PHYSICS

BOOKS - RESNICK AND HALLIDAY PHYSICS (HINGLISH)

WORK, POWER, AND ENERGY

Sample Problem

1. In 1896 in Waco, William Crush parked two locomotives at opposite ends of a 6.4-Km-long track, fired them up, tied throttles open, and theb allowed them to crash head-on at full speed (Fig. 8.1)in front of 30,000 spectators. Hundreds of people were hurt by flying debris, several were killed. Assuming each locomotive weighed and its acceleration was a constant what was the total kinetic energy of the two locomotives just before the collision?

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2. Figure 8-3 shows four situations in which the same box is pulled by an appiled force $\overrightarrow{F}$ up a frictionless ramp through (and then past) the same vertical distance In each situation, The force has a magnitude of 10 N. In situations (b) and (d), the force is directed along the plane: in situations (a) and (c). it is directed at an angle $\phi = 37^{\circ}$ to the plane. as shown. Rank the situations according to the work done on the box in the vertical distance by the appiled force. Also, discuss whether answer depends on the initial speed of box or the presence of other forces.

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3. A force $\overrightarrow{F} = (3.00N)\hat{i} + (7.00N)\hat{j} + (7.00N)\hat{k}$ act on a 2.00 kg mobile object that moves from an initial position of $\overrightarrow{r_i} = (3.00m)\hat{i} - (2.00m)\hat{j} + (5.00m)\hat{k}$ to a final position of $\overrightarrow{r_f} + (5.00m)\hat{i} + (4.00m)\hat{j} + (7.00m)\hat{k}$ in 4.00 s. Find the work done on the object by the force in the 4.00 s interval.

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4. Figure8-5a shows two industrial spies sliding an initially stationary 225 kg floor safe a displacement $\vec{d}$ of magnitude 8.50 m. The push $\vec{F}_1$ of spy 001 is 12.0 N at an angle of 30.0° downward from the horizontal, the pull $\vec{F}_2$ of spy 002 is 10.0 N at 40.0° above the horizontal. The magnitudes and directions of these forces do not change as the safe moves, and the floor and safe make frictionless contact.

(a) What is the net work done on the safe by forces $\vec{F}_1$ and $\vec{F}_2$ during the displacement $\vec{d}$?

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5. Figure8-5a shows two industrial spies sliding an initially stationary 225 kg floor safe a displacement $\vec{d}$ of magnitude 8.50 m. The push $\vec{F}_1$ of spy 001 is 12.0 N at an angle of 30.0° downward from the horizontal, the pull $\vec{F}_2$ of spy 002 is 10.0 N at 40.0° above the horizontal. The magnitudes and directions of these forces do not change as the safe moves, and the floor and safe make frictionless contact.

(b) During the displacement, what is the work W_g done on the safe by the gravitational force $\vec{F}_g$ and what is the work W_N done on the safe by the normal force $\vec{F}_N$ from the floor ?

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6. Figure8-5a shows two industrial spies sliding an initially stationary 225 kg floor safe a displacement $\vec{d}$ of magnitude 8.50 m. The push $\vec{F}_1$ of spy 001 is 12.0 N at an angle of 30.0° downward from the horizontal, the pull $\vec{F}_2$ of spy 002 is 10.0 N at 40.0° above the horizontal. The magnitudes and directions of these forces do not change as the safe moves, and the floor and safe make frictionless contact.

The safe is initially stationary. What is its speed v_f at the end of the 8.50 m displacement?

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7. During a storm, a crate of crepe is sliding across a slick, oily parking lot through a displacement $\vec{d} = (-3.0m)\hat{i}$ while a steady wind pushes against the crate with a force $\vec{F} = (2.0N)\hat{i} + (-6.0N)\hat{j}$. The situation and coordinate axes are shown in Fig. 8-6.

(a) How much work does this force do on the crate during the displacement ?

Figure 8-6 Force $\vec{F}$ slows a crate during displacement $\vec{d}$.

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8. During a storm, a crate of crepe is sliding across a slick, oily parking lot through a displacement $\vec{d} = (-3.0m)\hat{i}$ while a steady wind pushes against the crate with a force $\vec{F} = (2.0N)\hat{i} + (-6.0N)\hat{j}$. The situation and coordinate axes are shown in Fig. 8-6.

If the crate has a kinetic energy of 10 J at the beginning of displacement $\vec{d}$, what is its kinetic energy energy at the end of $\vec{d}$?

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9. In this problem an object is pulled along a ramp but the object starts and ends at rest and thus has no overall change in its kinetic energy (that is important). Figure 8-10a shows the situation. A rope pulls a 200 kg sleigh (which you may know) up a slope at incline angle $\theta = 30^\circ$, through distance $d = 20$ m. The sleigh and its contents have a total mass of 200 kg. the snowy slope is so slippery that we take it to be frictionless. How much work is done by each force acting on the sleigh ?

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10. An elevator cab of mass $m = 500$ kg is descending with speed $v_i = 4.0 m/s$ when its supporting cable begins to slip, allowing it to fall with constant acceleration $\vec{a} = \vec{g}/5$.

During the fall through a distance $d = 12$ m, what is the work W_g done on the cab by the gravitational force $\vec{F}_g$?

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11. An elevator cab of mass $m = 500$ kg is descending with speed $v_i = 4.0 m/s$ when its supporting cable begins to slip, allowing it to fall with constant acceleration $\vec{a} = \vec{g}/5$ (Fig. 8-11a).

(b) During the 12 m fall, what is the work W_T done on the cab by the upward pull $\vec{T}$ of hte elevator cable?

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12. An elevator cab of mass $m = 500$ kg is descending with speed $v_i = 4.0 m/s$ when its supporting cable begins to slip, allowing it to fall with constant acceleration $\vec{a} = \vec{g}/5$ (Fig. 8-11a).

(c) What is the net work W done on the cab during the fall?

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13. An elevator cab of mass $m = 500$ kg is descending with speed $v_i = 4.0m/s$ when its supporting cable begins to slip, allowing it to fall with constant acceleration $\vec{a} = \vec{g}/5.$

What is the cab's kinetic energy at the end of the 12 m fall ?

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14. When a spring does work on an object, we cannot find the work by simple multiplying the spring force by the object's displacement. The reason is that there is no one value for the force-it changes. However, we can split the displacement up into an infinite number of tiny parts and then approximate the force in each as being constant. Integration sums the work done in all those parts. Here we use the generic result of the integration.

In Fig. 8-13, a cansiter of mass m = 0.40 kg slides across a horizontal frictionless counter with speed v = 0.50 m/s. It then runs into and compresses a spring of spring constant k = 750 N/m. When the canister is momentarily stopped by the spring, by what distance d is the spring compressed?

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15. In Fig. 8-15b, an 8.0 kg block slides along a frictionless floor as a force acts on it, starting at $x_1 = 0$ and ending at $x_3 = 6.5m$. As the block moves, the magnitude and direction of the force varies according to the graph shown in Fig. 8-15a. For example, from x = 0 to x = 1 m, the force is positive (in the positive direction of the x axis) and increase in magnitude from 0 to 40 N. And from x = 4 m to x = 5, the force is negative and increases in magnitude from 0 to 20 N.

(Note that this latter value is displayed as -20 N.) The block's kinetic energy at x_1 is $K_1 = 280J$. What is the block's speed at $x_1 = 0$, $x_2 = 4.0m$, and $x_3 = 6.5m$?

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16. When the force on a object depends on the position of the object, we cannot find the work done by it on the object by simple multiplying the force by the displacement. The reason is that there is no one value for the force-it changes. So, we must find the work in tiny little displacements and then add up all the workk results. We effectively say, "Yes, the force varies over any given tiny little displacement. but the variation is so small we can approximate the force as being constant during the displacements infinitesimal, then our error becomes infinitesimal and the result becomes precise. But, to add an infinite number of work contributions by hand would take us forever, longer than a semester.So we add them up via an integration, which allows us to do all this in minutes (much less than a semester).

Force $\overrightarrow{F} = (3x^2 N)\hat{i} + (4N)\hat{j}$, with x in meters, acts on a particle, changing only the kinetic energy of th particle. How much work is done on the particle as it moves from coordinates (2 , 3 m) to 3 m, 0 m)? Does the speed of the particle increase, decrease, or remain the same?

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17. A worker on a railway cart is pushing a box. The cart is moving at a constant speed of 20 m/s by some external agent. The box has a mass of 25 kg, and is being pushed forward over a distance of 2m on the cart by the worker at constant acceleration, increasing its speed from 0 to 2 m/s relative to car.

(a) What will be the value of change in kinetic energy and work done by worker as calculated by Tenzing, who is standing on the cart.

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18. A worker on a railway cart is pushing a box. The cart is moving at a constant speed of 20 m/s by some external agent. The box has a mass of 25 kg, and is being pushed forward over a distance of 2m on the cart by the worker at constant acceleration, increasing its speed from 0 to 2 m/s relative to car.

(b) How does Girish standing on the ground interpret a similar measurement?

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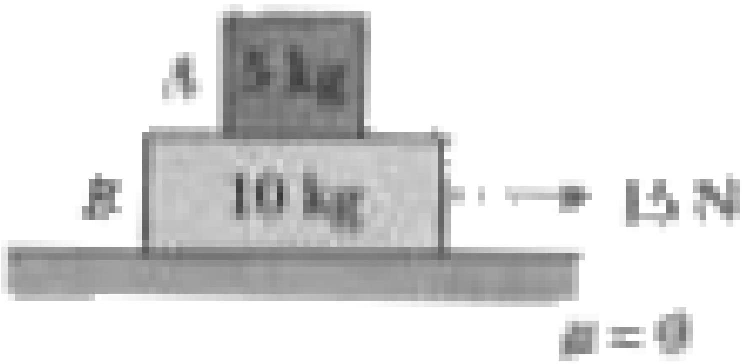
19. Two blocks are kept over one another as shown in Fig. 8-17a Ground is smooth and friction coefficient between blocks is 0.5. Lower block is pulled by a uniform horizontal force of 15 N for 2m. Find final speed of blocks. Apply work-kinetic energy theorem on the blocks separately and verify that work done by friction between blocks adds to zero.



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20. The main lesson of this sample problem is this: It is perfectly all right to choose an easy path instead of a hard path. Figure 8-22a shows a 2.0 kg block of slippery cheese that slides along a frictionless track from point a to point b. The cheese travels through a total distance of 2.0 m along the track, and a net vertical distance of 0.80 m . How much work is done on the cheese by the gravitational force during the slide ?

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21. Here is an example with this lesson plan: Generally you can choose any level to the reference level, but once chosen, be consistent. A 2.0 kg sloth hangs 5.0 m above the ground (Fig. 8-23).

