PHYSICS

BOOKS - RESNICK AND HALLIDAY PHYSICS (HINGLISH)

FORCE AND MOTION - I

Sample Problem

1. Here are examples of how to use Newton's second law for a quck when one or two forces act on it. Parts (a), (b), and (c) of Fig. 5-3 show three situations in which one or two forces act on a puck that moves over frictionless ice along an x axis, in one-dimensional motion. The puck's mass is m = 0.20 kg. Forces $\overrightarrow{F}_1$ and $\overrightarrow{F}_2$ are directed along the axis and have magnitudes $F_1 = 4.0$ N and $F_2 = 2.0$ N. Force $\overrightarrow{F}_3$ is directed at angle $\theta = 30^\circ$ and has magnitude $F_3 = 1.0$ N. In each situation, what is the acceleration of the puck ?

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2. Here we find a missing force by using the acceleration. In the overhead view of Fig. 5-4a, a 2.0 kg cookie tin is accelerated at $3.0 \ \mathrm{m/s^2}$ in the direction shown by $\overrightarrow{a}$, over a frictionless horizontal surface. The acceleration is caused by three horizontal forces, only two of which are shown: $\overrightarrow{F}_1$ of magnitude 10 N and $\overrightarrow{F}_2$ of magnitude 20

N. What is the third force $\vec{F}_3$ in unit-vector notation and in magnitude-angle notation?

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3. A mass 1 kg is attaced to the hook of a spring and the spring is suspended vertically from a ceiling (see Fig. 5.12a). The spring is displaced from its equilibrium position by a distance x. The spring constant of the spring is $2.0 \times 10^2 \text{ N}/\text{m}$. Calculate the displacement x.

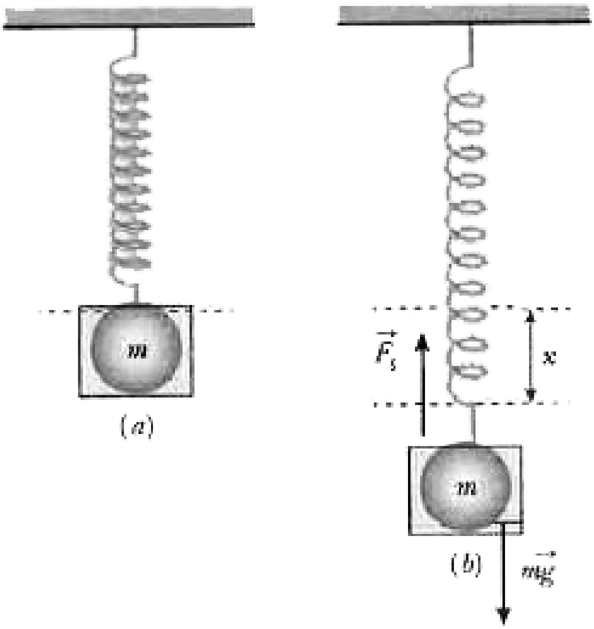

Figure 5-12 (a) Mass of 1 kg attached to a spring is suspended vertically. (b) Spring displace from equilibrium position by a distance x.

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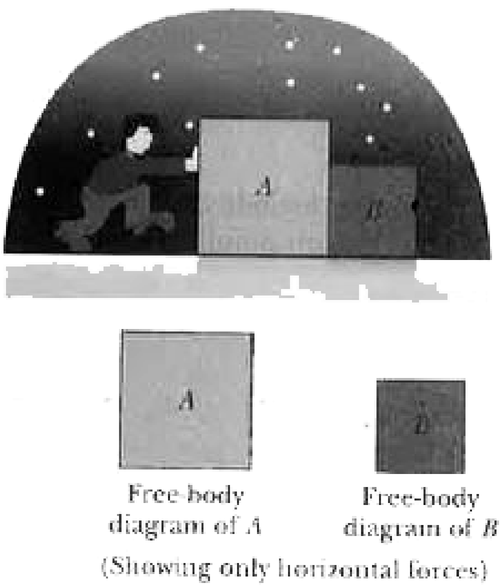
4. A secret agent pushes two mysterious crates across a frozen river in the dark of night. The crates slide frictionlessly. Their masses are 150 kg (A) and 50 kg (B). The agent's hands exert a 100 N force on A (see Fig. 5-19). How much force does A exert on B? If there is no friction, can either block's acceleration be zero? Therefore, can $\sum \overrightarrow{F}_{\text{on A}} = 0$? Therefore, can the force exerted on A by B (which is equal in magnitude to that exerted on B by A) "balance" (be equal and opposite to) the force exerted by the agent?



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5. Figure 5-20 shows a block S (the sliding block) with mass M = 3.3 kg. The block is free to move along a horizontal frictionless surface and connected, by a cord that wraps over a frictionless pulley, to a second block H (the hanging block), with mass m = 2.1 kg. The cord and pulley have negligible masses compared to the blocks (they are "massless"). The hanging block H falls as the sliding block S accelerates to the right. Find (a) the acceleration of block S, (b) the acceleration of block H, and (c) the tension in the cord.

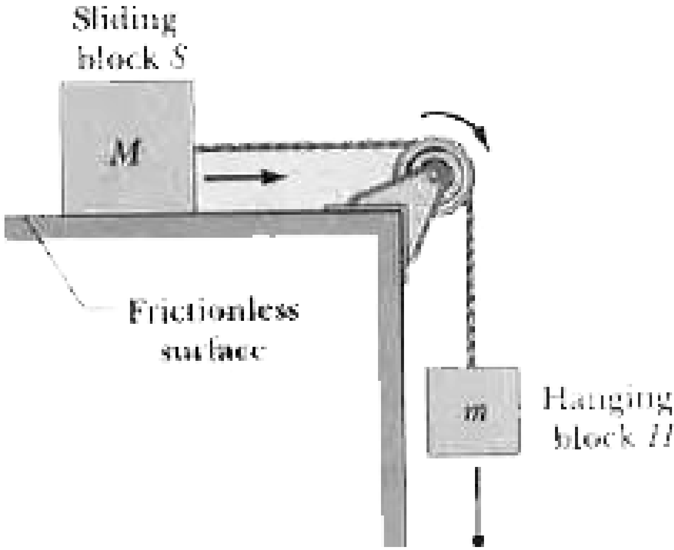

Figure 5.20 A block S of mass M is connected to a block H of mass m by a cord that wraps over a pulley.

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6. In Fig. 5-23a, a cord pulls a box of sea biscuits up along a frictionless plane inclined at angle $\theta = 30.0^\circ$. The box has mass m = 5.00 kg, and the force from the cord has magnitude T = 25.0 N. What is the box's acceleration a along the inclined plane ?

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7. Here is an example of where you must dig information out of a graph, not just read off a number. In Fig. 5-24a, two forces are applied to a 4.00 kg block on a frictionless floor, but only force $\overrightarrow{F}_1$ is indicated. That force has a fixed magnitude but can be applied at an adjustable angle θ to the positive direction of the x axis. Force F_2 is horizontal and fixed in both magnitude and angle. Figure 5-24b gives the horizontal acceleration a_x of the block for any given value of θ from 0° to 90°. What is the value of a_x for $\theta = 180^\circ$?

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8. In Fig. 5-25a, a passenger of mass m = 72.2 kg stands on a platform scale in an elevator cab. We are concerned with the scale readings when the cab is stationary and when it is moving up or down.

(a) Find a general solution for the scale readihng, whatever the vertical motion of the cab.

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9. What does the scale read if the cab is stationary or moving upward at a constant 0.50 m/s?

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10. In Fig. 5-26a, a constant horizontal force $\overrightarrow{F}_{\text{app}}$ of magnitude 20 N is applied to block A of mass $m_A = 4.0$ kg, which pushes against block B of mass $m_B = 6.0$ kg. The blocks slide over a frictionless surface, along an x axis.

(a) What is the acceleration of the blocks ? $F_{\text{app}} = m_A \alpha$

.

However, this is seriously wrong because $\overrightarrow{F}_{\text{app}}$ is not the only horizontal force acting on block A. There is also the force $\overrightarrow{F}_{\text{AD}}$ from block B (Fig. 5-26b).

Dead-End Solution: Let us now include force $\overrightarrow{F}_{AB}$ by writing, again for the x axis,

$F_{\text{app}} - F_{AB} = m_A \alpha.$

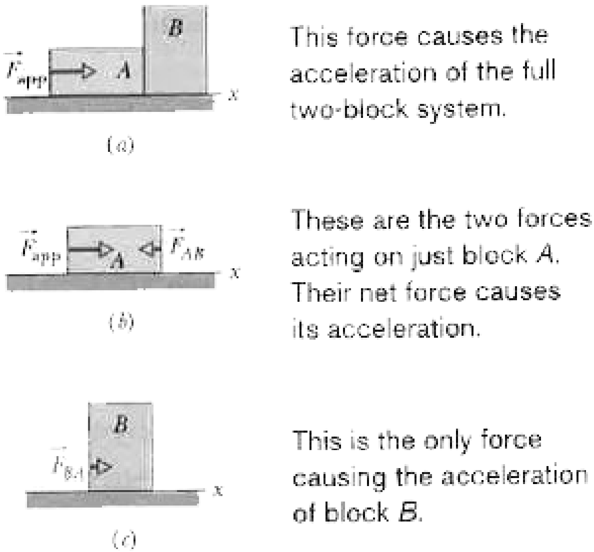

Figure 5-26 (a) A constant horizontal force $\overrightarrow{F}_{\text{app}}$ is applied to block A, which pushes against block B. (b) Two horizontal forces act on block A. (c) Only one horizontal force acts on block B.

(We use the minus sign to include the direction of $\overrightarrow{F}_{AB}$.) Because F_{AB} is a second unkon, we cannot solve this equation for a.

Successful Solution: Because of the direction in which force $\overrightarrow{F}_{\text{app}}$ is applied, the two blocks form a rigidly connected system. We can relate the net force on the system to the acceleration of the system with Newton's second law. Here, once again for the x axis, we can write that law as

$$F_{\text{app}} = (m_A + m_B)\alpha,$$

where now we properly apply $\vec{F}_{\text{app}}$ to the system with total mass $m_A + m_B$. Solving for a and substituting known values, we find

$$a = \frac{F_{\text{app}}}{m_A + m_B} = \frac{20 \text{ N}}{)} 4.0 \text{ kg} + 6.0 \text{ kg}\Big) = 2.0 \text{ m}/\text{s}^2$$

.

Thus, the acceleration of the system and of each block is in the positive direction of the x axis and has the magnitude $2.0 \text{ m}/\text{s}^2$.

(b) What is the (horizontal) force $\vec{F}_{BA}$ on block B from block A (Fig. 5-26c) ?

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11. In Fig. 5-27, a block attached to a chord is resting on an inclined plane. Let the mass of the block be 8.5 kg and the angle θ be 30°.

(a) Find the tension in the cord and normal force acting on the block.

(b) If the cord is cut, find the magnitude of the resulting acceleration of the block.

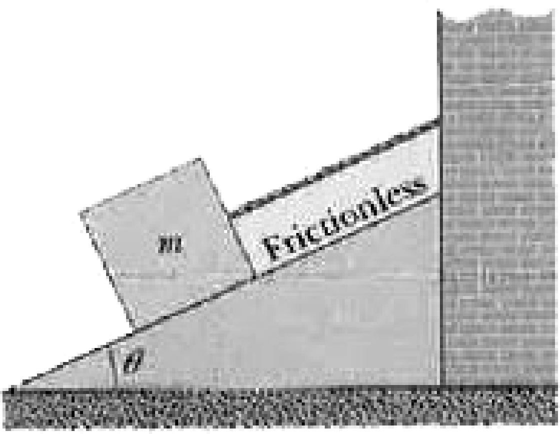

Figure 5-27 A block attached to a chord resting on an incline.

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12. In Fig. 5-29, a block of mass m = 5.00 kg is pulled along a horizonttal frictionless floor by a cord that exerts a force of magnitude F = 12.0 at an angle $\theta = 25.0^\circ$.

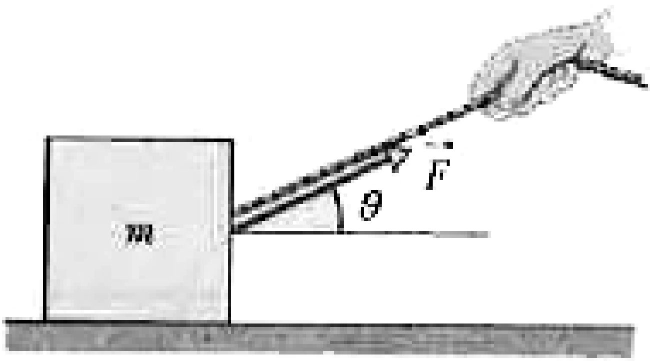

Figure 5-29 A block is pulled along a horizontal floor.

(a) What is the magnitude of the block's acceleration?

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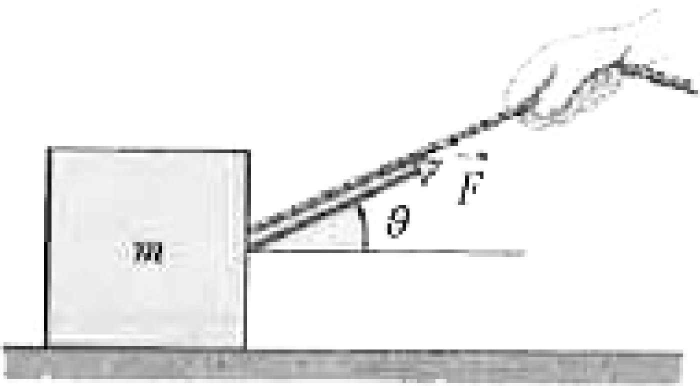
13. The force magnitude F is slowly increased. What is its value just before the block is lifted (completely) off the floor ?



