the particles takes place is a plane it follow that

A. (a) Its velocity is constant

B. (b) Its acceleration is constant

C. (c) Its kinetic energy is constant

D. (d) It moves in a circular path

Answer: C::D

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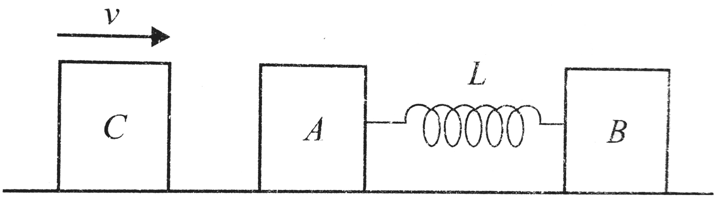
3. Two blocks A and H. each of mass m, are connected by a massless spring of natural length I. and spring constant K. The blocks are initially resting in a smooth horizontal floor with the spring at its natural length, as shown in Fig. A third identical block C, also of mass m, moves on the floor with a speed v along the line joining A and B. and collides elastically with A. Then



A. (a) The KE of the AB system at maximum compression of the spring is zero.

B. (b) The KE of the AB system at maximum compression of the spring is $(1/4)mv^2$.

C. (c) The maximum compression of the spring is $v\sqrt{\frac{m}{k}}$.

D. (d) The maximum compression of the spring is $v\sqrt{\frac{m}{2k}}$

Answer: B::D

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Archives (assertion-reasoning)

1. In the following questions, each question contains Statement I(assertion) and StatementII(reason). Each questions has four choices a, b, c, and d out of which only one is correct.

Statement I: 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 certain distance. The surface is now titled to an angle of 30° with the horizontal and the same block is made to go up on the surface with the same initial velocity v. The decrease in mechanical energy in the second situation is smaller than that in the first situation.

Statement II: The coefficient of friction between the block and the surface decreases with the increase in the angel of inclination.

A. (a) Statement I is true, Statement II is true, Statement II is a correct explanation for Statement I.

B. (b) Statement I is true, Statement II is true, Statement II is not a correct explanation for Statement I.

C. (c) Statement I is true, Statement II is false.

D. (d) Statement I is false, Statement II is true.

Answer: C

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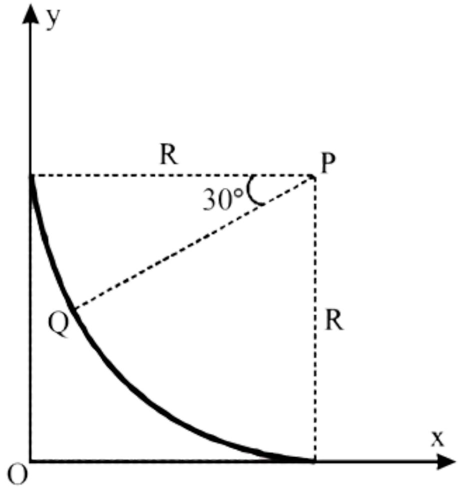
Archives (linked Comprehension)

1. A small block of mass 1 kg is a circular are of ratius 40 m . The block sides along the track without topping and a frictionnal force acts on it in the direction opposite in the instrmens velocity . The work done in evercoming the friction up to the point Q as shown is the figure below is $150J$

(Take the acceleration due to gravity $g = 10ms^{-2}$)



The speed of the block when it reaches the point Q is

A. (a) $5ms^{-1}$

B. (b) $10ms^{-1}$

C. (c) $10\sqrt{3}ms^{-1}$

D. (d) $20ms^{-1}$

Answer: B

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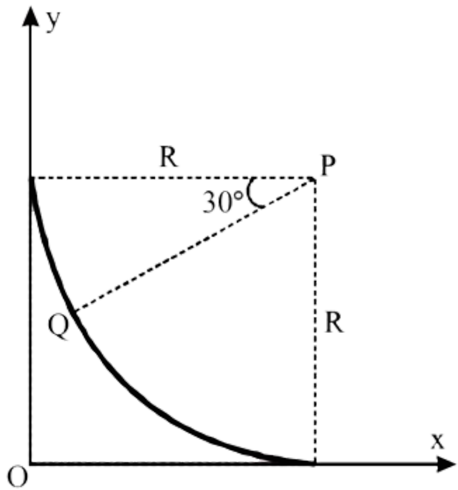
2. A small block of mass 1 kg is a circular are of ratius 40 m . The block sides along the track without topping and a frictionnal force acts on it in the direction opposite in the instrmens velocity . The work done in evercoming the friction up to the point Q as shown is the figure below is $150J$

(Take the acceleration due to gravity $g = 10ms^{-2}$)



The magnitude of the normal reaction that acts on the block at the point Q is

A. (a) $7.5N$

B. (b) $8.6N$

C. (c) $11.5N$

D. (d) $22.5N$

Answer: A

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Archives (integer)

1. A light inextensible string that gas over a smooth fixed pulley as shown in the figure connect two blocks of masses it 0.36 kg and 0.72 kg Taking $g = 10ms^{-2}$, find the work done(in joules) by the string on the block of mass 0.36 kg during the first second after the system is reposed from rest

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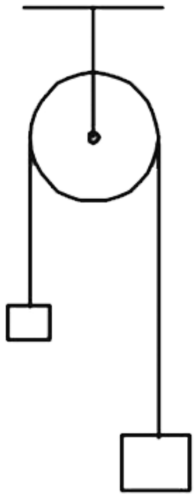

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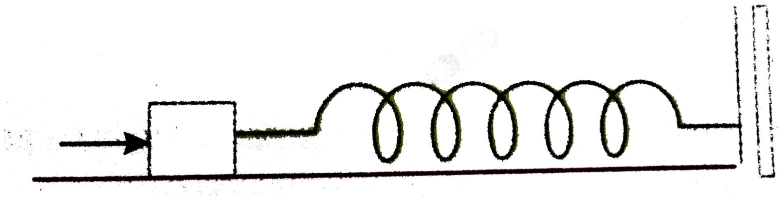
2. A block of mass $0.18kg$ is attached to a spring of force-constant $2N/m$. The coefficient of friction between the block and the floor is 0.1 Initially the block is at rest and the spring is un-stretched. An impulse is given to the block as shown in the figure. The block slides a distance of $0.06m$ and comes to rest for the first time. The initial velocity of the block in m//s is

$V = N/10$. Then N is :



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3. A bob of mass m, suspended by a string of length l_1 is given a minimum velocity required to complete a full circle in the vertical plane. At the highest point, it collides elastically with another bob of mass m suspended by a string of length l_2, which is initially at rest. Both the strings are mass-less and inextensible. If the second bob, after collision acquires the minimum speed required to complete a full circle in the vertical plane, the ratio $\frac{l_1}{l_2}$ is

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4. A particle of mass $0.2kg$ is moving in one dimension under a force that delivers constant power $0.5W$ to the particle.If the initial speed =0 then the final speed (in ms^{-1}) after $5s$ is.

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