(a) What is the gravitational potential energy U of the sloth-Earth system if we take the reference point $y = 0$ to be (1) at the grund, (2) at a balcony floor that is 3.0 m above the ground, (3) at the limb, and (4) 1.0 m above the limb? Take the gravitational potential energy to be zero at y=0.

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22. Here is an example with this lesson plan: Generally you can choose any level to e the reference level, but once chosen, be consistent. A 2.0 kg sloth hangs 5.0 m above the ground (Fig. 8-23).

(b) The sloth drops to the ground . For each choice of refrence point, What is the change ΔU in the potential energy of hte sloth-Earth system due to the fall?

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23. The huge advantage of using the conservation of energy instead of Newton's laws of motion is that we can jump from the initial state to the final state without considering all the intermediate motion. Here is an example. In Fig. 8-25, a child of mass m is released from rest at the top of a water slide, Assuming that the slide is frictionless because of the water on it, find the child's speed at the bottom of the slide.

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24. A food shipper pushes a wood crate of cabbage heads (total mass $m = 14$kg) across a concrete floor with a constant horizontal force $\overrightarrow{F}$ of magnitude 40 N. In a straight-line displacement of magnitude $d = 0.50$, the speed of the create decreases from $v_0 = 0.60m/s$ to $v = 0.20m/s$.

How much work is done by force $\vec{F}$, and on what system does it do the work?

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25. A food shipper pushes a wood crate of cabbage heads (total mass $m = 14\text{kg}$) across a concrete floor with a constant horizontal force $\vec{F}$ of magnitude 40 N. In a straight-line displacement of magnitude $d = 0.50$, the speed of the create decreases from $v_0 = 0.60m/s$ to $v = 0.20m/s$.

(b) What is the increase ΔE_{th} in the thermal energy of hte crate and floor?

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26. Figure 8-32 shows a water-slide ride in which a glider is shot by a spring along a water-drenched (frictionless) track that takes the glider from a horizontal section down to ground level. As the glider then moves along the ground-level track, it is gradually brought to rest by friction.

The total mass of the glider and its rider is $m = 200 kg$, the initial compression of the spring is $d = 5.00$m, the spring constant is $k = 3.20 \times 10^3$ N/m, the initial height is $h = 35.0$ m, and the coefficient of kinetic friction along the ground-level track is $\mu_s = 0.800$. Through what distance L does the glider slide along the ground-level track until it stops?

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27. Here we calculate on instantaneous work - that is, the rate at which work is being done at any given instant rather than averaged over a time interval. Figure 8-34 shows constant forces $\overrightarrow{F}_1$ and $\overrightarrow{F}_2$ acting on a box as the box slides rightward across a frictionless floor. Force $\overrightarrow{F}_1$ is horizontal , with magnitude 2.0 N, force $\overrightarrow{F}_2$ is angled upward by 60° to the floor and has magnitude 4.0 N. The speed v of the box at a certain instant is 3.0 m/s. What is the power due to each force acting on the box at that instant, and what is the net power? Is the net power changing at that instant?

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28. A loaded truck of mass 3000 kg moves on a level road at a constant speed of 6.00 0 m/s. The frictional force on the truck from the road is 1000 N. Assume that air drag is negligible.

(a) How much work is done by the truck engine in 10.00 min ?

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29. A loaded truck of mass 3000 kg moves on a level road at a constant speed of 6.00 0 m/s. The frictional force on the truck from the road is 1000 N. Assume that air drag is negligible.

(a) How much work is done by the truck engine in 10.00 min ?

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30. A loaded truck of mass 3000 kg moves on a level road at a constant speed of 6.00 0 m/s. The frictional force on the truck from the road is

1000 N. Assume that air drag is negligible.

(c) What is the total work done by the engine in the full 20 min ?

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31. A 2.00 kg particle moves along an x axis in onedimensional motion while a conservative force along that axis acts on it. The potential energy U(x) associated with the force is plotted in Fig. 8-36a. That is, if the particle were placed at any position between $x = 0$ and $x = 7.00$m, it would have the plotted value of U. At $x = 6.5m$, the particle has velocity $\overrightarrow{v}_0 = (-4.00m/s)\hat{i}$.

(a) Form Fig. 8-36a, determine the particle's speed at $x_1 = 4.5m$.

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32. A 2.00 kg particle moves along an x axis in onedimensional motion while a conservative force along that axis acts on it. The potential energy U(x) associated with the force is plotted in Fig. 8-36a. That is, if the particle were placed at any position between $x = 0$ and $x = 7.00$m, it would have the plotted value of U. At $x = 6.5m$, the particle has velocity $\overrightarrow{v}_0 = (-4.00m/s)\hat{i}$.

(b) Where is the particle's turning point located?

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33. A 2.00 kg particle moves along an x axis in onedimensional motion while a conservative force along that axis acts on it. The potential energy U(x) associated with the force is plotted in Fig. 8-36a. That is, if the particle were placed at any position between $x = 0$ and $x = 7.00$m, it would have the plotted value of U. At $x = 6.5m$, the particle has velocity $\overrightarrow{v}_0 = (-4.00m/s)\hat{i}$.

(c) Evaluate the force acting on the particle when it is in the region 1.9 $m < x < 4.0$ m.

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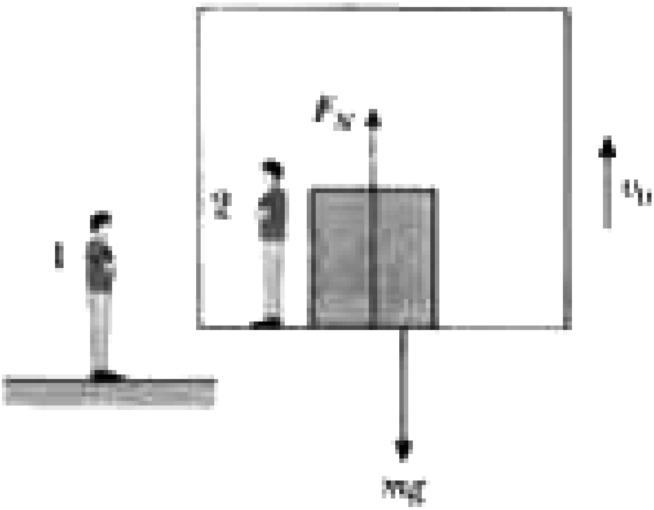
Checkpoint

1. A lift is going up with constant velocity v_0. Calculate the work done by normal force F_g from the reference frame of ground and lift in time t.



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2. A particle moves along an x axis. Does the kinetic energy of the particle increase, decrease, or reman the same if the particle's velocity changes (a) from $-3m/s$ to $-2m/s$ and (b) from $-2m/s$ to $2m/s$? (c) In each situation, is the work done on the particle positive, negative, or zero?

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3. For three situations, the initial and final positions, respectively, along the x axis for the block in Fig. 8-12 are (a) -3 cm, 2 cm, (b) 2cm, 3 cm , and (c) -2 cm, 2cm. In each situation, is the work done by the spring force on the block positive, negative, or zero?

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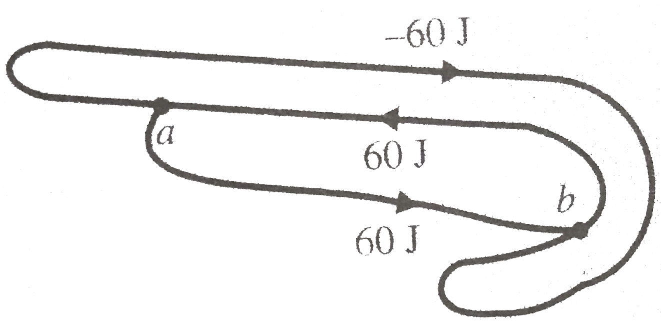
4. Figure shows three paths connecting points a and b, A single force F does the indicated work on a particle moving along each path in the indicated direction. On the basis of this information, is force F conservative?



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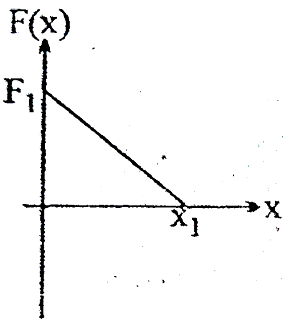
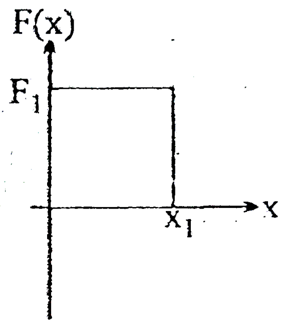
5. A particle is to move along the $x-$ axis from $x=0$ to $x=x_1$ while a conservative force, directed along the $x-$ axis, acts on the particle. For each force defination presented in the figures the maximum magnitude of the force (F_1) is the same for all cases. Rank the forces according to the change in potential energy associated with the motion shown. from most positive to most negative:

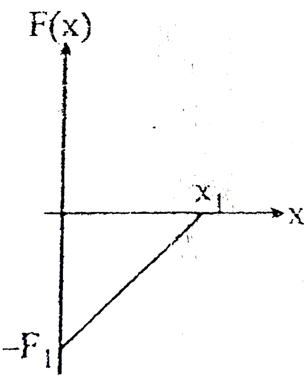
(A)



(B)



(C)



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6. 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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Problems

1. When accelerated along a straight line at $2.8 \times 10^{15} m / s^2$ in a machine, an electron (mass $m = 9.1 \times 10^{-31} kg$) has an initial speed of 1.4×10^7 m/s and travels 5.8 cm. Find (a) the final speed of the electron and (b) the increase in its kinetic energy.

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2. If a Saturn V rocket with an Apollo spacecraft attached had a combined mass of 2.9×10^5 kg and reached a speed of 11.2 m/s, how much kinetic energy would it then have ?

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3. A father racing his son has half the kinetic energy of the son, who has half the mass of the father. The father speeds up by 1.0 m/s and then has the same kinetic energy as the son. What are the original speeds of (a) the father and (b) the son ?

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4. A ice block floating in a river is pushed through a displacement $\overrightarrow{d} = (20m)\hat{i} - (16m)\hat{j}$ along a straight embankment by rushing water, which exerts a force $\overrightarrow{F} = (210N)\hat{i} - (150N)\hat{j}$ on the block. How much work does the force do on the block during the displacement ?

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5. The only force acting on a 2.0kg canister that is moving in an xy plane has a magnitude of 5.0 N. The canister initially has a velocity of 4.0 m/s in the positive x direction and some time later has a velocity of 6.0 m/s in the positive y direction . How much work is done on the canister by the 5.0 N force during this time ?