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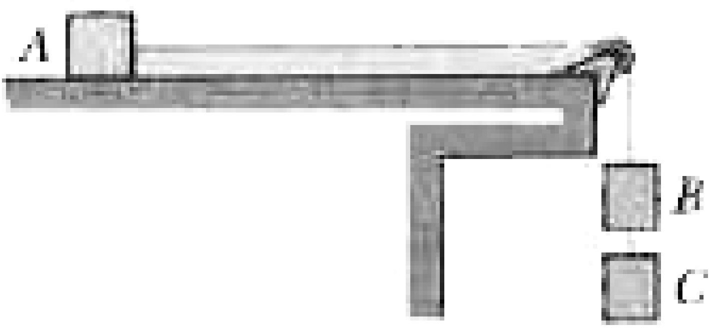
14. In Fig. 5-31, three ballot boxes are connected by cords, one of which wraps over a pulley having negligible friction on its axle and negligible mass. The three masses are $m_A = 30.0$ kg, $m_B = 40.0$ kg, and $m_c = 10.0$ kg.

(a) When the assembly is released from rest, what is the tension in the cord connecting B and C?

(b) When the assembly is released from rest, how far does A move in the first 0.250 s (assuming it does not reach the pulley)?



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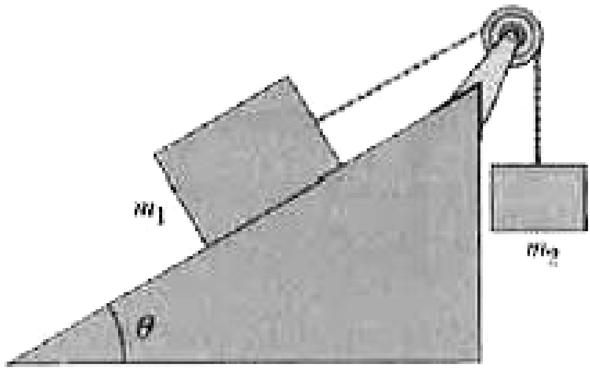
15. A block of mass $m_1 = 3.70$ kg on a frictionless plane inclined at angle 30.0° is connected by a cord over a massless, frictionless pulley to a second block of mass $m_2 = 2.30$ kg (see Fig. 5-32).

(a) What is the magnitude of the acceleration of each block?

(b) What is the direction of the acceleration of the hanging block ?

(c) What is the tension in the cord?



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16. Figure 5-34 shows three blocks attached by cords that loop over frictionless pulleys. Block B lies on a friction-less table, the masses are $m_A = 6.00$ kg, $m_B = 8.00$ kg, and $m_C = 10.0$ kg. When the blocks are released, what is the tension in the cord at the right?

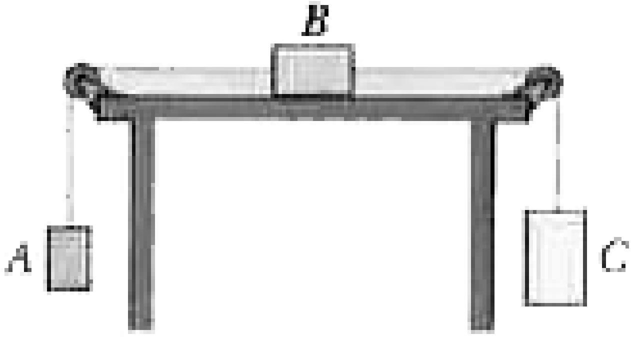

Figure 5-34 Three blocks attached over two pulleys by a cord.

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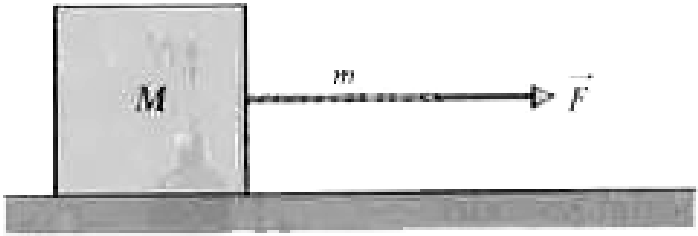
17. A block of mass M is pulled along a horizontal frictionless surface by a rope of mass m, as shown in Fig. 5-35. A horizontal force acts on one end of the rope.



(a) Show that the rope must sag, even if only by an imperceptible amount.

(b) Then, assuming that the sag is negligible, find the acceleration of rope and block.

(c) Find the force on the block from the rope.

(d) Find the tension in the rope at its midpoint.

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18. A customer sits in an amusement park ride in which the compartment is to be pulled downward in the negative direction of a y axis with an acceleration magnitude of 1.24 g, with $g = 9.80 \ \mathrm{m/s^2}$. A 0.567 g coin rests on the customer's knee. Once the motion begins and in unit-vector notation,

(a) What is the coin's acceleration relative to the ground?

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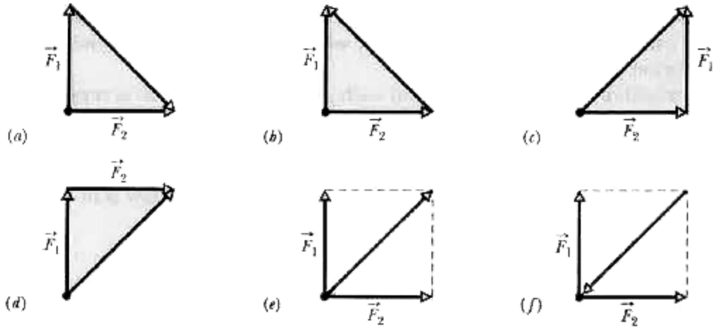
Checkpoint

1. Which of the figure's six arrangements correctly show the vector addition of forces $\overrightarrow{F}_1$ and $\overrightarrow{F}_2$ to yield the third vector, which is meant to represent their net force

$\overrightarrow{F}_{net}$?



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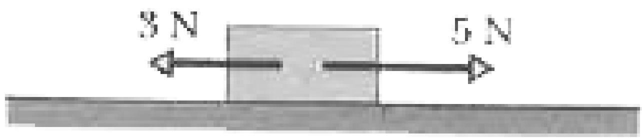
2. The figure here shows two horizontal forces acting on a block on a frictionless floor. If a third horizontal force $\overrightarrow{F}_3$ also acts on the block, what are the magnitude and direction of $\overrightarrow{F}_3$ when the block is (a) stationary and (b) moving to the left with a constant speed of $5 \ \mathrm{m/s}$?



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3. Suppose that the cantaloupe and table of Fig. 5-6 are in an elevator cab that begins to accelerate upward. (a) Do the magnitudes of $\vec{F}_{TC}$ and $\vec{F}_{CT}$ increase, decrease, or stay the same ? (b) Are those two forces still equal in magnitude and opposite in direction? (c) Do the magnitudes of $\vec{F}_{CE}$ and $\vec{F}_{EC}$ increase, decrease, or stay the same? (d) Are those two forces still equal in magnitude and opposite in direction?

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4. In Fig. 5-9, is the magnitude of the normal force $\overrightarrow{F}_N$ greater than, less than, or equal to mg if the block and table are in an elevator moving upward (a) at constant speed and (b) at increasing speed?

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5. The suspended body having weighs 75 N. Is T equal to, greater than, or less than 75 N when the body (a) at constant speed, (b) at increasing speed, and (c) at decreasing speed?

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Problems

1. When two perpendicular forces 9.0 N (toward positive x) and 7.0 N (toward positive y) act on a body of mass 6.0 kg, what are the (a) magnitude and (b) direction of the acceleration of the body ?

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2. Two horizontal forces act on a 2.5 kg chopping block that can slide over a frictionless kitchen counter, which lies in an xy plane. One force is $\vec{F}_1 = (3.0 \text{ N})\hat{i} + (4.0N)\hat{j}$. Find the acceleration of the chopping block in unit-vector notation when the other force is (a) $\vec{F}_2 = (-3.0N)\hat{i} + (-4.0N)\hat{j}$, (b) $\vec{F}_2 = (-3.0N)\hat{i} + (4.0N)\hat{j}$, and (c) $\vec{F}_2 = (3.0N)\hat{i} + (-4.0N)\hat{j}$.

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3. A body has an acceleration of 3.00 m/s^2 at 30.0° to the positive direction of an x axis. The mass of the body is 2.00 kg. Find (a) the x component and (b) the y component of the net force acting on the body. (c) What is the net force in unit-vector notation ?

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4. A particle is to move along a line at the constant velocity $\overrightarrow{v} = (2m/s)\hat{i} - (3m/s)\hat{j}$. During the motion of the particle, we assume that two forces are acting on it. If one of the forces is $\overrightarrow{F} = (2N)\hat{i} + (-5N)\hat{j}$, find the other force.

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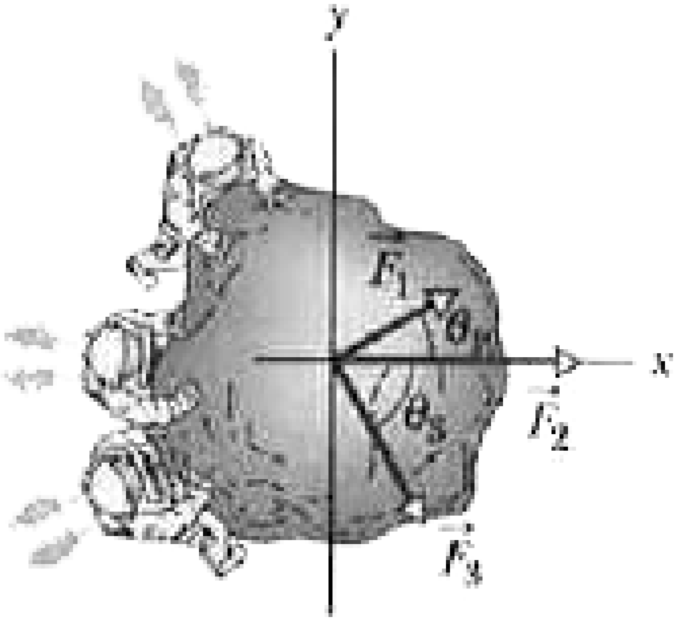
5. Three astronauts, propelled by jet backpacks, push and guide a 120 kg asteroid toward a processing dock, exerting the forces shown in Fig. 5-37, with $F_1 = 32N$, $F_2 = 55N$, $F_3 = 41N$, $\theta_1 = 30^\circ$, and $\theta_3 = 60^\circ$. What is the asteroid's acceleration (a) in unit-vector notation and as (b) a magnitude and (c) a direction relation relative to the positive direction of the x axis ?



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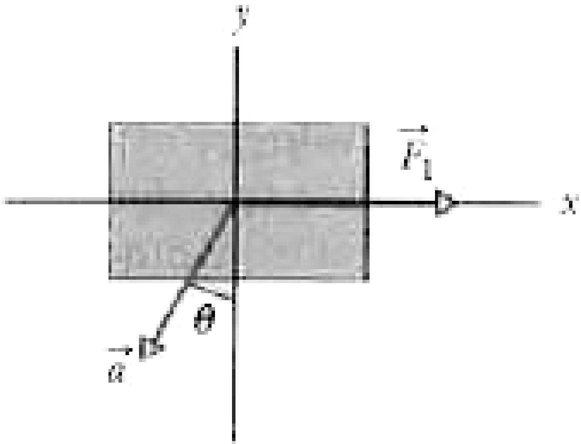
6. There are two forces on the 2.00 kg box in the overhead view of Fig. 5-38, but only one is shown. For

$F_1 = 20.0N$, $a = 12.0 \text{ m/s}^2$, and $\theta = 30.0^\circ$, find the second force (a) in unit-vector notation and as (b) a magnitude and (c) an angle relative to the positive direction of the x axis.



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7. A 1.50kg object is subjected to three forces that give it an acceleration $\vec{a} = -(8.00 \text{m/s}^2)\hat{j}$. If two of the three forces are $\overrightarrow{F}_1 = (30.0N)\hat{i} + (16.0N)\hat{j}$ and $\overrightarrow{F_2} = -(12.0N)\hat{i} + (8.00N)\hat{j}$, find the third force.

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8. In an xy plane, a 0.450 kg object moves is such a way that $x(t) = -16.0 + 3.00t - 5.00t^3$ and $y(t) = 26.0 + 8.00t - 10.0t^2$, where x and y are measured in meters and t in seconds. At t = 0.800 s, find (a) the magnitude and (b) the angle, relative to the positive direction of the x axis, of the net force on the object, and (c) the angle of the object's travel direction.

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9. A 0.150 kg particle moves along an x axis according to $x(t) = -13.00 + 2.00t + 4.00t^2 - 3.00t^3$, with x in meters and t in seconds. In unit-vector notation, what is the net force acting on the particle at $t = 2.60 \text{ s}$?

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10. A 3.0 kg object is driven along an x axis by a variable force that is directed along that axis. Its position is given by $x = 4.0 \text{ m} + (5.0 \text{ m/s})t + kt^2 - (3.0 \text{ m/s}^3)t^3$, where x is measured in meters and t in seconds. The factor k is a constant. At t = 4.0 s, the force on the particle has a magnitude of 37 N and is in the negative direction of the axis. Find the value of k.