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6. A coin slides over a frictionless plane and across an xy coordinate system from the origin to a point with xy coordinates (3.0 m , 4.0 m) while a constant force acts on it. The force has magnitude 2.5 N and is directed at a counter-clockwise angle of 100° from the positive direction of the x axis. How much work is done by the force on the coin during the displacement ?

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7. A particle travels through a three-dimensional displacement given by $\overrightarrow{d} = \left(5.00\hat{i} - 3.00\hat{j} + 4.00\hat{k}\right)m$. If a force of magnitude 22.0 N and with fixed orientation does work on the particle, find the angle between the force and the displacement if the change in the particle's kinetic energy is (a) 45.0 J and (b) -45.0 J.

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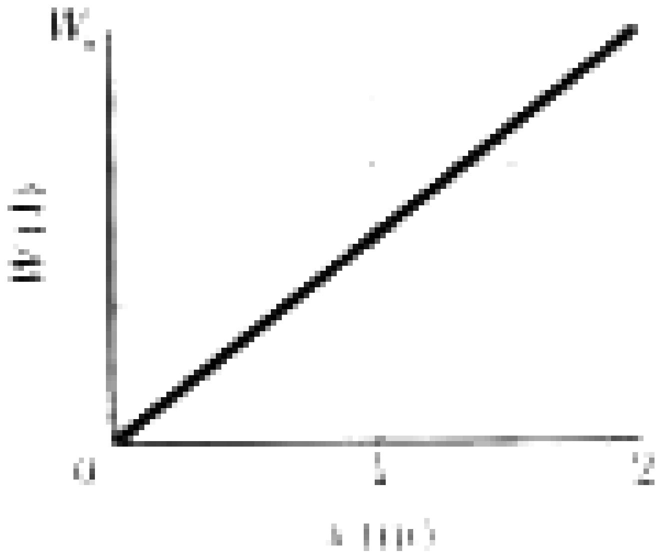
8. A can of bolts and nuts is pushed 2.00 m along an x axis by a broom along the greasy (frictionless) floor of car repair shop in a version of shuffleboard. Figure 8-46 gives the work W done on the can by the constant horizontal force from the broom, versus the can's position x. The scale of the figure's vertical axis is set by $W_s = 6.0J$. (a) What is the magnitude of that force ? (b) If the can had an initial kinetic energy of 3.00 J, moving in the positive direction of the x axis, what is its kinetic energy at the end of the 2.00 m ?



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9. A sledge and its rider, with a total mass of 85 kg, emerge fro a downhill track onto a horizontal straight track with an initial speed of 37 m/s. If a force slows them to a stop at a constant rate of $2.0m/s^2$, (a) what magnitude F is required for the force, and (c) what work W is done on them by the force ? What work W is done on them by the force ? What are (d) F, (e) d, and (f) W if they, instead, slow at $4.0m/s^2$?

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10. A military helicopter lifts a 75 kg flood survivor 16 m vertically from the river by a rope. If the acceleration of the survivor is g/10, how much work is done on the survivor by (a) the force from the helicopter and (b) the gravitational force on her ? Just before she reaches the helicopter, what are her (c) kinetic energy and (d) speed ?

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11. A cord is used to vertically lower an initially stationary block of mass M at a constant downward acceleration of g/4. When the block has fallen a distance d, find (a) the work done by the cord's force on the block, (b) the work done by the graviational force on the block, (c) the kinitic energy of the block, and (d) the speed of the block.

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12. A cave rescue team lifts an injured person directly upward and out of a sinkhole by means of a motor-driven cable. The lift is performed in three stages, each requiring a vertical distance of 12.0 m: (a) the initially stationary spelunker is accelerated to a speed of 5.00 m/s, (b) he is then lifted at the constant speed of 5.00 m/s, (c) finally he is decelerated to zero speed. How much work is done on the 85.0 kg rescuee by the force lifting him during each stage ?

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13. A spring of spring constant 5×10^2Nm is streched initially by $5cm$ from the unstriched position . Then the work required to streach is further by another $5cm$ is

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14. A spring and block are in the arrangement of Fig. 8-12. When the block is pulled out to $x = +4.0cm$, we must apply a force of magnitude 360 N to hold it there. We pull the block to $x = 11$ cm and then release it. How much work does the spring do on the block as the block moves from $x_i = +5.0cm$ to (a) $x = +3.0cm$, (b) $x = 3.0cm$, (c) $x = -5.0cm$, and (d) $x = -9.0cm$?

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15. As a 2.5 kg body moves in the positive direction along an x axis, a single force acts on it. The force is given by $F_x = -6xN$, with x in meters. The velocity at $x = 3.5m$ is 8.5 m/s. (a) Find the velocity of the body at $x = 4.5$ m. (b) Find the positive value of x at which the body has a velocity of 5.5 m/s.

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16. The block in Fig. 8-12a lies on a horizontal frictionless surface, and the spring constant is 50 N/m. Initially, the spring is at its relaxed length and the block is stationary at position $x = 0$. Then an applied force with a constant magnitude of 3.0 N pulls the block in the positive direction of the x axis, stretching the spring until the block stops. When that stopping point is reached, what are (a) the position of the block, (b) the work that has been done on the block by the spring force ? During the block's displacement, what are (d) the block's position when its kinetic energy is maximum and (e) the value of that maximum kinetic energy ?

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17. The force on a particle is directed along an x axis and given by $F = F_0(x / x_0 - 1)$. Find the work done by the force in moving the particle from $x = 0$ to $x = 2x_0$ by (a) plotting $F(x)$ and measuring the work from the graph and (b) integrating $F(x)$.

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18. A 1.0 kg block is initially at rest on a horizontal frictionless surface when a horizontal force along an x axis is applied to the block. The force is given by $\overrightarrow{F}(x) = (2.5 - x^2)\hat{i} N$, where x is in meters and the initial position of the block is $x = 0$. (a) What is the kinetic energy of the block as it passes through $x = 2.0m$? (b) What is the maximum kinetic energy of the block between $x = 0$ and $x = 2.0m$?

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19. A particle of mass 0.020 kg moves along a curve with velocity $5.0\hat{i} + 18\hat{k}m/s$. After some time, the velocity changes to $9.0\hat{i} + 22\hat{j}$ m/s due to action of a single force. Find the work done on the particle during this interval of time.

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20. A can of cookies is made to move along an x axis from $x = 0.25m$ to $x = 2.25$ m by a force with a magnitude given by $F =$ exp $\left(-4x^2\right)$, with x in meters and F in newtons. (Here exp is the exponential function.) How much work is done on the can by the force ?

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21. Only one force is acting on a 2.8 kg particle-like object whose position is given by $x = 4.0t - 5.0t^2 + 2.0t^3$, with x in meters and t in seconds. What is the work done by the force from $t = 0$ to $t = 6.0$ s ?

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22. A force of 5.0 N acts on a 15 kg body initially at rest. Compute the work done by the force in (a) the first, (b) the second, and (c) the third seconds and (d) the instantaneous power due to the force at the end of the third second.

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23. A skier is pulled by towrope up frictionless ski slope that makes an angle of 12° with the horizontal . The rope moves parallel to the slope with a constant speed of 1.0 m/s. The force of the rope does 880 J of work on the skier as the skier moves a distance of 7.0 m up the incline. (a) If the rope moved with a constant speed of 2.0 m/s, how much work would the force of the rope do on the skier as the skier moved a distance of 8.0 m up the incline ? At what rate is the force of the rope doing work on the skier when the rope moves with a speed of (b) 1.0 m/s and (c) 2.0 m/s ?

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24. Across a horizontal floor, a 102 kg block is pulled at a constant speed of 5.5 m/s by an applied force of 125 N directed 38° above the horizontal. Calculate the rate at which the force does work on the block.

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25. The loaded cab of an elevator has a mass of 5.0×10^{3} kg and moves 210 m up the shaft in 23 s at constant speed. At what average rate does the force from the cable do work on the cab ?

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26. A machine carries a 4.0 kg package from an initial position of $\vec{d}_i = (0.50m)\hat{i} + (0.75m)\hat{j} + (0.20m)\hat{k}$ at $t = 0$ to a final position of $\vec{d}_f = (7.50m)\hat{i} + (12.0m)\hat{k}$ at $t = 12$ s. The constant force applied by the machine on the package is $\vec{F} = (2.00N)\hat{i} + (4.00N)\hat{j} + (6.00N)\hat{k}$. For that displacement, find (a) the work done on the package by the machine's force and (b) the average power of the machine's force on the package.

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27. A fully loaded, slow-moving freight elevator has a cab with a total mass of 1200 kg, which is required to travel upward 54 m in 3.0 min, starting and ending at rest. The elevator's counterweight has a mass of only 950 kg, and so the elevator motor must help. What average power is required of the force the motor exerts on the cab via the cable ?

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28. (a) At a certain instant, a particle-like object is acted on by a force $\vec{F} = (4.0N)\hat{i} - (2.0N)\hat{j} + (9.0N)\hat{k}$ while the object's velocity is $\vec{v} = -(2.0m/s)\hat{i} + (4.0m/s)\hat{k}$. What is the instan-taneous rate at which the force does work on the object ? (b) At some other time, the velocity consists of only a y component. If the force is unchanged and the instantaneous power is -15 W, what is the velocity of the object ?

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29. A force $\vec{F} = (3.00N)\hat{i} + (7.00N)\hat{j} + (7.00N)\hat{k}$ acts on a 2.00 kg mobile object that moves from an initial position of $\vec{d}_i = (3.00m)\hat{i} - (2.00m)\hat{j} + (5.00m)\hat{k}$ to a final position of $\vec{d}_f = -(5.00m)\hat{i} + (4.00m)\hat{j} + (7.00m)\hat{k}$ in 4.00 s. Find (a) the work done on the object by the force in the 4.00 s interval, (b) the average power due to the force during that interval, and (c) the angle between vectors $\vec{d}_i$ and $\vec{d}_f$.

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30. A funny car accelerates from rest through a measured track distance in time T with the engine operating at a constant power P. If the track crew can increase the engine power by a differential amount dP, what is the change in the time required for the run ?

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31. Adam stretches a spring by some length. John stretches the same spring later by three times the length stretched by Adam. Find the ratio of the stored energy in the first stretch to that in the second stretch.

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32. A 1.50 kg snowball is fired from a cliff 11.5 m high. The snowball's initial velocity is 16.0 m/s, directed to 41.0° above the horizontal . (a) How much work is done on the snowball by the gravitational force during its flight to the flat ground below the cliff ? (b) What is the change in the gravitational potential energy of the snowball-Earth system during the flight ? (c) If that gravitational potential energy is taken to be zero at the height of the cliff, what is its value when the snowball reaches the ground ?

Watch Video Solution

33. (a) In Problem 53, using energy techniques rather than the techniques of Chapter 4, find the speed of the snowball as it reaches the ground below the cliff. What is that speed (b) if the launch angle is changed to 41.0° below the horizontal and (c) if the mass is changed to 3.00 kg ?

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34. A 5.0g marble is fired vertically upward using a spring gun. The spring must be compressed 8.0 cm if the marble is to just reach a target 20 m above the marble's position on the compressed spring. (a) What is the change ΔU_g in the gravitational potential energy of the marble-Earth system during the 20 m ascent ? (b) What is the change ΔU_s in the elastic potential energy of the spring during its launch of the marble ? (c) What is the spring constant of the spring ?

Watch Video Solution

35. A 700 g block is released from rest at height h_0 above a vertical spring with spring constant $k = 450N/m$ and negligible mass. The block sticks to the spring and momentarily stops after compressing the spring 19.0 cm. How much work is done (a) by the block on the spring and (b) by the spring on the block ? (c) What is the value of h_0 ? (d) If the block were released from height $2.00h_0$ above the spring, what would be the maximum compression of the spring ?

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36. In Problem 51, what are the magnitudes of (a) the horizontal component and (b) the vertical component of the net force acting on the block at point Q ? (c) At what height h should the block be released from rest so that it is on the verge of losing contact with rest so that it is on the verge of losing contact with the track at the top of the loop ? (On the verge of losing contact means that the normal force on the block from the track has just then become zero.) (d) Graph the magnitude of the normal force on the block at the top of the loop versus initial height h, the range $h = 0$ to $h = 6R$.

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37. A 1.0 kg block moving at 8.0 m/s strikes a spring fixed at one end to a wall and compresses the spring by 0.40 m, where its speed gets reduced to 2.0 m/s. After this event, the spring is mounted upright by fixing its bottom end to afloor, and a stone of mass 2.0 kg is placed on it, the spring is now compressed by 0.50 m from its rest length. The system is then released. How far above the rest-length point does the stone rise ?

View Text Solution

38. A pendulum consists of a 2.0 kg stone swinging on a 4.5 m string of negligible mass. The stone has a speed of 8.0 m/s when it passes its lowest point. (a) What is the speed when the string is at 60° to the vertical ? (b) What is the greatest angle with the vertical that the string will reach during the stone's motion ? (c) If the potential energy of the pendulum-Earth system is taken to be zero at the stone's lowest point, what is the total mechanical energy of the system ?

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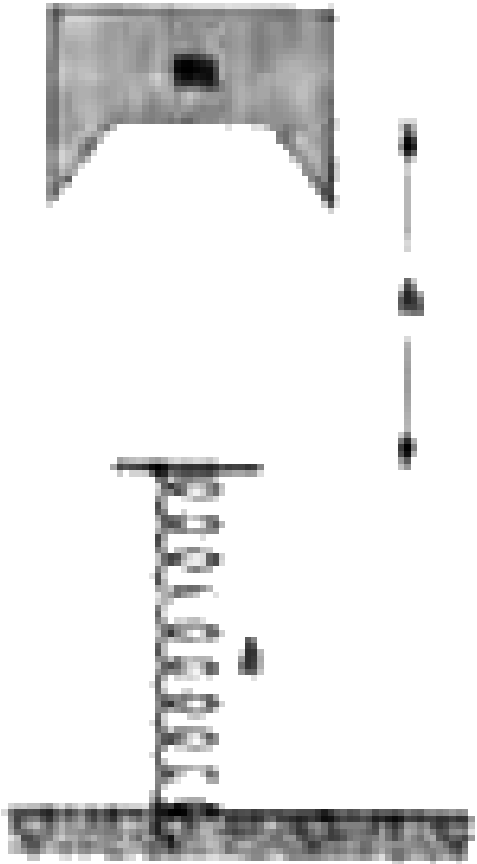
39. A block of mass $m = 2.0$ kg is dropped from height $h = 50$ cm onto a spring of spring constant $k = 1960$ N/m (Fig. 8-68). Find the maximum distance the spring is compressed.



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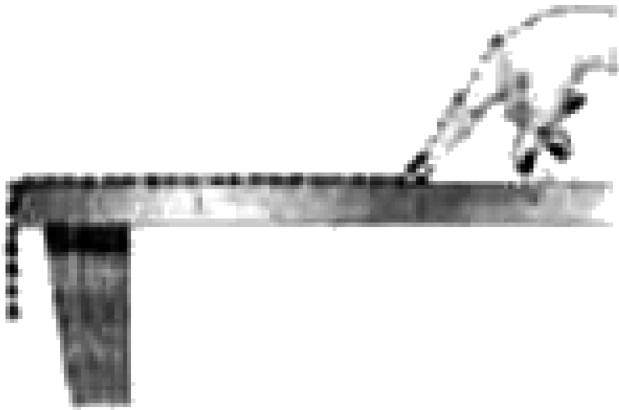
40. At $t=0$ a 1.0 kg ball is thrown from a tall tower with $\vec{v}=(18m/s)\hat{i}+(24m/s)\hat{j}$. What is ΔU of the ball-Earth system between $t=0$ and $t=6.0s$ (still free fall) ?

Watch Video Solution

41. A conservative force, $\overrightarrow{F} = (6.0x - 12)\hat{i}N$, where x is in meters, acts on a particle moving along an x axis. The potential energy U associated with this force is assigned a value of 27 J at $x = 0$. (a) Write an expression for U as a function of x, with U in joules and x in meters. (b) What is the maximum positive potential energy ? At what (c) negative value and (d) positive value of x is the potential energy equal to zero ?

Watch Video Solution

42. In Fig. 8-73, a chain is held on a frictionless table with one-fourth of its length hanging over the edge. If the chain has length $L = 24$ cm and mass $m = 0.016$ kg, how much work is required to pull the hanging part back onto the table ?



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43. A uriform chain hangs over the edge of a horizontal platform. A machine does 1.0 J of work in pulling the rest of the chain onto the platform. The chain has a mass of 2.0 kg and a length of 3.0 m. What length was initially hanging over the edge ? On the Moon, the gravitational acceleration is 1/6 of $9.8m/s^2$.

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44. A worker pushed a 23 kg block 8.4 m along a level floor at constant speed with a force directed 32° below the horizontal . If the coefficient of kinetic friction between block and floor was 0.20, what were (a) the work done by the worker's force and (b) the increase in thermal energy of the block-floor system ?

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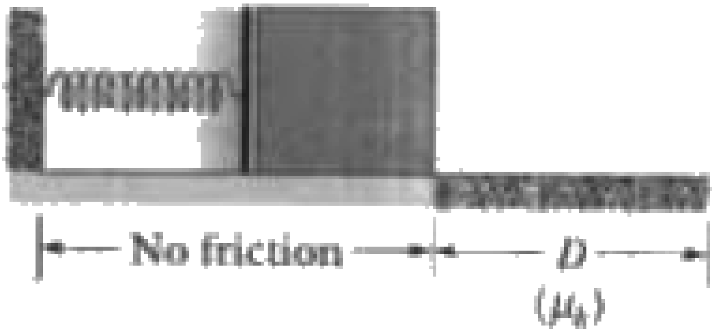
45. In Fig. 8-78, a 3.5 kg block is accelerated from rest by a compressed spring of spring constant 640 N/m. The block leaves the spring a the spring's relaxed length and then travels over a horizontal floor with a coefficient of kinetic friction $\mu_g = 0.25$. The frictional force stops the block in distance $D = 7.8m$. What are (a) the increase in the thermal energy of the block-floor system, (b) the maximum kinetic energy of the block, and (c) the original compression distance of the spring ?



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46. A horizontal force of magnitude 41.0 N pushes a block of mass 4.00 kg across a floor where the coefficient of kinetic friction is 0.600. (a) How much work is done by that applied force on the block-floor system when the block slides through a displacement of 2.00 m across the floor ? (b) During that displacement, the thermal energy of the block increases by 40.0 J. What is the increase in thermal energy of the floor ? (c) What is the increase in the kinetic energy of the block ?

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47. An outfielder throws a baseball with an initial speed of 83.2 mi/h. Just before an infielder catches the ball at the same level, the ball's speed is 110 ft/s. In foot-pounds, by how much is the mechanical energy of the ball-Earth system reduced of air drag ? (The weight of a baseball is 9.0 oz.)

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48. A 60 kg skier leaves the end of a ski-jump ramp with a velocity of 27 m/s directed 25° above the horizontal. Suppose that as a result of air drag the skier returns to the ground with a speed of 22 m/s, landing 14 m vertically below the end of the ramp. From the launch to the return to the ground, by how much is the mechanical energy of the skier-Earth system reduced because of air drag ?

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49. A large fake cookie sliding on a horizontal surface is attached to one end of a horizontal spring with spring constant $k = 360$ N/m, the other end of the spring is fixed in place. The cookie has a kinetic energy of 20.0 J as it passes through the spring's equilibrium position. As the cookie slides, a frictional force of magnitude 10.0 N acts on it . (a) How far will the cookie slide from the equilibrium position before coming momentarily to rest ? (c) What will be the kinetic energy of the cookie as it slides back through the equilibrium position ?

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50. A swimmer moves through the water at an average speed of 0.22 m/s. The average drag force is 110 N. What average power is required of the swimmer ?

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51. A child whose weight is 267 N slides down a 6.5 m playground slide that makes an angle of 20° with the horizontal. The coefficient of kinetic friction between slide and child is 0.10 (a) How much energy is transferred to thermal energy ? (b) If she starts at the top with a speed of 0.457 m/s, what is her speed at the bottom ?

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52. The total mechanical energy of a 2.00 kg particle moving along an x axis is 5.00 J. The potential energy is given as $U(x) = (x^4 - 2.00x^2)J$, with x in meters. Find the maximum velocity.

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53. You push a 2.0 kg block against a horizontal spring , compressing the spring by 12 cm. Then You release the block, and the spring sends it sliding across a tabletop. It stops 75 cm from where you released it. The spring constant is 170 N/m. What is the block-table coefficient of kinetic friction ?

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54. A block of mass 6.0 kg is pushed up an incline to its top by a man and then allowed to slide down to the bottom. The length of incline is 10 m and its height is 5.0 m. the coefficient of friction between block and incline is 0.40. Calculate (a) the work done by the gravitational force over the complete round trip of the block, (b) the work done by the man during the upward journey, (c) the mechanical energy loss due to friction over the round trip, and (d) the speed of the block when it reaches the bottom.

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55. A cookie jar is moving up a 40° incline. At a point 45 cm from the bottom of the incline (measured along the incline) ,the jar has a speed of 1.4 m/s. The coefficient of kinetic friction between jar and incline is 0.15 . (a) How much farther up the incline will the jar move ? (b) How fast will it be going when it has slid back to the bottom of the incline ? (c) Do the answers to parts (a) and (b) increase, decrease, or remain the same if we decrease the coefficient of kinetic friction (but do not change the given speed or location) ?