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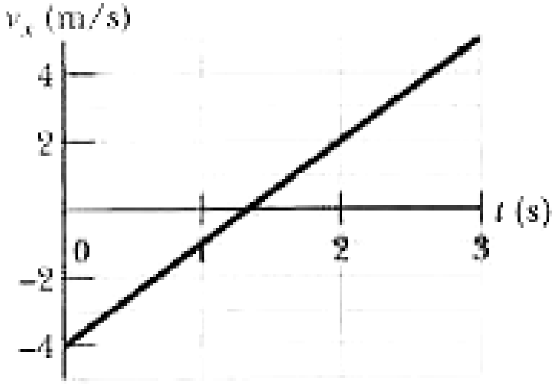
11. Two horizontal forces $\overrightarrow{F}_1$ and $\overrightarrow{F}_2$ act on a 4.0 kg disk that slides over frictionless ice, on which an xy coordinate system over frictionless ice, on which an xy coordinate system is laid out. Force $\overrightarrow{F}_1$ is in the positive direction of the x axis and has a magnitude of 7.0 N. Force $\overrightarrow{F}_2$ has a magnitude of 9.0 N. Figure 5-39 gives the x component v_x of the velocity of the disk as a function of time t during the sliding. What is the angle

between the constant directions of forces $\vec{F}_1$ and $\vec{F}_2$?



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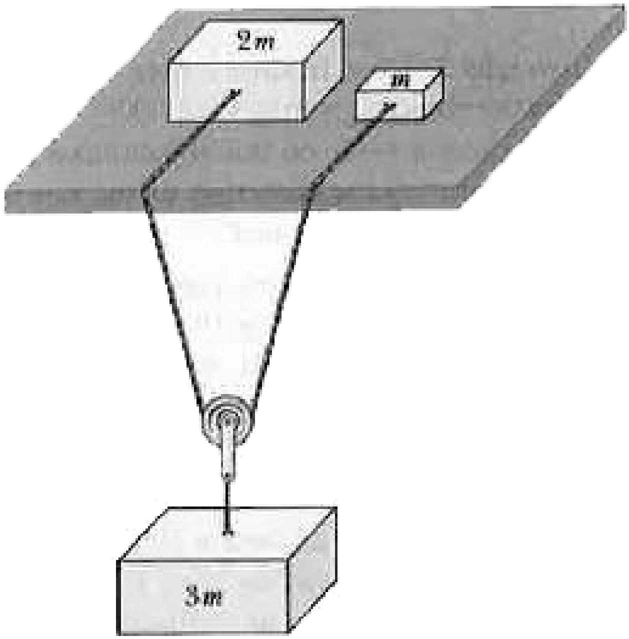
12. Two particles of masses m and 2m are placed on a smooth horizonttal table. A string, which joins these two masses, hangs over the edge supporting a pulley, which suspends a particle of mass 3m, as shown in Fig. 5-40. The pulley has negligible mass. The two parts of the string on the table are parallel and perpendicular to the edge of the table. The hanging parts of the string are vertical. Find the acceleration of the particle of mass 3m.



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13. A block with a weight of 4.0 N is at rest on a horizontal surface A 1.0 N upward force is applied to the block by means of an attached vertical string. What are the (a) magnitude and (b) direction of the force of the block on the horizontal surface ?

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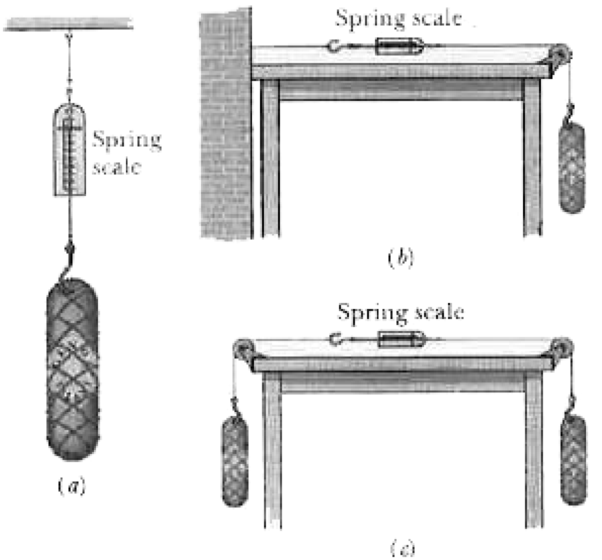
14. (a) An 11.0 kg salami is supported by a cord that runs to a spring scale, which is supported by a cord hung from the ceiling (Fig. 5-41a). What is the reading on the scale, which is marked in SI weight units? (This is a way to measure weight by a cord that runs around a pulley and to a scale.The opposite end of the scale? (This is the way by a physics major.) (c) In Fig. 5-41c the wall has been replaced with a second 11.0 kg salami, and the assembly is stationary. What is the reading on the scale?

(This is the way by a deli owner who was once a physics major.)



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15. A 550 kg rocket sled can be accelerated at a constant rate from rest to 1650 km/h in 2.0 s. What is the magnitude of the required net force ?

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16. A car traveling at 63 km/h hits a bridge abutment. A passenger in the car moves forward a distance of 65 cm (with respect to the road) while being brought to rest by an inflated air bag. What magnitude of force (assumed constant) acts on the passenger's upper torso, which has a mass of 41 kg ?

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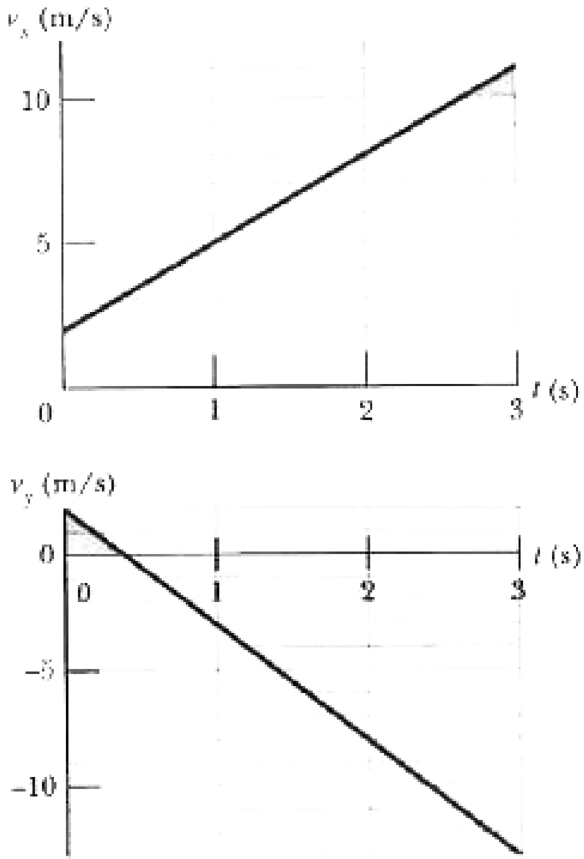
17. A constant horizontal force $\overrightarrow{F}_a$ pushes a 2.00 kg package across a frictionless floor on which an xy coordinate system has been drawn. Figure 5-42 gives the package's x and y velocity components versus time t.

What are the (a) magnitude and (b) direction of $\vec{F}_a$?



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18. Tarzan, who weighs 860 N, swings from a cliff att the end of a 20.0 m vine that hangs from a high tree limb and initially makes an angle of 22.0° with the vertical. Assume that an x axis extends horizontally away from the cliff edge and a y axis extends upward. Immediately after Tarzan steps of the cliff, the tension in the vine is 760 N. Just then, what are (a) the force on him from the vine in unit-vector notation and as (c) a magnitude and (d)an angle relative to the positive direction of Tarzon's acceleration just then ?

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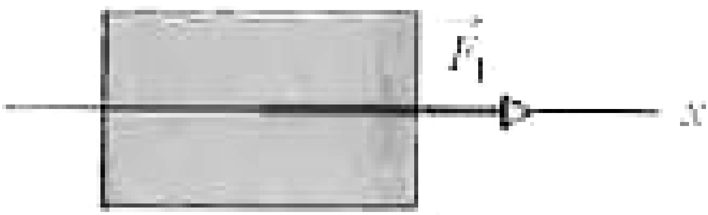
19. There are two horizontal forces on the 2.0 kg box in the overhead view of Fig. 5-43 but only one (of magnitude $F_1 = 30 \ \mathrm{N}$) is shown. The box moves along the x axis. For each of the following values of the acceleration a_x of the box, find the second force in unitvector notation: (a) $10 \ \mathrm{m/s^2}$, (b) $20 \ \mathrm{m/s^2}$, (c) 0, (d) $-10 \ \mathrm{m/s^2}$, and (e) $-20 \ \mathrm{m/s^2}$.



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20. The tension at which a fishing line snaps is commonly called the line's "strength." What minimum strength is needed for a line that is to stop a salmon of weight 90 N in 11 cm if the fish is initially drifting at 2.8 m/s ? Assume a constant deceleration.

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21. A car that weighs 1.30×10^4 N is initially moving at 35 km/h when the brakes are applied and the car is brought to a stop in 15 m. Assuming the force that stops the car is constant, find (a) the magnitude of the force and (b) the time required for the car experiences the same force during the braking, by what factors are

(c) the stopping distance and (d) the stopping time multiplied? (There could be a lesson here about the danger of driving at high speeds.)

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22. A firefighter who weighs 689 N slides down a vertical pole with an acceleration of $2.00 \mathrm{~m} / \mathrm{s}^{2}$, directed downward. What are the (a) magnitude and (b) direction (up or down) of the vertical force on the firefighter from the pole and the (c) magnitude and (d) direction of the vertical force on the pole from the firefighter ?

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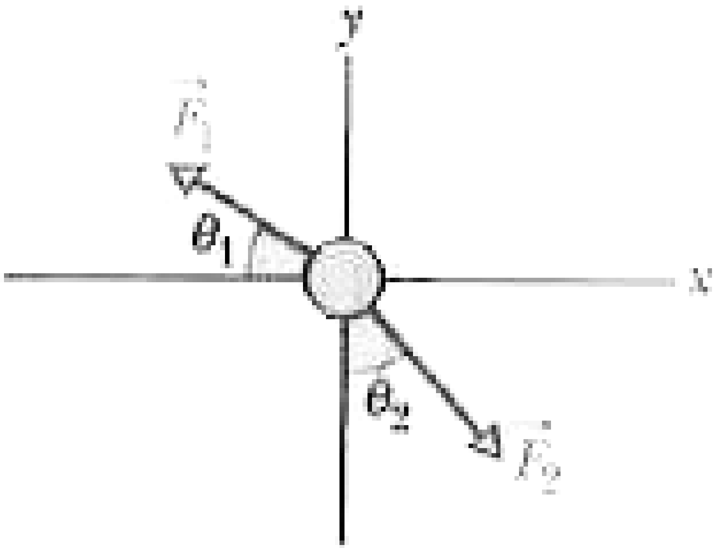
23. Figure 5-44 shows an overhead view of a 0.0250 kg lemon half and two of the three horizontal forces that act on it as it is on a fric tionless table. Force $\vec{F}_1$ has a magnitude of 6.00 N and is at $\theta_1 = 30.0°$. Force $\vec{F}_2$ has a magnitude of 7.00 N and is at



$\theta_2 = 30.0°$. In unit-vector notation, what is the third force if the lemon half (a) is stationary, (b) has the constant velocity $\vec{v} = \left(13.0\hat{\imath} - 14.0\hat{\jmath}\right)$ m/s, and (c) has the varying velocity $\bar{v} = \left(13.0t\hat{i} - 14.0t\hat{j}\right)\ \mathrm{m/s^2}$, where t is time?

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24. A 1500 kg cable car moves vertically by means of a cable that connects the ground and the top of a hill. What is the tension in the supporting cable when the cab, originally moving downard at a speed of 9.0 m/s, is brought to rest with constant acceleration in a distance of 38 m.

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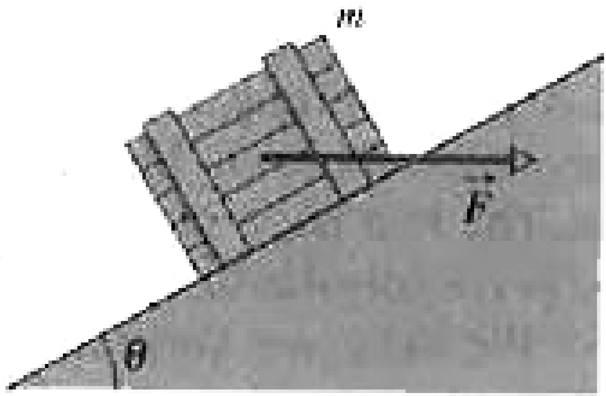
25. In Fig. 5-45, a crate of mass m = 115 kg is pushed at constant speed up a frictionless ramp $(\theta = 30.0^\circ)$ by a horizontal force $\vec{F}$. What are the magnitudes of (a) $\vec{F}$ and (b) the force on the crate from the ramp ?



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26. An object weighs 2.50 kg. In time t, measured in seconds, the velocity of the object is given by

$\bar{v} = \left(7.00t\hat{i} + 2.00t^2\hat{j}\right)$ m/s. At the instant the net force on the object has a magnitude of 35.0 N, what are the direction of the net force and the object's direction of travel ?