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56. A stone with a weight of 5.29 N is launched vertically from ground level with an initial speed of 20.0 m/s, and the air drag on it is 0.265 N throughout the flight. What are (a) the maximum height reached by the stone and (b) its speed just before it hits ground ?

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57. A 4.0 kg bundle starts up a 30° incline with 150 J of kinetic energy. How far will it slide up the incline if the coefficient of kinetic friction between bundle and incline is 0.36 ?

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58. A 10.0 kg block falls 30.0 m onto a vertical spring whose lower end is fixed to a platform. When the spring reaches its maximum compression of 0.200 m, it is locked in place. The block is then removed and the spring apparatus is transported to the Moon, where the gravitational acceleration is g/6. A 50.0 kg astronaut then sits on top of the spring and the spring is unlocked so that it propels the astronaut upward. How high above that initial point does the astronaut rise ?

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Practice Questions Single Correct Choice Type

1. Which one of the following statements about kinetic energy is true ?

A. Kineticenergycanbemeasuredinwatts.

B. Kineticenergyisalwaysequaltothepotentialenergy.

C. Kineticenergyisalwayspositive.

D. Kineticenergyisaquantitativemeasureofinertia.

Answer: C

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2. A fighter jet is launched from an aircraft carrier with the aid of its own engines and a steam-powered catapult. The thrust of its engines is $2.3 \times 10^5 N$. In being launched from rest position, it moves through a distance of 87 m and has a kinetic energy of 4.5×10^7 J at lift-off. What is the work done on the jet by the catapult ?

A. $2.0 \times 10^6 J$

B. $2.5 \times 10^7 J$

C. $6.0 \times 10^6 J$

D. $6.5 \times 10^7 J$

Answer: D

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3. A person pulls a sledge for a distance of 35.0 m along the snow with a rope directed 25.0° above the snow. The tension in the rope is 94.0 N. How much work is done on the sledge by the tension force ?

A. 1390J

B. 2740J

C. 2980J

D. 3290J

Answer: C

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4. A block of mass M is hanging over a smoth and light pulley through a light string. The other end of the string is pulled by a constant force F. The kinetic energy of the block increases by 20 J in 1 s:-

A. ThetensioninthestringisMg.

B. ThetensioninthestringisF.

C. Theworkdonebythetensionontheblockis20Jintheabove1s.

D. Theworkdonebytheforceofgravityis-20Jintheabove1s.

Answer: B

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5. Use the work-energy theorem to find the force required to accelerate an electron $\left(m = 9.11 \times 10^{-31} kg\right)$ from rest to a speed of 1.50×10^{7} m/s in a distance of 0.0125 m.

A. $8.20 \times 10^{-15} N$

B. $8.20 \times 10^{-17} N$

C. $5.47 \times 10^{-22} N$

D. $1.64 \times 10^{-14} N$

Answer: A

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6. How much power is needed to lift a 75- kg student vertically upward at a constant speed of 0.33 m/s ?

A. 12.5W

B. 115W

C. 242.5

D. 230W

Answer: C

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7. Two blocks of masses m_1 and m_2 are connected by a spring having spring constant K. Initially , the spring is at its natural length. The coefficient of friction between the blocks and the surface is μ. What minimum constant force has to be applied in the horizontal direction to the block of mass m_1, in order to shift the other block ?

A. $F = \mu\left(m_1 + \frac{m_2}{2}\right)g$

B. $F = \mu\left(\frac{m_1}{2} + m_2\right)g$

C. $F = \mu\left(m_1^2 + \frac{m_2^2}{2}\right)g$

D. $F = \mu^2\left(m_1^2 + \frac{m_2}{2}\right)g$

Answer: A

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8. A pitcher throws a 0.140 -kg baseball, and it approaches the bat at a speed of 40.0 m/s. The bat does $W_{nc} = 70.0J$ of work on the ball in hitting it. Ignoring air resistance, determine the speed of the ball after the ball leaves the bat and is 25.0 m above the point of impact.

A. 23.4m/s

B. 48.5m/s

C. 45.9m/s

D. 51.0m/s

Answer: C

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9. Mike is cutting the grass using a lawn mower. He pushes the mower with a force of 45 N directed at an angle of 41° below the horizontal direction. Calculate the work that Mike does on the mower in pushing it 9.1 m across the yard.

A. 510J

B. 410J

C. 310J

D. 360J

Answer: C

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10. A bead can slide on a smooth circular wire frame of radius R which is fixed in a vartical plane. The bead is displaced slightly from the highest point of the wire frame. The speed of the bead subsequently as a function of the angle θ made by the bead with the vertical line is

A. $\sqrt{2gR}$

B. $\sqrt{2gR(1-\sin\theta)}$

C. $\sqrt{2gR(1-\cos\theta)}$

D. $2\sqrt{gR}$

Answer: C

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11. A 5.00-kg block of ice is sliding across a frozen pond at 2.00 m/s. A 7.60-N force is applied in the direction of motion. After the ice block slides 15.0 m, the force is removed. The work done by the applied force is

A. -114J

B. -735J

C. $+19.7$J

D. $+114J$

Answer: D

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12. A 5.0×10^4 kg space probe is traveling at a speed of 11000 m/s through deep space. Auxiliary rockets are fired along the line of motion of reduce the probe's speed. The auxiliary rockets generate a force of $4.0 \times 10^5 N$ over a distance of 2500 km. What is the final speed of the probe ?

A. 10000m/s

B. 8000m/s

C. 9000m/s

D. 7000m/s

Answer: C

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13. An object of mass (m) is located on the horizontal plane at the origin O. The body acquires horizontal velocity V. The mean power developed by the frictional force during the whole time of motion is ($\mu =$ frictional coefficient)

A. μmgV

B. $\frac{1}{2}\mu mgV$

C. $\mu mg\frac{V}{g}$

D. $\frac{3}{2}\mu mgV$

Answer: B

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14. A force of magnitude 25 N directed at an angle of 37° above the horizontal moves a 10-kg crate along a horiaontal surface at constant velocity . How much work is done by this force in moving the crate a distance of 15 m ?

A. 0J

B. 40J

C. 300J

D. 98J

Answer: C

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15. A 0.075-kg arrow is fired horizontally. The bowstring exerts an average force of 65 N on the arrow over a distance of 0.90 m. With what speed does the arrow leave the bow ?

A. 39m/s

B. 28m/s

C. 82m/s

D. 66m/s

Answer: A

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16. A 1,00,000 kg engine is moving up a slope of gradient 5° at a speed of 100 m/h. The coefficient of friction between the engine and rails is 0.1. If the engine ahs an efficiency of 4% for converting heat into work, find the amount of coal the engine has to burn up in one hour (burning of 1 kg of coal yields 50,000 J)

A. 9.23×10^4kg

B. 9.15×10^3kg

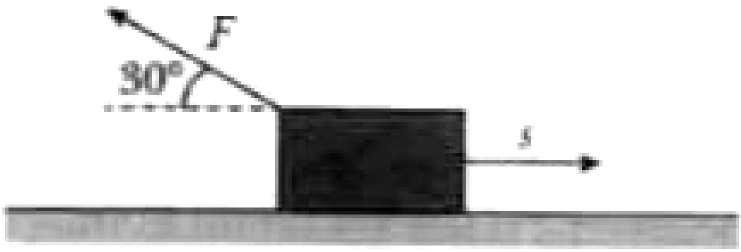
C. 8.41×10^4kg

D. 8.65×10^3kg

Answer: B

View Text Solution

17. A constant force of 25 N is applied as shown to a block which undergoes a displacement of 7.5 m to the right along a frictionless surface while the force acts. What is the work done by the force ?



A. zerojoules

B. $-94J$

C. $-160J$

D. $+160J$

Answer: B

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18. The stopping distance for a vehicle of mass M moving with a speed v along a level road, will be - (μ is the coefficient of friction between tyres and the road)

A. $\frac{2v^2}{\mu g}$

B. $\frac{v^2}{2\mu g}$

C. $\frac{2v^2}{\mu^2 g}$

D. $\frac{v^2}{2\mu^2 g}$

Answer: B

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19. A 63-kg skier goes up a snow-convered hill that makes an angle of 25° with the horizontal . The initial speed of the skier is 6.6 m/s. After coasting a distance of 1.9 m up the slope, the speed of the skier is 4.4 m/s. Find the work done by the kinetic frictional force that acts on the skis .

A. -760J

B. $+270$J

C. $+300$J

D. -270J

Answer: D

Watch Video Solution

20. A 10.0-g bullet traveling horizontally at 755 m/s strikes a stationary target and stops after penetrating 14.5 cm into the target. What is the average force of the target on the bullet ?

A. 1.97×10^4N

B. 6.26×10^3N

C. 2.07×10^5N

D. $3.13 \times 10^4 N$

Answer: A

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21. A 3.00 kg model rocket is launched straight up. It reaches a maximum height of 1.00×10^2 m above where its engine cuts out, even though air resistance performs $-8.00 \times 10^2 J$ of work on the rocket. What would have been this height if there were no air resistance ?

A. 111m

B. 135m

C. 159m

D. 127m

Answer: D

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22. A car is traveling at 7.0 m/s when the driver applies the brakes. The car moves 1.5 m before it comes to a complete stop. It the car had been moving at 14 m/s, how far would it have continued to move after the brakes were applied ? Assume the braking force is constant .

A. 1.5m

B. 4.5m

C. 7.5m

D. 6.0m

Answer: D

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23. A boy pulls a 5 kg block 20 metres along a horizontal sur- face at a constant speed with a force directed 45° above the horizontal. If the coefficient of kinetic friction is 0.20, how much work does the boy do on the block?

A. 197.50J

B. 219.76J

C. 162.32J

D. 334.15J

Answer: C

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24. A bicyclist is traveling at a speed of 20.0 m/s as the approaches the bottom of a hill. He decides to coast up the hill and stops upon reaching the top. Neglecting friction, determine the vertical height of the hill .

A. 28.5m

B. 11.2m

C. 20.4m

D. 40.8m

Answer: C

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25. A 55-kg box is being pushed a distance of 7.0 m across the floor by a force $\overrightarrow{p}$ whose magnitude is 150 N. The force $\overrightarrow{P}$ is parallel to the displacement of the box. The coefficient of kinetic friction is 0.25. Determine the work done on the box by each of the four forces that act on the box. Be sure to include the proper plus or minus sign for the work done by each force. (The four forces and the force P, the frictional force f, the normal force N, and the force due to gravity mg.)

A.