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27. Holding on to a tow rope moving parallel to a frictionless ski slope, a 45 kg skier is pulled up the slope, which is at an angle of 8.0° with the horizontal. What is the magnitude F_{rope} of the force on the skier from the rope when (a) the magnitude v of the skier's velocity is constant at 2.0 m/s and (b) v = 2.0 m/s as v increases at a rate of 0.10 m/s^2 ?

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28. A boy with a mass of 35 kg and a sled with a mass of 6.5 kg are on the frictionless ice of a frozen lake, 12 m apart but connected by a rope of negligible mass. The boy exerts a horizontal 4.2 N force on the rope. What are the acceleration magnitudes of (a) the sled and (b) the boy ? (c) How far from the boy's initial position do they meet ?

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29. A 50 kg skier skis directly down a frictionless slope angled at 10° to the horizontal. Assume the skier moves in the negative direction of an x axis along the slope. A wind force with component F_x acts on the skier. What is F_x if the magnitude of the skier's velocity is (a) constant, (b) increasing at a rate of $1.0 \mathrm{~m/s}^2$, and (c) increasing at a rate of $2.0 \mathrm{~m/s}^2$?

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30. A bead of mass 2.5×10^{-4} kg is suspended from a cord. A steady horizontal breeze pushes the bead so that the cord makes a constant angle of 40° with the vertical. Find (a) the tension in the cord and (b) the push magnitude.

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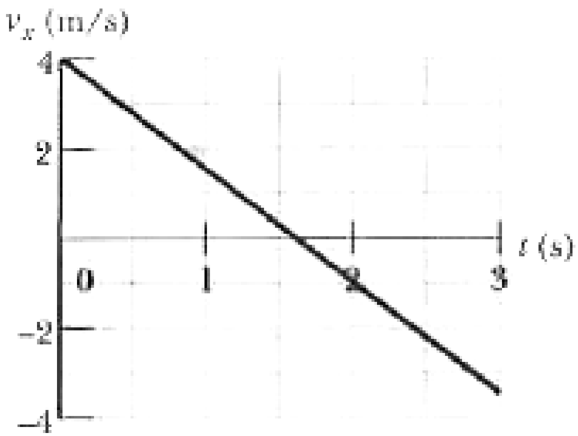
31. A dated box of dates, of mass 4.50 kg, is sent sliding up a frictionless ramp at an angle of θ to the horizontal. Figure 5-46 gives, as a function of time t, the component v_x of the box's velocity along an x axis that extends directly up the ramp. What is the magnitude of the normal force on the box from the ramp ?



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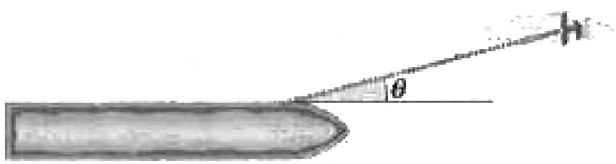
32. In earlier days, horses pulled barges down canals in the manner shown in Fig. 5-47. Suppose the horse pulls on the rope with a force of 8600 N at an angle of $\theta = 18^\circ$ to the direction of motion of the barge, which is headed straight along the positive direction of an x axis. The mass of the barge is 9500 kg, and the magnitude of its acceleration is $0.12 \ \mathrm{m/s^2}$. What are the (a) magnitude and (b) direction (relative to positive x) of the force on the barge from the water ?



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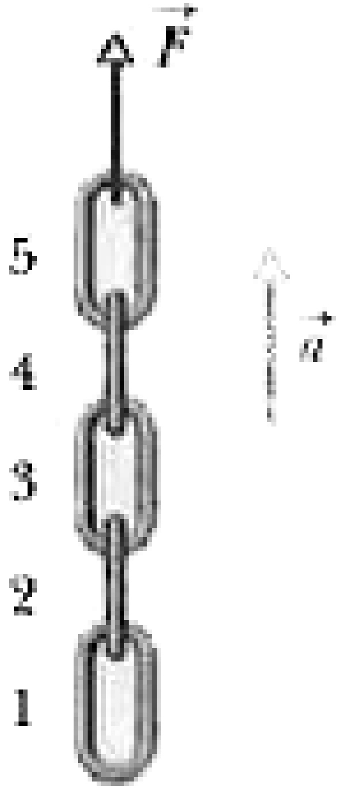
33. If Fig. 5-48, a chain consisting of five links, each of mass 0.100 kg, is lifted vertically with constant acceleration of magnitude $a = 2.50 \ \mathrm{m/s^2}$. Find the magnitudes of (a) the force on link 1 from link 2, (b) the force on link 2 from link 3, (c) the force on link 3 from link 4, and (d) the force on link 4 from link 5. Then find the magnitudes of (e) the force $\vec{F}$ on the top link from the person lifting the chain and (f) the net force accelerating each link.



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34. A lamp hangs vertically from a cord in a descending elevator that decelerates at 2.4 m/s^2. (a) If the tension in the cord is 93 N, what is the lamp's mass? (b) What is the cord's tension when the elevator ascends with an upward acceleration of $2.4 \text{ m}/\text{s}^2$?

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35. An elevator cab that weighs 29.0 kN moves upward. What is the tension in the cable if the cab's speed is (a)increasing at a rate of $1.50 \text{ m}/\text{s}^2$ and (b) decreasing at a rate of $1.50 \text{ m}/\text{s}^2$?

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36. An elevator cab is pulled upward by a cable. The cab and its single occupant have a combined mass of 2000 kg. When that occupant drops a coin, its acceleration relative to the cab is $8.30 \ \mathrm{m/s^2}$ downward. What is the tension in the cable?

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37. The Zacchini family was renowned for their human-cannonball act in which a family member was shot from a cannon using either elastic bands or compressed air. In one version of the act, Emanuel Zacchhini was shot over three Ferris wheels to land in a net at the same height as the open end of the cannon and at a range of

69 m. He was propelled inside the barrel for 5.2 m and launched at an angle of 53°. If his mass was 85 kg and he underwent consttant acceleration inside the barrel, what was the magnitude of the force propelling him? (Hint: Treat the launch as though it were along a ramp at 53°. Neglect air drag.)

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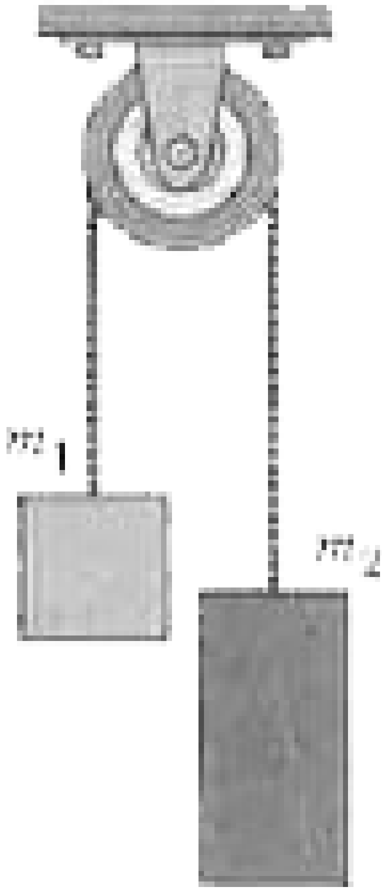
38. Figure 5-50 shows two blocks connected by a cord (of negligible mass) that passes over a frictionless pulley (also of negligible mass). The arrangement is known as Atwood's machine. One block has mass $m_1 = 1.30$ kg, the other has mass $m_2 = 2.80$ kg. What are (a) the magnitude of the blocks' acceleration and (b) the tension in the cord ?



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39. A 93 kg man lowers himself to the grouund from a height of 10.0 m by holding onto a rope that runs over a frictionless pulley to a 65 kg sandbag. With runs over a frictionless pylley to a 65 kg sandbag. With what speed does the man hit the ground if he started from rest ?

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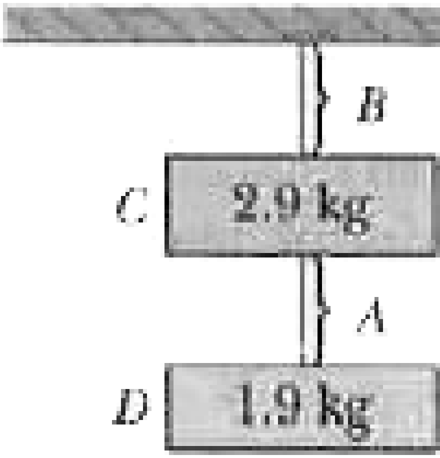
40. As shown in Fig. 5-51, body C (2.9 kg) and body D (1.9 kg) are suspended from a rigid support by inextensible wires B and A, each of length 1.0 m. Wire B has negligible mass, wire A has a uniform density of 0.20 kg/m. The whole system undergoes an upward acceleration of magnitude $0.50 \ m/s^2$. Find the tension at the midpoint in (a) wire A and (b) wire B.



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41. Figure 5-52 shows four penguins that are being playfully pulled along very slippery (frictionless) ice by a curator. The masses of three penguins and the tension in two of the cords are $m_1 = 12$ kg, $m_3 = 15$ kg, $m_4 = 20$ kg, $T_2 = 111$ N, and $T_4 = 222$ N. Find the penguin mass m_2 that is not given.

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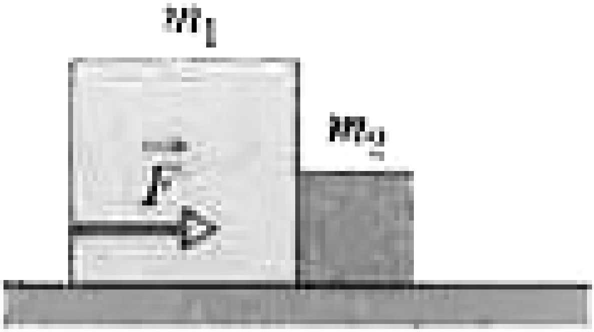
42. Two blocks are in contact on a frictionless table. A horizontal force is applied to the larger block, as shown in Fig. 5-53. (a) If $m_1 = 2.3 \text{ kg}, m_2 = 1.2 \text{ kg},$ and F = 3.2 N, find the magnitude of the force between the two blocks. (b) Show that if a force of the same magnitude F is applied to the smaller block but in the opposite direction, the magnitude of the force between the blocks is 2.1 N, which is not the same value calculated in (a). (c) Explain the difference.



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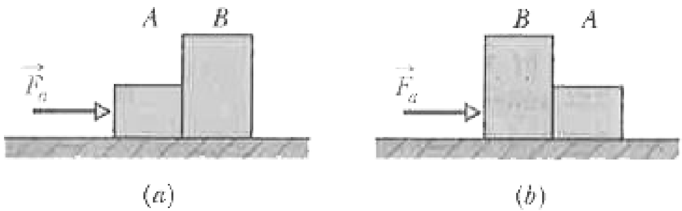
43. In Fig. 5-54a, a constant horizontal force $\overrightarrow{F}_a$ is applied to block A, which pushes against block B with a 15.0 N force directed horizontally to the right. In Fig. 5-54b, the same force $\overrightarrow{F}_a$ is applied to block B, now block A pushes on block B with a 10.0 N force directed horizontally to the left. The blocks have a combined mass of 12.0 kg. What are the magnitudes of (a) their acceleration in Fig. 5-54a and (b) force $\vec{F}_a$?



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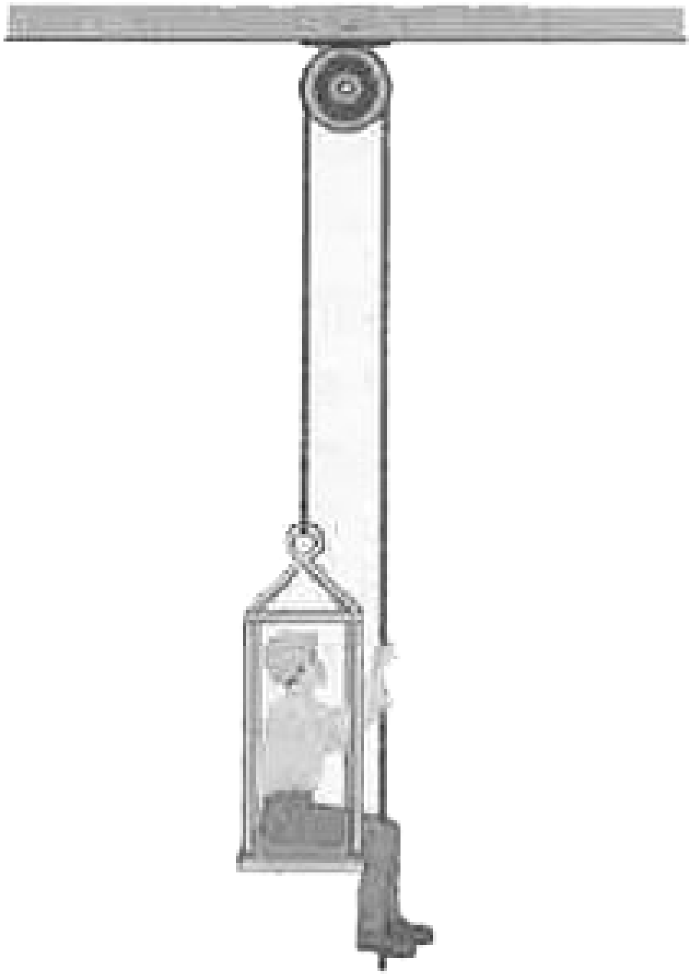
44. Figure 5-55 shows a man sitting in a bosun's chair that dangles from a mass-less rope, which runs over a massless, frictionless pulley and back down to the man's hand. The combined mass of man and chair is 103.0 kg. With what force magnitude must the man pull on the rope if he is to rise (a) with a constant velocity and (b) with an upward acceleration of $1.30 \ m/s^2$?