W_p	W_f	W_N	W_{mg}
$1.0 \times 10^3 J$	$-940J$	$-3.8 \times 10^3 J$	$3.8 \times 10^3 J$

B. $\begin{matrix} W_p & W_f & W_N & W_{mg} \\ 1.0 \times 10^3 & -940J & \text{zero}J & \text{zeroJ} \end{matrix}$

C. $\begin{matrix} W_p & W_f & W_N & W_{mg} \\ \text{zeroJ} & 940J & -3.8 \times 10^3 J & 3.8 \times 10^3 J \end{matrix}$

D. $\begin{matrix} W_p & W_f & W_N & W_{mg} \\ -1.0 \times 10^3 J & \text{zeroJ} & \text{zeroJ} & -3.8 \times 10^3 J \end{matrix}$

Answer: B

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26. What power is needed to lift a 49-kg person a vertical distance of 5.0 m in 20.0 s ?

A. 12.5W

B. 60W

C. 25W

D. 120W

Answer: D

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27. A motorcycle (mass of cycle plus rider $= 2.50 \times 10^2$ kg) is travelling at a steady speed of 20.0 m/s. The force of air resistance acting on the cycle and rider is 2.00×10^2 N. Find the power necessary to sustain this speed if the road is sloped upward at 3.70° with respect to the horizontal .

A. 5.75×10^3W

B. 2.17×10^4W

C. $3.35 \times 10^4 W$

D. $4.90 \times 10^4 W$

Answer: C

View Text Solution

28. The initial velocity of a 4.0-kg box is 11 m/s , due west. After the box slides 4.0 m horizontally, its speed is 1.5 m/s. Determine the magnitude and the direction of the non-conservative force acting on the box as it slides .

A. 42N,duewest

B. 31N,dueeast

C. 83N,duewest

D. 59N,dueeast

Answer: D

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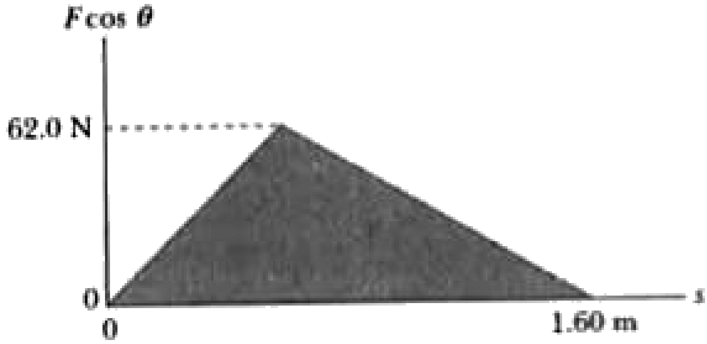
29. The graph shows how the force component F $\cos\theta$ along the displacement varies with the magnitude s of the displacement . Find the work done by the force. (Hint: Recall how the area of a triangle is related to the triangle's base and height .)



A. 24.8J

B. 55.1J

C. 99.2J

D. 49.6J

Answer: D

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30. A small block of mass m is kept on a rough inclined surface of inclination θ fixed in an elevator. The elevator goes up with a uniform velocity v and te block does not slide n te wedge. The work done by the force of friction on the block in time t will be

A. zero

B. $mgvt\cos^2\theta$

C. $mgvt\sin^2\theta$

D. $mgvt\sin^2\theta$

Answer: C

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31. A 51-kg woman runs up a flight of stairs in 5.0 s. Her net upward displcement is 5.0 m. Approximately, what everage power did the woman exert while she was running ?

A. 5.0W

B. 0.75kW

C. 0.25kW

D. 0.50kW

Answer: D

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32. A particle of mass $100g$ is thrown verically upward with a speed of $5m/s$. The work done by the of gravity during the time the particle goes up is

A. 0.5J

B. -0.5J

C. -1.25J

D. 1.25J

Answer: C

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33. An escalator is 30.0 meters long and slants at 30.0° relative to the horizontal. If it moves at 1.00 m/s, at what rate does it do work in lifting a 50.0-kg woman from the bottom to the top of the escalator ?

A. 49.3W

B. 245W

C. 98.0W

D. 292W

Answer: B

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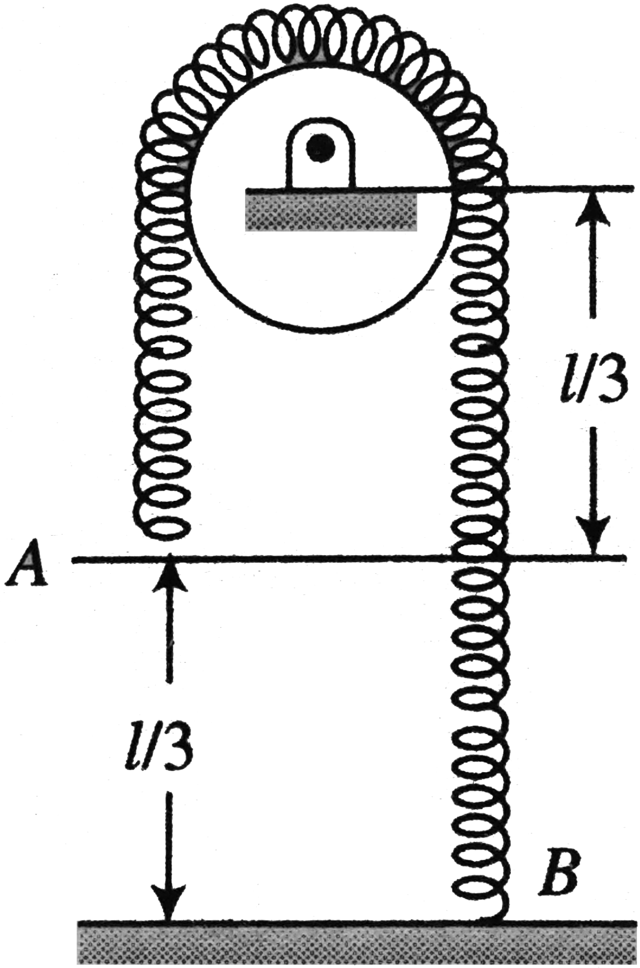
34. Two ends A and B of a smooth chain of mass m and length l are situated as shown in figure. If an external agent pulls A till it comes to same level of B, work done by external agent is



A. $\frac{mgl}{36}$

B. $\frac{mgl}{15}$

C. $\frac{mgl}{9}$

D. noneofthese

Answer: A

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35. A warehouse worker uses a forkift to lift a crate of pickles on a platform to a height 2.75 m above the floor. The combined mass of the platform and the crate is 207 kg. If the power expended by the forklift is 1440 W, how long does it take to lift the crate ?

A. 37.2s

B. 3.87s

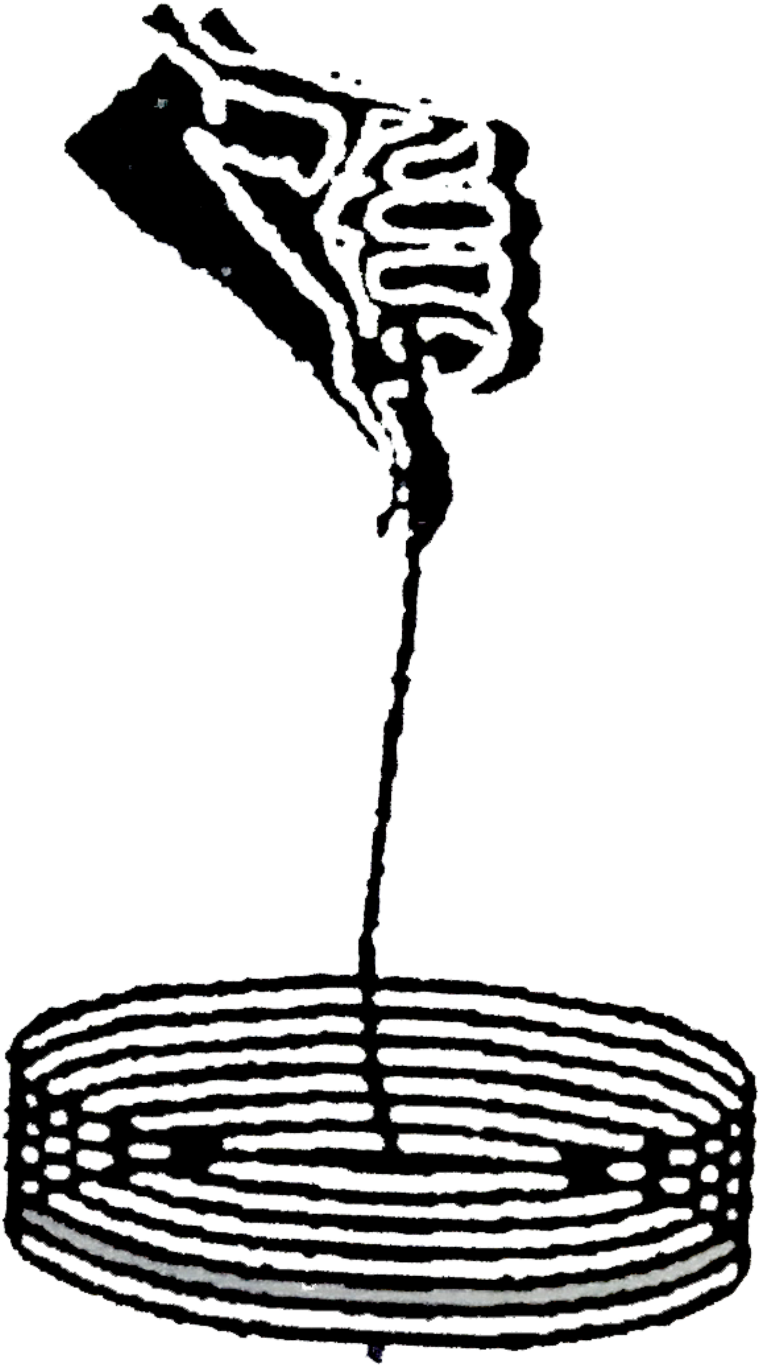
C. 1.86s

D. 5.81s

Answer: B

Watch Video Solution

36. A uniform rope of linear mass density λ and length l is coiled on a smooth horizontal surface. One end is pulled up with constant velocity v. Then the average power applied by the external agent in pulling the entire rope just off the ground is :-



A. $\frac{1}{2}\lambda l v^2 + \frac{\lambda l^2 g}{2}$

B. $\lambda l g v$

C. $\frac{1}{2}\lambda v^3 + \frac{\lambda l g v}{2}$

D. $\lambda g v + \frac{1}{2}\lambda v^3$

Answer: C

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37. A dam is used to block the passage of a river and to generate electricity. Approximately 5.73×10^4 kg of water fall each second through a height of 19.6 m. If one half of the gravitational potential energy of the water were converted to electrical energy, how much power would be generated ?