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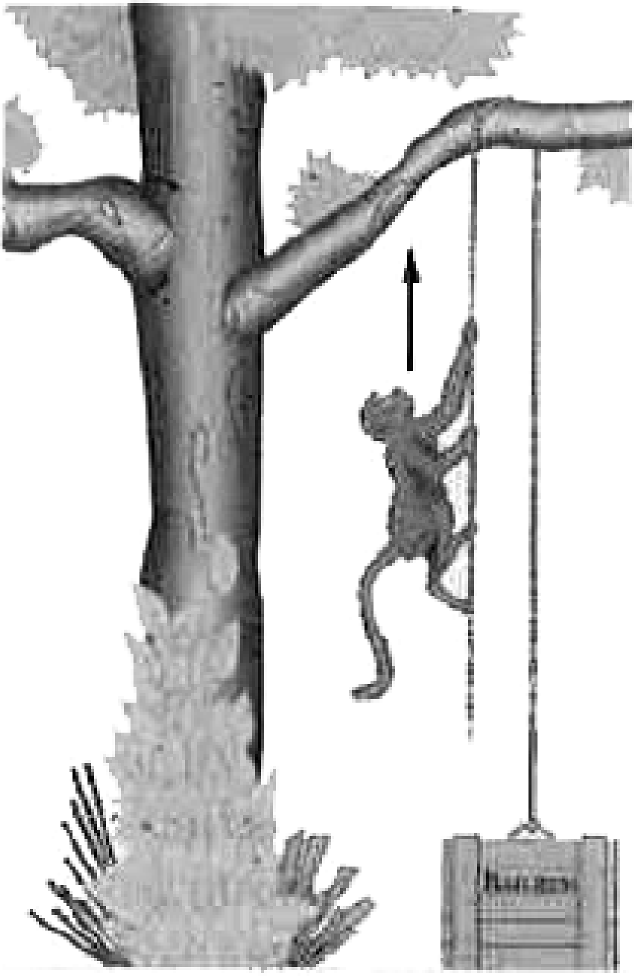
45. A 10 kg monkey climbs up a massless rope that runs over a frictionless tree limb and back down to a 15 kg package on the ground (Fig. 5-56). (a) What is the magnitude of the least acceleration the monkey must have if it is to lift the package off the ground? If, after the package has been lifted, the monkey stops its climb and holds on to the rope, what are the (b) magnitude and (c) direction of the monkey's acceleratiohn and (d) the tension in the rope ?



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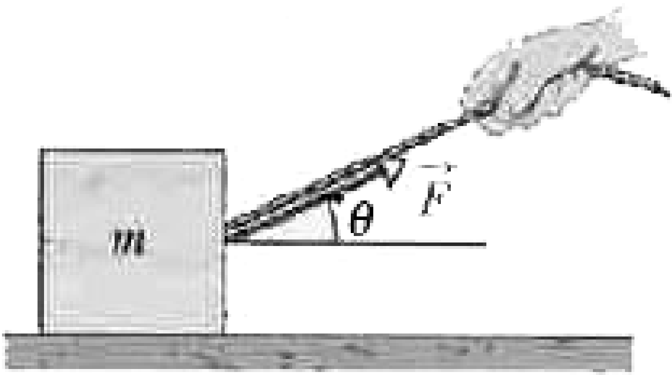
46. Figure shows a 5.00 kg block being pulled along a frictionless floor by a cord that applies a force of constant magnitude 15.0 N but with an angle $\theta(t)$ that varies with time. When angle $\theta = 25.0^\circ$, at what rate is the acceleration of the block changing if (a) $\theta(t) = (2.00 \times 10^{-2} deg/s)t$ and (b) $\theta(t) = -(2.00 \times 10^{-2} deg/s)t$?



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47. A hot-air balloon of mass M is descending vertically with downward acceleration of magnitude a. How much mass (ballast) must be thrown out to give the balloon an upward acceleration of magnitude a? Assume that the upward force from the air (the lift) does not change because of the decrease in mass.

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48. In shot putting, many athletes elect to launch the shot at an angle that is smaller than the theoretical one (about 42°) at which the distance of a projected ball at the same speed and height is greatest. One reason has to do with the speed the athlete can give the shot during the acceleration phase of the throw. Assume that a 7.260 kg shot is acclerated along a straight path of length 1.650 m by a constant applied force of magnitude 380.0 N, starting with an initial speed of 2.500 m/s (due to the athlete's preliminary motion). What is the shot's speed at the end of the acceleration phase if the angle between the path and the horizontal is (a) 30.00° and (b) 42.00° ?

(c) By what percentage is the launch speed decreased if the athlete increases the angle from 30.00° to 42.00° ?

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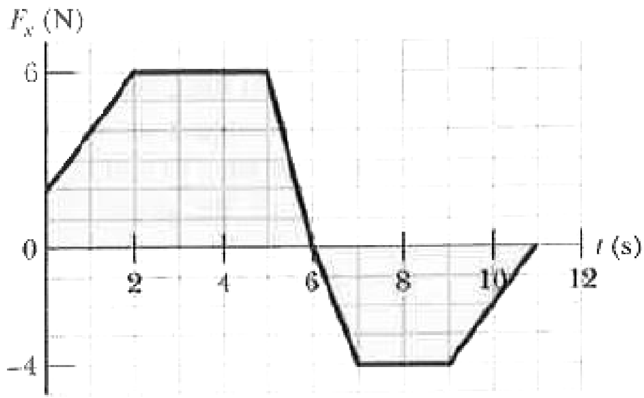
49. Figure 5-58 gives, as a function of time l, the force component F, that acts on a 3.00 kg ice block is moving in the positive direction of the axis, with a speed of 3.0 m/s. What are its speed and (b) direction of travel of travel at t = 11 s ?



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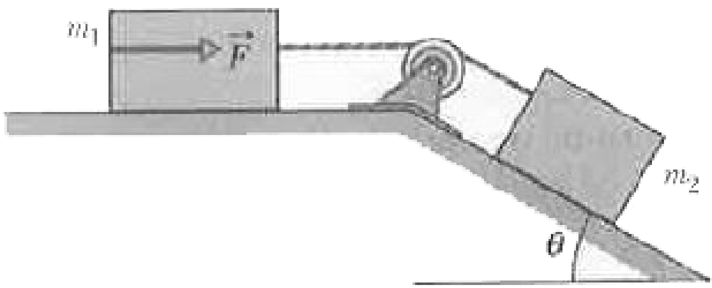
50. Figure 5-59 shows a box of mass $m_2 = 1.0$ kg on a friction-less plane inclined at angle $\theta = 30^\circ$. It is connected by a cord of negligible mass to a mass $m_1 = 2.5$ kg on a horizontal frictionless surface. The pulley is frictionless and massless. (a) If the magnitude of horizontal force $\vec{F}$ is 2.3 N, what is the tension in the connecting cord? (b) What is the largest value the magnitude of $\vec{F}$ may have without the cord becoming slack?



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51. Figure 5-50 shows Atwood's machine, in which two containers are connected by a cord (of negligible mass) passing over a frictionless pulley (also of negligible mass). At time t = 0, container 1 has mass 1.30 kg and container 2 has mass 2.80 kg, but container 1 is losing mass (through a leak) at the constant rate of 0.200 kg/s. At what rate is the acceleration magnitude of the containers changing at (a) t = 0 and (b) t = 3.00 s? (c) When does the acceleration reach its maximum value ?

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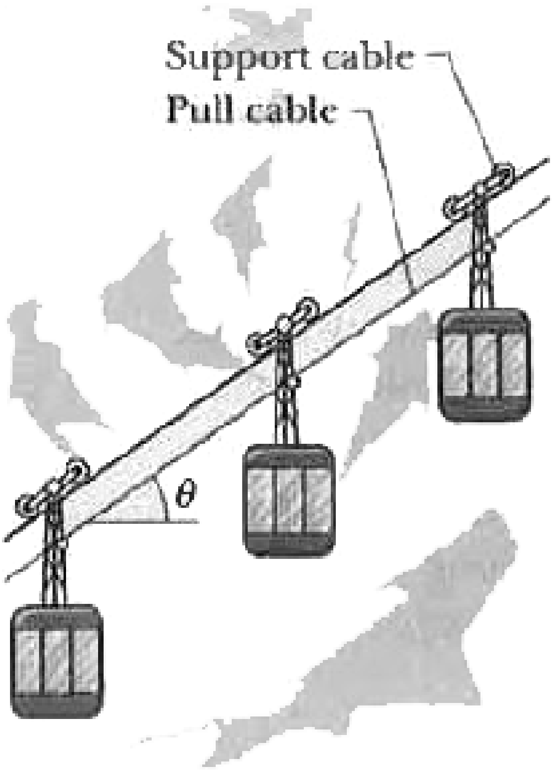
52. Figure 5-60 shows a section of a cable-car system. The maximum permissible mass of each car with occupants is 2750 kg. The cars, riding on a support cable, are pulled by a second cable attached to the support tower on each car. Assume that the cables are taut and inclined at angle $\theta = 35^{\circ}$. What is the difference in tension between adjacent sections of pull cable if the cars are at the maximum permissible mass and are being accelerated up the incline at $0.81 \ \mathrm{m/s^2}$?



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Practice Questions Single Correct Choice Type

1. A boat has a mass of 6800 kg. Its engines generate a drive force of 4100 N, due west, while the wind exerts a force of 800 N, due east, and the water exerts a resistive force of 1200 N due east. What is the magnitude and direction of the boat's acceleration ?

A. $0.54 \ \text{m}/\text{s}^2$, due west

B. $0.54 \ \text{m}/\text{s}^2$, due east

C. $0.66 \ \text{m}/\text{s}^2$, due west

D. $0.31 \ \text{m}/\text{s}^2$, due west

Answer: D

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2. Complete the following statement: An inertial reference frame is one in which

A. Newton's first law of motion is valid.

B. the inertias of objects within the frame are zero.

C. the frame is accelerating.

D. the acceleration due to gravity is greater than zero m/s^2.

Answer: A

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3. When a horse pulls a cart, the force that helps the horse to move forward is the force exerted by

A. the cart on the horse.

B. the ground on the horse.

C. the ground on the cart.

D. the horse on the ground.

Answer: B

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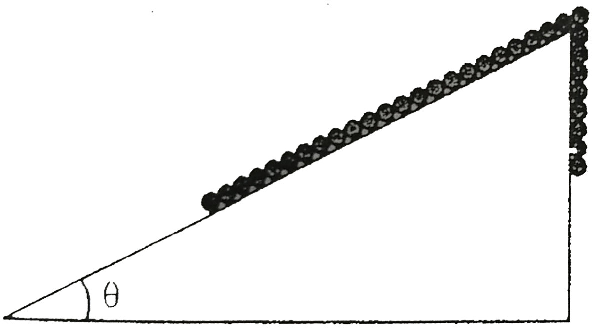
4. Sixteen beads in a string are placed on a smooth inclined plane to inclination $\theta = \sin^{-1}(1/3)$ such that some of them lie along the incline whereas the rest hang over the top of the plane. If N beads lie along inclined plane then the acceleration of the bead just below vertiex is $g/2$. Value of N is



A. 8

B. 9

C. 10

D. 11

Answer: C

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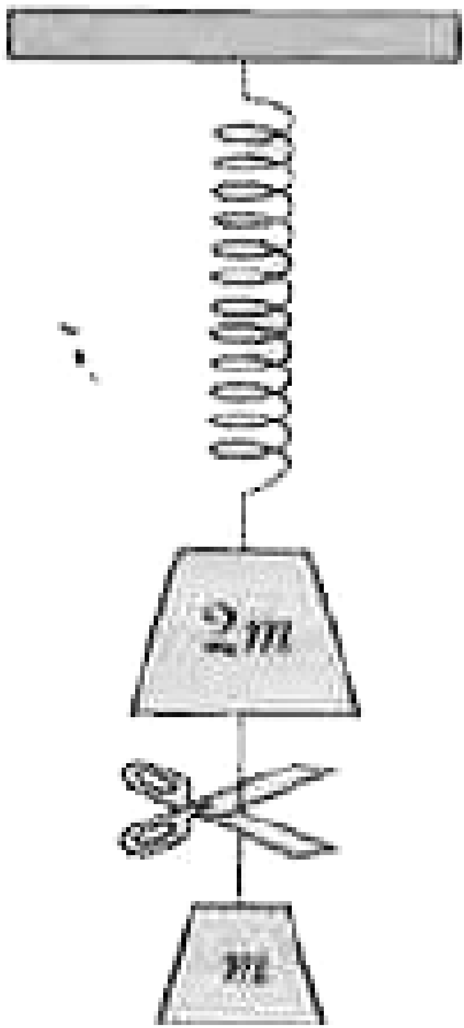
5. The system shown in the following figure is in equilibrium and at rest. The spring and string are massless. Now, the string is cut. The acceleration of mass 2m and m, just after the string is cut, will be



A. g/2 upwards, g downwards.

B. g upwards, g/2 downwards.

C. g upwards, 2 g downwards.

D. 2g upwards, g downwards.

Answer: A

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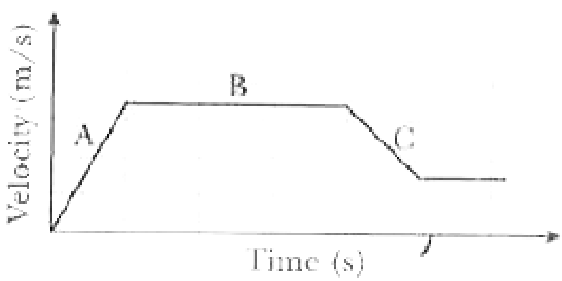
6. The given figure shows the velocity versus time curve for a car traveling along a straight line. Which of the following statements is false ?



A. Net forces act on the car during intervals A and C.

B. Opposing forces may be acting on the car during interval B.

C. Opposing forces may be acting on the car during interval C.

D. The magnitude of the net force acting duriing interval A is less then that during C.

Answer: D

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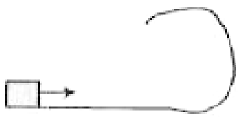
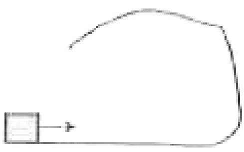
7. A small block is projected into each of the four tracks as shown below. Each of the tracks rises to the same height. The speed with which the block enters the track is the same in all cases. At the highest point of the track, the normal reaction is maximum in

A. 

B. 

C. 

D. 

Answer: A

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8. A rock is suspended from a string, and it accelerates upward. Which statement is true concerning the tension in the string ?

A. The tension points downward.

B. The tension is less than the weight of the rock.

C. The tension is equal to the weight of the rock.

D. The tension is greater than the weight of the rock.

Answer: D

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9. A paraglider is flying horizontally at a constant speed. Assume that only two forces act on it in the vertical direction, its weight and a vertical lift force exerted on its wings by the air. The lift force has a magnitude of 1800 N. If the lift force should suddenly decrease to 1200 N, what would be the vertical acceleration of the glider? For question, take the upward direction to be the +y direction.

A. -0.67 m/s^2

B. -3.3 m/s^2

C. -4.9 m/s^2

D. $-6.6 \ m/s^2$

Answer: B

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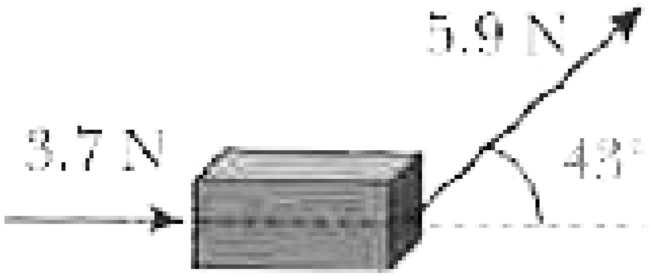
10. Two forces act on a 4.5 kg block resting on a frictionless surface as shown in the given figure. What is the magnitude of the horizontal acceleration of the block ?



A. $1.8 \ m/s^2$

B. $1.2 \ \mathrm{m/s^2}$

C. $0.82 \ \mathrm{m/s^2}$

D. $3.2 \ \mathrm{m/s^2}$

Answer: A

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11. A force F_1 acts on a particle so as to accelerate it from rest to a velocity v. The force F_1 is then replaced by F_2 which decelerates it to rest

A. F_1 must be equal to F_2

B. F_1 may be equal to F_2

C. F_1 must be unequal to F_2

D. None of these.

Answer: B

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12. A 15 N net force is applied for 6.0 s to a 12 kg box initially at rest. What is the speed of the box at the end of the 6.0 s interval?

A. 1.8 m/s

B. 15 m/s

C. 3.0m/s

D. 7.5 m/s

Answer: D

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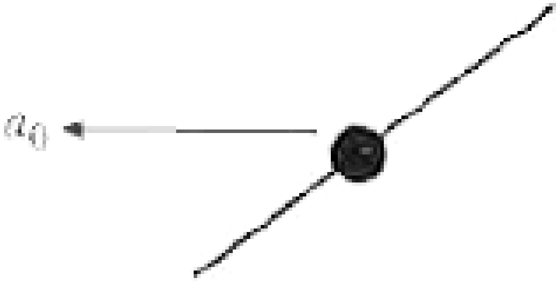
13. A bead of mass m moves on a rod without friction. Initially the bead is at the middle of the rod and the rod moves translationally in a vertical plane with an acceleration a_0 in a direction forming angle θ with the horizontal as shown in the given figure. The acceleration of bead with respect to rod is



A. $g \sin \theta$

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

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

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

Answer: D

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14. Two satellites of different masses are in the same circular orbit about the Earth. Which one of the following statements is true concerning the magnitude of the gravitational force that acts on each of them ?

A. The magnitude of the gravitational force is zero new-tons for both satellites.

B. The magnitude of the gravitational force is the same for both satellites, but not zero newtons.

C. The magnitude of the gravitational force is zero new-tons for one, but not for the other.

D. The magnitude of the gravitational force depends on their masses.

Answer: D

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15. Neglect the effect of rotation of the earth. Suppose the earth suddenly stops attracting objects placed near its surface. A paerson standing on the surface of the earth will

A. fly up.

B. slip along the surface.

C. fly along a tangent to the Earth's surface.

D. remain standing.

Answer: D

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16. A 810 kg car accelerates from rest to 27 m/s in a distance of 120 m. What is the magnitude of the average net force acting on the car ?

A. 740 N

B. 2500 N

C. 91 N

D. 1300 N

Answer: B

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17. A 1580 kg car is traveling with a speed of 15.0 m/s. What is the magnitude of the horizontal net force that is required to bring the car to a halt in a distance of 50.0 m ?

A. 1030 N

B. 2490 N

C. 3560 N

D. 4010 N

Answer: C

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18. An elevator and its load weigh a total of 1600 kg. Find the tension T in the supporting cable when the elevator, originally moving downward at 20 m/s is brought to rest with constant acceleration in a distance of 50 m.

A. $2024 \times 10^{2} N$

B. $1024 \times 10^{4} N$

C. $2024 \times 10^{4} N$

D. $2024 \times 10^{-4} N$

Answer: C

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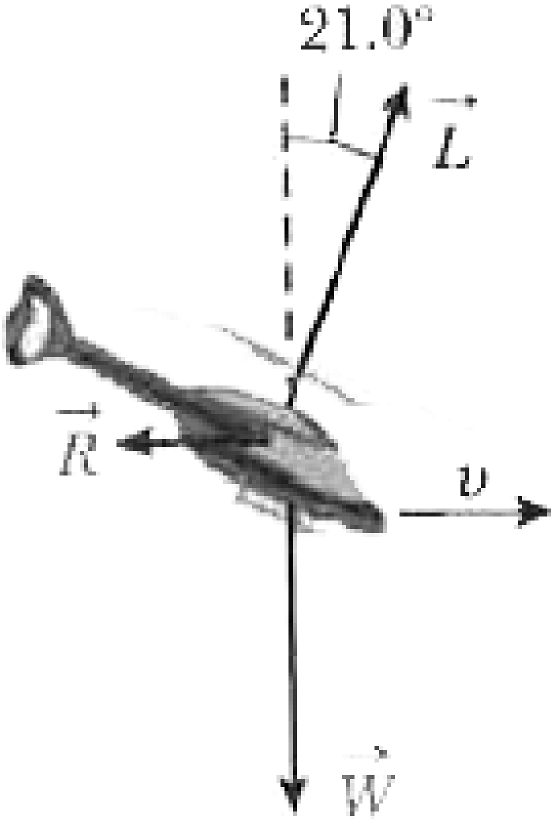
19. The helicopter in the drawing is moving horizontally to the right at a constant velocity. The weight of the helicopter is W = 53 800 N. The lift force $\vec{L}$ generated by the rotating blade makes an angle of 21.0° with respect to the vertical as shown in the following figure.

What is the magnitude of the lift force ?



A. 18 800 N

B. 57 600 N

C. 20 600 N

D. 37 600 N

Answer: B

Watch Video Solution

20. A rock is suspended from a string, and it moves downward at constant speed. Which one of the following statements is true concerning the tension in the string if air resistance is not ignored ?

A. The tension is zero newtons.

B. The tension points downward.

C. The tension is equal to the weight of the rock.

D. The tension is less than the weight of the rock.

Answer: D

Watch Video Solution

21. A 71 kg man stands on a bathroom scale in an elevator. What does the scale read if the elevator is ascending with an acceleration of $3.0 \mathrm{~m} / \mathrm{s}^{2}$?

A. 140 N

B. 480 N

C. 690 N

D. 910 N

Answer: D

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22. Two bodies of masses m and M are attached to the two ends of a light string passing over a fixed ideal pulley $(M > > m)$. When the bodies are in motion, the tension in the string is approximately

A. $(M - m)g$

B. mg

C. 2 mg

D. (m/M)mg

Answer: C

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23. Two forces act on a 16 kg object. The first force has a magnitude of 68 N and is directed 24° north of east. The second force is 32 N, 48° north of west. What is the acceleration of the object resulting from the action of these two forces ?

A. $1.6\ \text{m}/\text{s}^2, 5.5^\circ$ north of east

B. $1.9\ \text{m}/\text{s}^2, 18^\circ$ north of west

C. $2.4\ \text{m}/\text{s}^2, 34^\circ$ north of east

D. $4.1\ \text{m}/\text{s}^2, 52^\circ$ north of east

Answer: D

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24. On earth, two parts of a space probe weigh 11 000 N and 3400 N. These parts are separated by a center-to-center distance of 12 m and may be treated as uniform spherical objects. Find the magnitude of the gravitational force that each part exerts on the other out in space, far from any other objects.

A. 1.7×10^{-6} N

B. $3.4 \times 10^{-7} N$

C. 1.8×10^{-7} N

D. 3.6×10^{-5} N

Answer: C

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25. A certain crane can provide a maximum lifting force 2500 N. It hoists a 2000 kg load starting at ground level by applying the maximum force for a 2 second interval, then, it applies just sufficient force to keep the load moving upward at constant speed. Approximately how long does it take to raise the load from ground level to a height of 30 m ?

A. 2 s

B. 7 s

C. 5 s

D. 9 s

Answer: C

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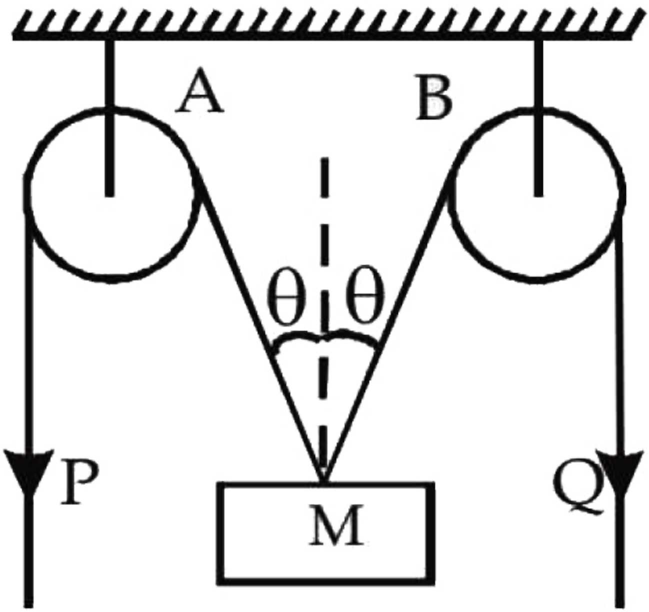
26. In the arrangement shown in the Fig, the ends P and Q of an unstretchable string move downwards with uniform speed U. Pulleys A and B are fixed.

Mass M moves upwards with a speed



A. $2u \cos \theta$

B. $u / \cos \theta$

C. $2u / \cos \theta$

D. $u \cos \theta$

Answer: B

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27. Two point masses m and M are separated by a distance d. If the separation d remains fixed and the masses are increased to the values 3m and 3M, respectively, how does the gravitational force between them change ?

A. The force will be one-third as great.

B. The force will be one-ninth as great.

C. The force will be three times as great.

D. The force will be nine times as great.

Answer: D

Watch Video Solution

28. A car is towing a boat on a trailer. The driver starts from rest and accelerates to a velocity of +11 m/s in a time of 28 s. The combined mass of the boat and trailer is 410 kg. The frictional force acting on the trailer can be ignored. What is the tension in the hitch that connects the trailer to the car ?

A. $3.2 \times 10^2 N$

B. $1.6 \times 10^2 N$

C. $6.5 \times 10^2 N$

D. $4.0 \times 10^3 N$

Answer: B

Watch Video Solution

29. A marble is dropped straight down from a distance h above the floor.

Let F_m = the magnitude of the gravitational force on the marble due to the Earth,

F_e = the magnitude of the gravitational force on the Earth due to the marble,

a_m = the magnitude of the acceleration of the marble toward the Earth,

a_e = the magnitude of the acceleration of the Earth toward the marble.

Which set of conditions is true as the marble falls toward the earth? Neglect any effects of air resistance.