A. $5.50 \times 10^6 W$

B. $1.10 \times 10^7 W$

C. $2.70 \times 10^9 W$

D. $1.35 \times 10^9 W$

Answer: A

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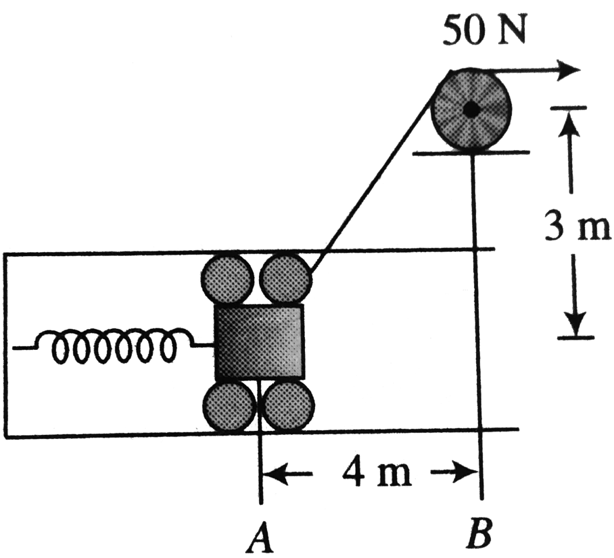
38. A $20 - kg$ block attached to a spring of spring constant $5Nm^{-1}$ is released from rest at A. The spring at this instant is having an elongation of $1m$. The block is allowed to move in smooth horizontal slot with the help of a constant force $50N$ in the rope as shown. The velocity of the block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



A. 4m/s

B. 2m/s

C. 1m/s

D. 3m/s

Answer: B

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39. A motorist driving a 1000-kg car wishes to increase her speed from 20 m/s to 30 m/s in 5 s. Determine the horse-power required to accomplish this increase. Neglect friction .

A. 70hp

B. 90hp

C. 30hp

D. 80hp

Answer: A

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40. A skier slides horizontally along the snow for a distance of 21 m before coming to rest. The coefficient of kinetic friction between the stier and the snow is $\mu_k = 0.050$. Initially, how fast was the skier going ?

A. 6.4m/s

B. 4.5m/s

C. 2.7m/s

D. 5.4m/s

Answer: B

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41. An automobile approaches a barrier at a speed of 20 m/s along a level road. The driver locks the brakes at a distance of 50 m from the barrier. What minimum coefficient of kinetic friction is required to stop the automobile before it hits the barrier ?

A. 0.4

B. 0.6

C. 0.8

D. 0.5

Answer:

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42. A 1900-kg car experiences a combined force of air resistance and friction that has the same magnitude whether the car goes up or down a hill at 27 m/s. Going up a hill, the car's engine needs to produce 47 hp more power to sustain the constant velocity than it does going down the same hill. At what angle is the hill inclined above the horizontal ?

A. 1.4°

B. 2.5°

C. 1.1°

D. 2.0°

Answer: D

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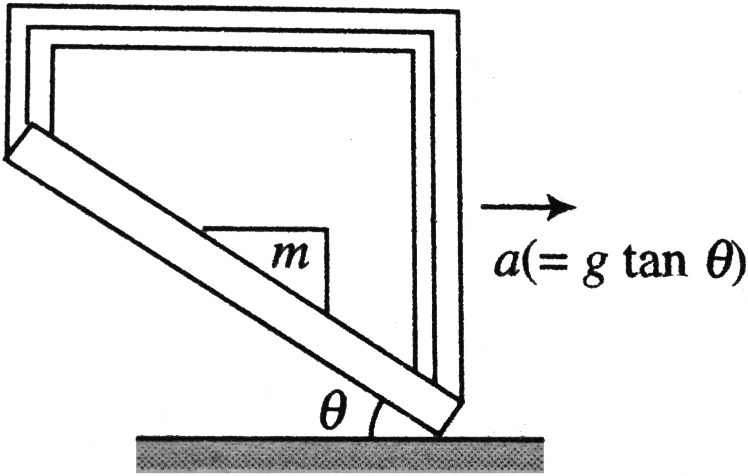
43. A block m is kept stationary on the surface of an accelerating cage as shown in figure. At the given instant, study the following statetments regarding the block.



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. onlystatement(i)iscorrect.

B. onlystatement(ii)iscorrect.

C. onlystatement(iii)iscorrect.

D. allthestatementcorrect.

Answer: A

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44. A racing car with a mass of 500.0 kg starts is from rest and completes a quarter mile (402 m) race in a time of 5.0 s. The race car's final speed is 130 m/s. Neglecting friction, what average power was needed to produce this final speed ?

A. 140hp

B. 1132hp

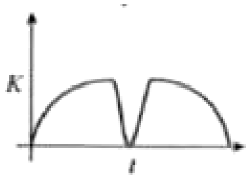
C. 8.5×10^5hp

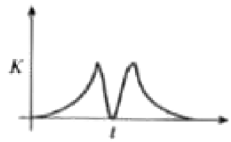
D. 750hp

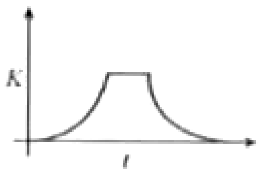
Answer: B

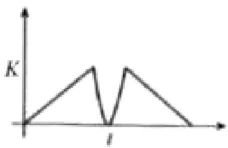
Watch Video Solution

45. 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. 

B. 

C. 

D. 

Answer: B

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46. A 1.00×10^2 kg crate is being pushed across a horizontal floor by a force $\vec{P}$ that makes an angle of 30.0° below the horizontal. The coefficient of kinetic friction is 0.200. What should be the magnitude of $\vec{P}$, so that the net work done by it and the kinetic frictional force is zero ?

A. 256N

B. 354N

C. 203N

D. 287N

Answer: A

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47. The potential energy of a $1kg$ particle free to move along the x- axis is given by $V(x) = \left(\frac{x^4}{4} - \frac{x^2}{2}\right)J$

The total mechainical energy of the particle is $2J$. Then , the maximum speed (in m//s) is

A. 2

B. $3/\sqrt{2}$

C. $\sqrt{2}$

D. $1/\sqrt{2}$

Answer: B

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48. A 1500-kg elevator moves upward with constant speed through a vertical distance of 25 m. How much work was done by the tension in the elevator cable ?

A. 990J

B. 8100J

C. 140,000J

D. 370,000J

Answer: D

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49. Two balls of equal size are dropped from the same height from the roof of a building . One ball has twice the mass of the other. When the balls the ground, how do the kinetic energies of the two balls compare ?

A. The lighter one has one fourt has much kinetic energy as the other does.

B. The lighter one has one half as much kinetic energy as the other does.

C. The lighter one has the same kinetic energy as the other does.

D. The lighter one has twice as much kinetic energy as the other does.

Answer: B

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50. A woman stands on the edge of a cliff and throws a stone vertically downward with an initial speed of 10 m/s. The instant before the stone hits the ground below, it has 450 J of kinetic energy. If she were to throw the stone horizontally outward from the cliff with the same initial speed of 10 m/s, how much kinetic energy would it have just before it hits the ground ?

A. 50J

B. 100J

C. 450J

D. 800J

Answer: C

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51. A stone rolls off the roof of a School hall and falls vartically. Just before it reaches the ground, the stone's speed is 17 m/s. Neglect air resistance and determine the height of the School Hall.

A. 42m

B. 33m

C. 26m

D. 15m

Answer: D

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52. A skier leaves the top of a slope with an initial speed of 5.0 m/s. Her speed at the bottom of the slope is 13 m/s. What is the height of the slope ?

A. 1.1m

B. 4.6m

C. 6.4m

D. 7.3m

Answer: D

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53. A 55.0-kg skateboarder starts out with a speed of 1.80 m/s. He does $+80.0J$ of work on himself by pushing with his feet against the ground. In addition, friction does $-265J$ of work on him. In both cases, the forces doing the work are non-conservative. The final speed of the skateboarder is 6.00 m/s. Caculate the change $\left[\Delta(P.E.) = (P.E.)_f - (P.E.)_0\right]$ in the gravitational potential energy .

A. $-1246J$

B. $-1086J$

C. -821J

D. -716J

Answer: B

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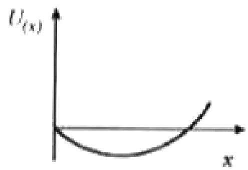
54. A particle which is constant to move along the $x - a\xi s$, is subjected to a force in the same direction which varies with the distance x of the particle from the origin as $F(x) = -Kx + ax^3$. Hero K and a are positive constant . For $x \geq 0$, the fanctional from of the patential every `U(x) of the particle is

A.


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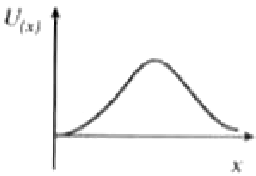
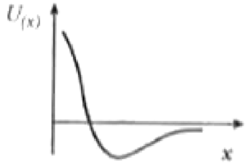
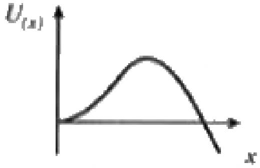


C. 

D. 

Answer: D

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55. A bullet fired into a fixed target loses half of its velocity after penetrating 3 cm . How much further it will penetrate before coming to rest assuming that it faces constant resistance to motion?

A. 3.0cm

B. 2.0cm

C. 1.5cm

D. 1.0cm

Answer: D

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56. A particle of mass m is moving in a horizontal circle of radius r, under a centripetal force equal to $\left(-K/r^2\right)$, where k is a constant. The total energy of the particle is -

A. $-\frac{k}{r}$

B. $-\frac{k}{2r}$

C. $+\frac{k}{r}$

D. $+\frac{k}{2r}$

Answer: B

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57. The potential energy function for a diatomic molecule is $U(x) = \frac{a}{x^{12}} - \frac{b}{x^6}$. In stable equilibrium, the distance between the particles is .

A. $\left(\frac{32b}{a}\right)^{1/3}$

B. $\left(\frac{2a}{b}\right)^{1/6}$

C. $\left(\frac{3a}{b}\right)^{1/2}$

D. $\left(\frac{3b}{a}\right)^{1/2}$

Answer: B

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58. A block is dropped from a high tower and is falling freely under the influence of gravity. Which one of the following statements is true concerning this situation ? Neglect air resistance.

A. As the block falls the net work done by all of the forces acting on the block is zero joules.

B. The kinetic energy increases by equal amounts over equal distances.

C. The kinetic energy of the block increases by equal amounts in equal times.

D. The potential energy of the block decreases by equal amounts in equal times.

Answer: B

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59. If the potential energy of a gas molecule is $U = \frac{M}{r^6} - \frac{N}{r^{12}}$, M and N being positive constants, then the potential energy at equilibrium must be

A. zero

B. $\frac{M^2}{4N}$

C. $\frac{N^2}{4M}$

D. $\frac{MN^2}{4}$

Answer: B

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Practice Questions More Than One Choice Correct Type

1. A boy pulls 5 kg block by 20 m along a horizontal surface at constant speed with a force directed 45° above the horizontal. If the coefficient of friction is 0.2, then

A. the work done by the boy on the block 163.32J.

B. the normal force on the surface by the block is 40.8N.

C. the normal on the surface by the block is mumg`.

D. none of these

Answer: A::B

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2. Which of the following statement (S) is/are correct ?

A. Total work done by internal forces of a system on the system is sometimes zero.

B. Total work done by internal forces of a system on the system is always zero.

C. Total work done by internal forces acting between the particles of a rigid body is sometimes zero.

D. Total work done by internal forces acting between the particles of a rigid body is always zero.

Answer: A::D

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3. Choose the correct statement (s) :

A. Totalworkdonebyinternalforcesofasystemonthesystemisalwayszero.

B. Totalworkdonebyinternalforcesofasystemonthesystemissometimeszero.

C. Totalworkdonebyinternalforcesactingbetweentheparticlesofarigidbodyi

D. Totalworkdonebyinternalforcesactingbetweentheparticlesofarigidbodyi

Answer: B::C

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4. Choose the correct statement (s) :

A. Whenpowerisconstant,thenvariationofforcewithvelocityishyperbolic.

B. Whenconstantpowerisappliedonthestationarybodyintimet,thenvariatio

C. Whenpowerisconstant,thenvariationofvelocitywithtimeislinear.

D. Noneofthese.

Answer: A::B

Watch Video Solution

5. 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. theworkdonebytheboyagainstthegravitationalforceactingontheblock.

B. thelossofenergystoredinthespringminustheworkdonebythetensioninthe

C. theworkdoneontheblockbytheboyminustheworkdonebythetensioninthe

D. theworkdoneontheblockbytheboyminustheworkdonebythetensioninthe

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

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6. A particle is acted upon by a force of constant magnitude which is always perpendicular to the velocity of the particle. The motion of the particle takes place in a plane. It follows that

A. itsvelocityisconstant.

B. itsaccelerationisconstant.

C. itskineticenergyisconstant.

D. itmovesincircularpath.

Answer: C::D

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7. Which of the following statement are correst ?

A. A pendulum bob suspended by a string of length l is pulled to one side so that it is at a height $l/4$above the rest position. if the bob is now released from rest, its speed at the lowest point will be$gl/2$.

B. If the mass and velocity of a moving body are increased three times and two times,respectively then the kinetic energy is increased by a factor of 12.

C. Aboatisbeingtowedatavelocityof20m/s.Ifthetensioninthetow-lineis6kN,thenthepowersuppliedtotheboatis120kW.

D. Iftheworkdoneinincreasingtheextensionofaspringfrom0.4mto0.5mis18J,t

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

View Text Solution

8. 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. $W_{nc} - \Delta U = \Delta K$

B. $W_{nc} - \Delta U = -\Delta K$

C. $W_{nc} + W_c = \Delta K$

D. $W_c = -\Delta U$

Answer: A::C::D

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9. A particle of mass $5kg$ moving in the $X - Y$ plane has its potential energy given by $U = (-7x + 24y)J$. The particle is initially at origin and has a velocity $\vec{U} = (14.4 + 4.2J)m/s$

A. Theparticlehasaspeedof35m/sat$t = 4$s.

B. Theparticlehasanaccelerationof$5m/s^2$.

C. Theaccelerationoftheparticleisperpendiculartoitsinitialvelocity.

D. Noneoftheaboveiscorrect.

Answer: A::B::C

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

A. theparticlehasconstantacceleration.

B. theworkdonebytheexternalforces,fromthepositionofrestoftheparticlean

C. thespeedoftheparticlewhenitcrossestheyaxisis10m/s.

D. thecoordinatesoftheparticleattime$t=4$sare(-18,-28).

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

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Practice Questions Linked Comprehension

1. A block of mass m is released from rest at a height R above a horizontal surface. The acceleration due to gravity is g. The block slides along the inside of a frictionless circular hoop of radius R.

Which one of the following expressions gives the speed of the mass at the bottom of the hoop ?

A. zerom/s^2

B. $v = \frac{mg}{2R}$

C. $v^2 = 2gR$

D. $v = mgR$

Answer: C

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2. A block of mass m is released from rest at a height R above a horizontal surface. The acceleration due to gravity is g. The block slides along the inside of a frictionless circular hoop of radius R.

What is the magnitude of the normal force exerted on the block by the hoop when the block has reached the bottom ?

A. mg

B. 3mg

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

D. 2mg

Answer: B

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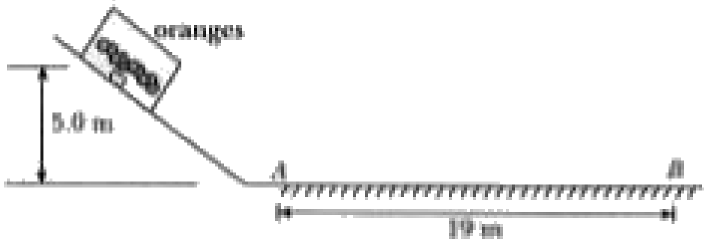
3. A 9.0 kg box of oranges slides from rest down a frictionless incline from a height of 5.0 m. A constant frictional force, introduced at point A, brings the block to rest at point B, 19 m to the right of point A.



What is the coefficient of kinetic friction, μ_k, of the surface from A to B ?

A. 0.11

B. 0.33

C. 0.26

D. 0.47

Answer: C

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4. A 2.0-kg projectile is fired with initial velocity components $v_{ox} = 30m/s$ and $v_{oy} = 40m/s$ from a point on the earth's surface. Neglect any effects due to air resistance.

What is the kinetic energy of the projectile when it reaches the highest point in its trajectory ?

A. zerojoules

B. 1600J

C. 900J

D. 2500J

Answer: C

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5. A 2.0-kg projectile is fired with initial velocity components $v_{ox} = 30m/s$ and $v_{oy} = 40m/s$ from a point on the earth's surface. Neglect any effects due to air resistance.

How much work was done in firing the projectile ?

A. 900J

B. 2500J

C. 1600J

D. 4900J

Answer: C

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6. Potential energy function is the energy possessed by the body by virtue of its position. Potential energy of a body is the energy possessed by the body by virtue of its velocity and is given by $1/2mv^2$. Energy can neither be created nor be destroyed. However, energy can be changed from one form to the other, such that energy appearing in one form to the other, such that energy appearing in one form is equal to the energy disappearing in the other form.

Kinetic energy of the body 5 s after it starts falling is

A. 1250J

B. 2500J

C. 625J

D. 25,000J

Answer: A

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7. Potential energy of a body is the energy possessed by the body by virtue of its position. P.E. $= mgh$ where the symbols have their usual meaning. Kinetic energy of a body is the energy possessed by the body by virtual of its velocity.

$$K.E. = \frac{1}{2}mv^2$$

Energy can neither be created nor be destroyed. However energy can be changed from one form to other, such that energy appearing in one form is equal to the energy disappearing in the other form.

With the help of the passage given above, choose the most appropriate alternative for each of the following question :

The body will attain this K.E. when it falls freely from a height of

A. 125m

B. 250m

C. 1250m

D. 2500m

Answer: A

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8. Potential energy function is the energy possessed by the body by virtue of its position. Potential energy of a body is the energy possessed by the body by virtue of its velocity and is given by $1/2mv^2$. Energy can neither be created nor be destroyed. However, energy can be changed from one form to the other, such that energy appearing in one form to the other, such that energy appearing in one form is equal to the energy disappearing in the other form.

Velocity of the body on striking the ground after 5 secs of release will be

A. 25m/s

B. 12.5m/s

C. 50m/s

D. 100m/s

Answer: C

Watch Video Solution

9. Potential energy of a body is the energy possessed by the body by virtue of its position. P.E. $= mgh$ where the symbols have their usual meaning. Kinetic energy of a body is the energy possessed by the body by virtual of its velocity.

$$K.\,E. \;= \frac{1}{2}mv^2$$

Energy can neither be created nor be destroyed. However energy can be changed from one form to other, such that energy appearing in one form is equal to the energy disappearing in the other form.

With the help of the passage given above, choose the most appropriate alternative for each of the following question :

The ratio of potential energy to kinetic energy at a height of $62.5m$ above the ground is

A. 2

B. 1

C. 3

D. 4

Answer: B

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Practice Questions Matrix Match

1. Match the statements in Column I with the statements in Column II :

Column I	Column II
(a) Force is equal to	(p) the work is path independent.
(b) For the conservative force	(q) the rate of change of linear momentum.
(c) Power is equal to	(r) the rate of work done.
(d) Area of power-time curve gives	(s) the product of force to the velocity.
	(t) the work done.
	(u) the negative of the potential energy gradient.

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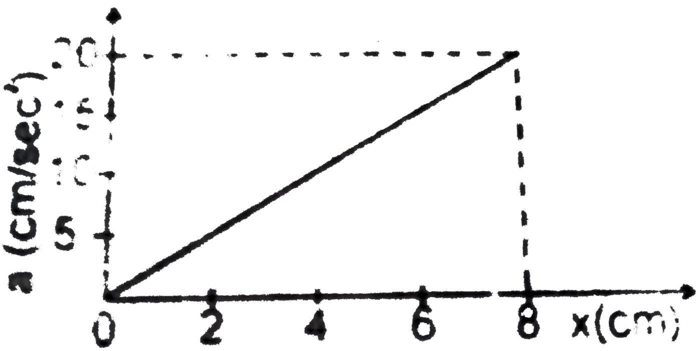
Practice Questions Integer Type

1. A 10 kg mass moves x-axis. Its acceleration as function of its position is shown in the figure. What is the total work done on the mass by the force as the mass moves from x = 0 to x = 8 cm ?



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2. A car of mass 900 kg accelerates uniformly from rest to a speed of 60 km/h in a time of 2 s when traveling on a level road. If there is a constant resistance to motion of 20 N. Find the maximum power (in kW) of the engine.

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3. If the speed of a car increases 4 times, the stopping distance (in m) for this will increase by _______ .

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4. A swimmer moves through the water at a speed of 0.22 m/s. The drag force opposing this motion is 110 N. How much power (in W) is developed by the swimmer ?

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5. A river descends 15 m through rapids. The speed of the water is 3.2 m/s upon entering the rapids and 13 m/s upon leaving . What percentage of the gravitational potential energy of the water-Earth system is transferred to kinetic energy during the descent ? (Hint : Consider the descent of, say, 10 kg of water.)

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