A. $F_m = F_e$ and $a_m < a_e$

B. $F_m < F_e$ and $a_m > a_e$

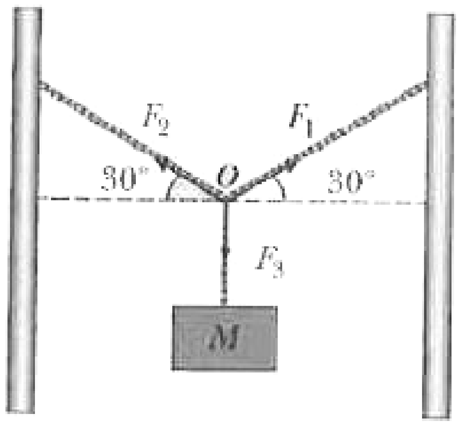
C. $F_m < F_e$ and $a_m = a_e$

D. $F_{m = F_e}$ and $a_m > a_e$

Answer: D

Watch Video Solution

30. A block of mass M is hung by ropes as shown in the following figure. The system is in equilibrium. The point O represents the knot, the junction of the three ropes. Which of the following statements is true concerning the magnitudes of the three forces in equilibrium ?



A. $F_1 = F_2 = F_3$

B. $F_2 = 2F_3$

C. $F_2 < F_3$

D. $F_1 = F_2 = F_3 / 2$

Answer: A

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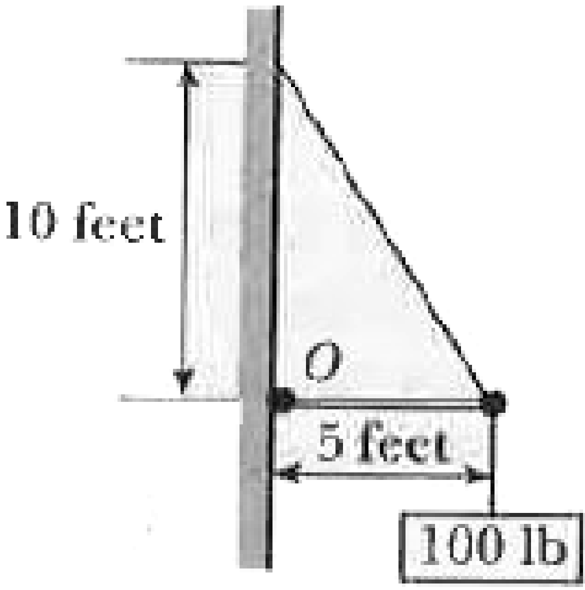
31. A massless horizontal strut is attached to the wall at the hinge O as shown in the following figure. Which one of the following phrases best describes the force that the hinge pin applies to the strut if the weight of the cables is also neglected ?



A. 50 lb, to the right

B. 100 lb, straight up

C. 200 lb, to the right

D. 244 lb, 27° above the strut

Answer: A

Watch Video Solution

32. A woman stands on a scale in a moving elevator. Her mass is 60.0 kg, and the combined mass of the elevator and scale is an additional 815 kg. Starting from rest, the elevator accelerates upward. During the acceleration, the hoisting cable applies a force of 9410 N. What does the scale read during the acceleration ?

A. 588 N

B. 606 N

C. 645 N

D. 720 N

Answer: C

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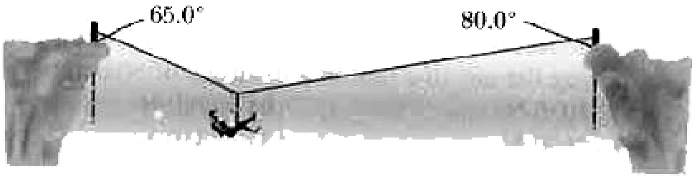
33. A mountain climber, in the process of crossing between two cliffs by a rope, pauses to rest. She weighs 535 N. As the drawing shows, she is closer to the left cliff than to the right cliff, with the result that the tensions in the left and right sides of the rope are not the same. Find the tensions in the rope to the left and to the right of the mountain climber (see given figure).



T_L	T_R
(a) 919 N	845 N
(b) 909 N	998 N
(c) 919 N	919 N
(d) 998 N	845 N

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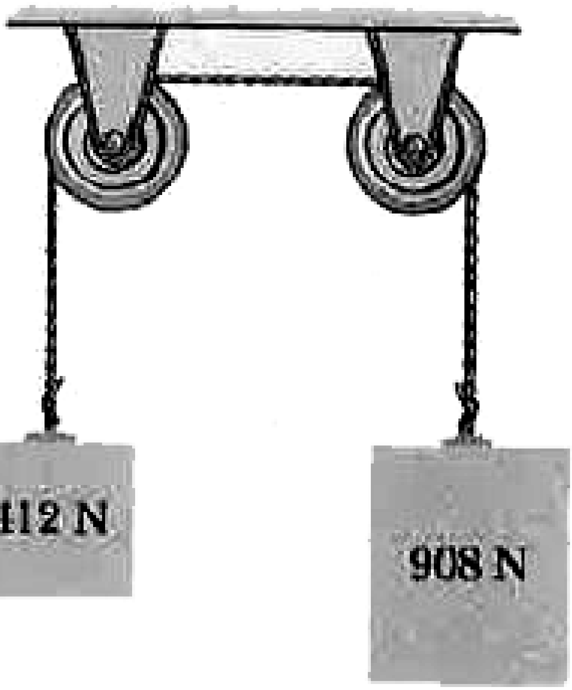
34. As shown in the given figure, two blocks are connected by a rope that passes over a set of pulleys. One block has a weight of 412 N, and the other has a weight of 908 N. The rope and the pulleys are massless and there is no friction. What is the acceleration of the lighter block ?



A. $4.44 \ \mathrm{m/s^2}$

B. $6.34 \ \mathrm{m/s^2}$

C. $2.66 \ \mathrm{m/s^2}$

D. $3.68 \ \mathrm{m/s^2}$

Answer: D

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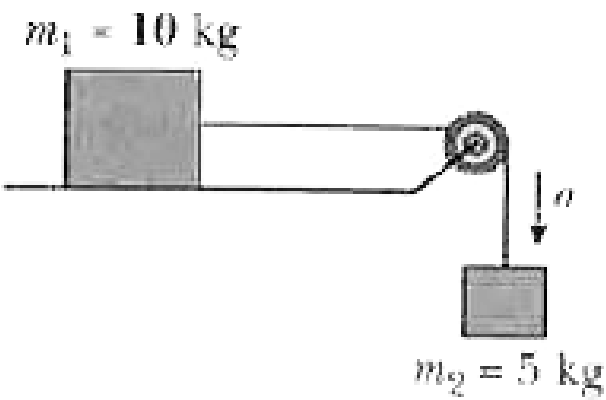
35. A body of mass 10 kg is placed on the horizontal smooth table (see given figure). A string is tied with it which passes over a frictionless pulley. The other end of the string is tied with a body of mass 5 kg. When the bodies move, the acceleration produced in them, is



A. $9.8 \text{ m}/\text{s}^2$

B. $4.8 \text{ m}/\text{s}^2$

C. $4.25 \quad m/s^2$

D. $3.27 \quad m/s^2$

Answer: D

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36. When a parachute opens, the air exerts a large drag force on it. This upward force is initially greater than the weight of the sky diver and, thus, slows him down. Suppose the weight of the sky diver is 915 N and the drag force has a magnitude of 1027 N. The mass of the sky diver is 93.4 kg. What are the magnitude and direction of his acceleration ?

A. 1.20 m/s^2, downward

B. 11.0 m/s^2, downward

C. 1.20 m/s^2, upward

D. 4.90 m/s^2, upward

Answer: C

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Practice Questions More Than One Correct Choice Type

1. A block A kept on an inclined surface just begins to slide if the inclination is 30^0. The block is replaced by another block B and it is found that it just begins to slide if the inclination is 40^0

A. mass of $A >$ mass of B

B. mass of $A <$ mass of B

C. mass of A = mass of B

D. insufficient information

Answer: A::B::C

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2. A ball of mass m is attached to the lower end of a light vertical spring of force constant K. The upper end of the spring is fixed. The ball is released from rest with the spring at its normal (unstretched) length, and comed to rest again after descending through a distance x.

A. $x = \frac{mg}{K}$

B. $x = \frac{2mg}{K}$

C. The ball will have no acceleration at the position where it has descent through $x / 2$.

D. The ball will have an upward acceleration equal to g at its lower most position.

Answer: B::C::D

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3. A particle is moving horizontally with constant acceleration.

A. The sum of the horizontal components of the forces acting on the particle is not zero.

B. The sum of the vertical component of the forces acting on the particle is not zero.

C. The forces acting on the particle are not in equilibrium.

D. All of the above.

Answer: A::C

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4. A balloon of mass m is rising up with an acceleration a.

A. The upthrust on the balloon is $m(g+a)$.

B. The upthrust on the balloon is ma.

C. $ma/(2a+g)$ mass must be detached in order to double its acceleration.

D. m/2 mass must be detached in order to double its acceleration.

Answer: A::C

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5. The two ends of a spring asre displaced along the length of the spring. All displacements have equal magnitudes. In which case or cases the tension or compression in the spring will have as maximum magnitude?

A. the right end is displaced towards right and the left end towards left.

B. both ends are displaced towards right.

C. both ends are displaced towards left.

D. the right end is displaced towards left and the left end towards right.

Answer: A::D

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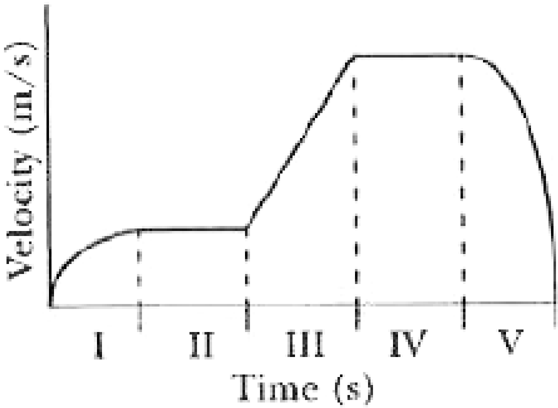
Practice Questions Linked Comprehension

1. A 2.0 kg object moves in a straight line on a horizontal frictionless surface. The graph in the given figure shows the velocity of the object as a function of time. The various equal time intervals are labeled using Roman numerals: I, II, III, IV, and V.

The net force on the object always acts along the line of motion of the object.



Which section of the graph corresponds to the application of the largest constant net force ?

A. I

B. II

C. III

D. IV

Answer: C

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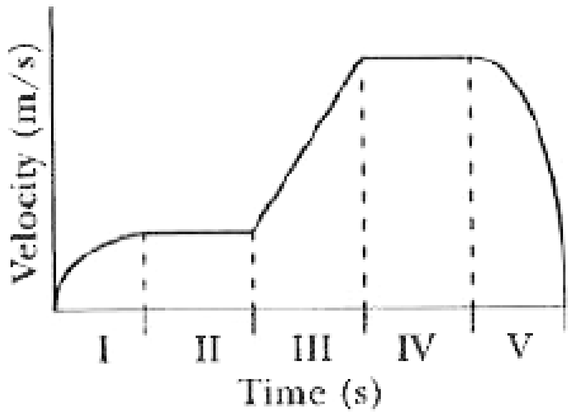
2. A 2.0 kg object moves in a straight line on a horizontal frictionless surface. The graph in the given figure shows the velocity of the object as a function of time. The various equal time intervals are labeled using Roman numerals: I, II, III, IV, and V.

The net force on the object always acts along the line of motion of the object.



In which section of the graph is the magnitude of the net force decreasing ?

A. I

B. II

C. III

D. IV

Answer: A

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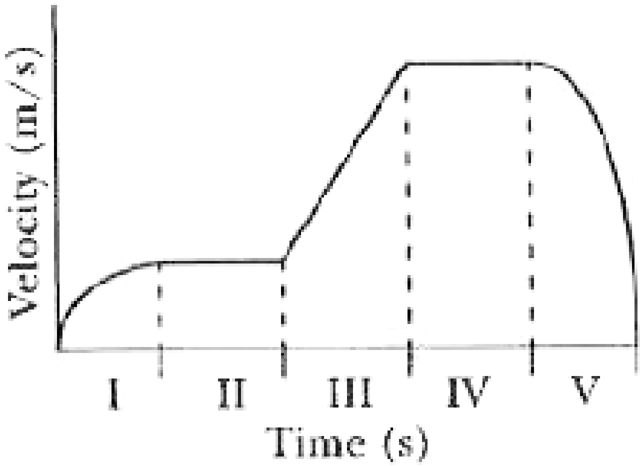
3. A 2.0 kg object moves in a straight line on a horizontal frictionless surface. The graph in the given figure shows the velocity of the object as a function of time. The various equal time intervals are labeled using Roman numerals: I, II, III, IV, and V.

The net force on the object always acts along the line of motion of the object.



In which section(s) of the graph is the net force changing ?

A. I and III

B. II and IV

C. III

D. I and V

Answer: D

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4. A 70.0 kg astronaut pushes to the left on a spacecraft with a force $\overrightarrow{F}$ in "gravity-free" space. The spacecraft has a total mass of 1.0×10^4 kg. During the push, the astronaut accelerates to the right with an acceleration of $0.36 \text{ m} / \text{s}^2$.

Which one of the following statements concerning this situation is true ?

A. The spacecraft does not move, but the astronaut moves to the right with a constant speed.

B. The astronaut stops moving after he stops pushing on the spacecraft.

C. The force exerted on the astronaut is larger than the force exerted on the spacecraft.

D. The velocity of the astronaut increases while he is pushing on the spacecraft.

Answer: D

Watch Video Solution

5. A 70.0 kg astronaut pushes to the left on a spacecraft with a force $\vec{F}$ in "gravity-free" space. The spacecraft has a total mass of 1.0×10^4 kg. During the push, the astronaut accelerates to the right with an acceleration of $0.36 \ \text{m}/\text{s}^2$.

Determine the magnitude of the acceleration of the spacecraft.

A. $51.4 \ \text{m}/\text{s}^2$

B. $0.36 \ \text{m}/\text{s}^2$

C. $2.5 \times 10^{-3} \ \text{m}/\text{s}^2$

D. $7.0 \times 10^{-3} \ \text{m}/\text{s}^2$

Answer: C

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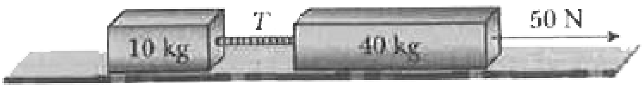
6. A 10 kg block is connected to a 40 kg block as shown in the figure. The surface on that the blocks slide is frictionless. A force of 50 N pulls the blocks to the right.



What is the magnitude of the acceleration of the 40 kg block ?

A. $0.5 \text{ m}/\text{s}^2$

B. $1 \text{ m}/\text{s}^2$

C. $2 \text{ m}/\text{s}^2$

D. $4 \text{ m}/\text{s}^2$

Answer: B

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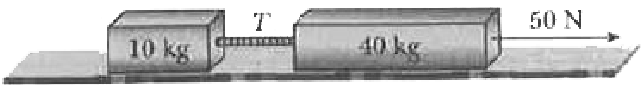
7. A 10 kg block is connected to a 40 kg block as shown in the figure. The surface on that the blocks slide is frictionless. A force of 50 N pulls the blocks to the right.



What is the magnitude of the tension T in the rope that connects the two blocks?

A. 0 N

B. 10 N

C. 20 N

D. 40 N

Answer: B

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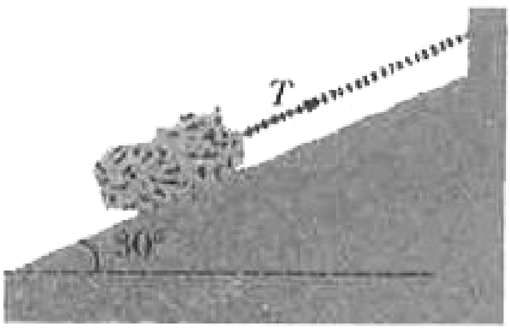
8. A rope holds a 10 kg rock at rest on a frictionless inclined plane as sown in the figure.



Datermine the tension in the rope.

A. 9.8 N

B. 20 N

C. 49 N

D. 85 N

Answer: C

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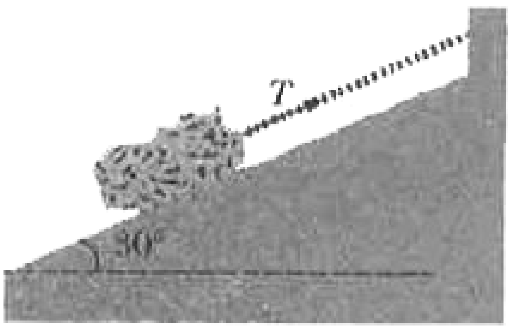
9. A rope holds a 10 kg rock at rest on a frictionless inclined plane as sown in the figure.



Which one of the following statements concerning the force exerted on the plane by the rock is true ?

A. It is 0 N.

B. It is 98 N.

C. It is greater than 98 N.

D. It is less than 98 N, but greater than zero newtons.

Answer: D

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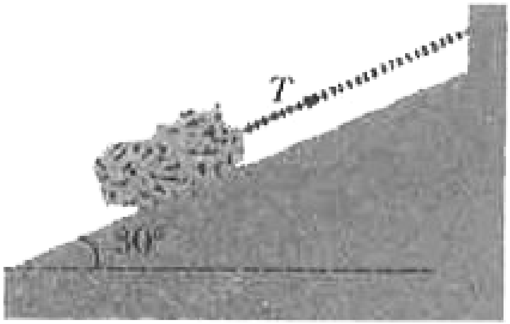
10. A rope holds a 10 kg rock at rest on a frictionless inclined plane as sown in the figure.



Determine the magnitude of the acceleration of the rock down the inclined plane if the rope breaks ?

A. zero m/s^2

B. $4.9\ \text{m}/\text{s}^2$

C. $5.7\ \text{m}/\text{s}^2)$

D. $8.5\ \text{m}/\text{s}^2$

Answer: B

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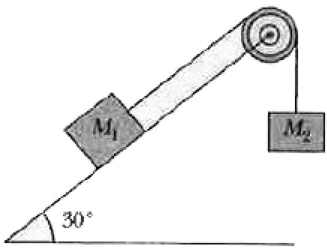
Practice Questions Matrix Match

1. In the system shown in the given figure, the inline is frictionless, the string is massless, and inextensible pulley is light and frictionless. The system is released from rest.



Column I	Column II
(a) $M_1 > M_2$	**(p)** M_2 accelerates down
(b) $M_2 > M_1$	**(q)** M_2 accelerates up
(c) $M_1 = M_2$	**(r)** M_1 and M_2 are in equilibrium
(d) $M_1 \gg M_2$	**(s)** Tension in string equals the weight of either block

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2. In each question, there is a table having 3 columns and 4 rows. Based on the table, there are 3 questions. Each question has 4 options (a), (b), (c) and (d), ONLY ONE of these four options in correct.

Column I	Column II	Column III
(I) Mass of one of the objects is 4 kg, mass of the other object is 0.05 kg.	(i) Velocity of one object before collision is $u_1 = 10$ m/s and velocity of another object before collision is $u_2 = 0$ m/s.	(J) Velocity of one object after collision $v_1 = -0.4375$ m/s.
(II) Mass of one of the objects is 0.1 kg, mass of the other object is 0.2 kg.	(ii) Velocity of one object before collision is $u_1 = 2$ m/s and velocity of another object before collision is $u_2 = 1$ m/s.	(K) Velocity of one object after collision $v_1 = 0$ m/s
(III) Mass of one of the objects is 1.5 kg, mass of the other object is 1.5 kg.	(iii) Velocity of one object before collision is $u_1 = 2.5$ m/s and velocity of another object before collision is $u_2 = -2.5$ m/s.	(L) Velocity of one object after collision $v_1 = 1.67$ m/s
(IV) Mass of one of the objects is 1 kg, mass of the other object is 5 kg.	(iv) Velocity of one object before collision is $u_1 = 0$ m/s and velocity of another object before collision is $u_2 = 0$ m/s.	(M) Velocity of the combined object after collision is 5/3 m/s

In which condition is the velocity of one of the objects after collision 35 m/s ?

A. (I) (iv) (J)

B. (IV) (ii) (L)

C. (II) (i) (K)

D. (I) (ii) (M)

Answer: A

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3. In each question, there is a table having 3 columns and 4 rows. Based on the table, there are 3 questions. Each question has 4 options (a), (b), (c) and (d), ONLY ONE of these four options in correct.

Column I	Column II	Column III
(I) Mass of one of the objects is 4 kg, mass of the other object is 0.05 kg.	(i) Velocity of one object before collision is $u_1 = 10$ m/s and velocity of another object before collision is $u_2 = 0$ m/s.	(J) Velocity of one object after collision $v_1 = -0.4375$ m/s.
(II) Mass of one of the objects is 0.1 kg, mass of the other object is 0.2 kg.	(ii) Velocity of one object before collision is $u_1 = 2$ m/s and velocity of another object before collision is $u_2 = 1$ m/s.	(K) Velocity of one object after collision $v_1 = 0$ m/s
(III) Mass of one of the objects is 1.5 kg, mass of the other object is 1.5 kg.	(iii) Velocity of one object before collision is $u_1 = 2.5$ m/s and velocity of another object before collision is $u_2 = -2.5$ m/s.	(L) Velocity of one object after collision $v_1 = 1.67$ m/s
(IV) Mass of one of the objects is 1 kg, mass of the other object is 5 kg.	(iv) Velocity of one object before collision is $u_1 = 0$ m/s and velocity of another object before collision is $u_2 = 0$ m/s	(M) Velocity of the combined object after collision is 5/3 m/s

In which condition is the total momentum after collision

10 kg m/s ?

A. (I) (ii) (J)

B. (IV) (i) (M)

C. (II) (iii) (K)

D. (I) (i) (L)

Answer: B

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4. In each question, there is a table having 3 columns and 4 rows. Based on the table, there are 3 questions. Each question has 4 options (a), (b), (c) and (d), ONLY ONE of these four options in correct.

Column I	Column II	Column III
(I) Mass of one of the objects is 4 kg, mass of the other object is 0.05 kg.	(i) Velocity of one object before collision is $u_1 = 10$ m/s and velocity of another object before collision is $u_2 = 0$ m/s.	(J) Velocity of one object after collision $v_1 = -0.4375$ m/s.
(II) Mass of one of the objects is 0.1 kg, mass of the other object is 0.2 kg.	(ii) Velocity of one object before collision is $u_1 = 2$ m/s and velocity of another object before collision is $u_2 = 1$ m/s.	(K) Velocity of one object after collision $v_1 = 0$ m/s
(III) Mass of one of the objects is 1.5 kg, mass of the other object is 1.5 kg.	(iii) Velocity of one object before collision is $u_1 = 2.5$ m/s and velocity of another object before collision is $u_2 = -2.5$ m/s.	(L) Velocity of one object after collision $v_1 = 1.67$ m/s
(IV) Mass of one of the objects is 1 kg, mass of the other object is 5 kg.	(iv) Velocity of one object before collision is $u_1 = 0$ m/s and velocity of another object before collision is $u_2 = 0$ m/s.	(M) Velocity of the combined object after collision is 5/3 m/s

In which condition is the velocity of one of the objects after collision 1.165 m/s ?

A. (II) (ii) (J)

B. (III) (iv) (M)

C. (IV) (i) (L)

D. (II) (ii) (L)

Answer: C::D

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5. In the given table, Column I shows masses of the objects, Column II shows the initial and final velocity of the object after force is applied on it and Column III shows the time span for which force is applied on the object.

Column I	Column II	Column III
(I) Mass = 0.5 kg	(i) $u = 50$ m/s, $v = 0$ m/s	(J) $t = 3$ s
(II) Mass = 300 kg	(ii) $u = 25$ m/s, $v = 5$ m/s	(K) $t = 0.23$ s
(III) Mass = 1200 kg	(iii) $u = 20$ m/s, $v = 4$ m/s	(L) $t = 0.01$ s
(IV) Mass = 3.5 kg	(iv) $u = 20$ m/s, $v = 30$ m/s	(M) $t = 4$ s

Conditions for a motorcar with the force of 6000 N applied in opposite direction of motion are :

A. (I) (iii) (L)

B. (II) (ii) (K)

C. (III) (ii) (M)

D. (I) (iii) (J)

Answer: A::C

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6. In the given table, Column I shows masses of the objects, Column II shows the initial and final velocity of the object after force is applied on it and Column III shows the time span for which force is applied on the object.

Column I	Column II	Column III
(I) Mass = 0.5 kg	(i) $u = 50$ m/s, $v = 0$ m/s	(J) $t = 3$ s
(II) Mass = 300 kg	(ii) $u = 25$ m/s, $v = 5$ m/s	(K) $t = 0.23$ s
(III) Mass = 1200 kg	(iii) $u = 20$ m/s, $v = 4$ m/s	(L) $t = 0.01$ s
(IV) Mass = 3.5 kg	(iv) $u = 20$ m/s, $v = 30$ m/s	(M) $t = 4$ s

Conditions for a hammer with the force of 2500 N applied in opposite direction of motion are:

A. (I) (i) (L)

B. (III) (ii) (J)

C. (II) (ii) (K)

D. (III) (i) (M)

Answer: A::B

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7. In the given table, Column I shows masses of the objects, Column II shows the initial and final velocity of the object after force is applied on it and Column III shows the time span for which force is applied on the object.

Column I		Column II		Column III	
(I)	Mass = 0.5 kg	(i)	$u = 50$ m/s, $v = 0$ m/s	(J)	$t = 3$ s
(II)	Mass = 300 kg	(ii)	$u = 25$ m/s, $v = 5$ m/s	(K)	$t = 0.23$ s
(III)	Mass = 1200 kg	(iii)	$u = 20$ m/s, $v = 4$ m/s	(L)	$t = 0.01$ s
(IV)	Mass = 3.5 kg	(iv)	$u = 20$ m/s, $v = 30$ m/s	(M)	$t = 4$ s

Conditions for a dumbbell with the force of 1000 N applied in same direction of motion are :

A. (III) (i) (L)

B. (IV) (i) (K)

C. (I) (iv) (M)

D. (II) (iv) (J)

Answer: C::D

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Practice Questions Integer Type

1. An elevator starts from rest with a constant upward acceleration. It moves 5 m in the first 2 s. A passenger in the elevator is holding a 4 kg package by a vertical string. Find the tension in the string during the acceleration process in N.

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2. Workers are loading equipment into a freight elevator at the top floor of a building. However, they overload the elevator and the worn cable snaps. The mass of the loaded elevator at the time of the accident is 1600 kg. As the elevator falls, the guide rails exert a constant retarding force of 3700 N on the elevator. At what speed does the elevator hit the bottom of the shaft 72 m below?

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3. Three blocks A, B and C of masses 5 kg, 10 kg and 15 kg respectively connected by two ideal strings are present on a smooth horizontal surface. An external horizontal force of 30 N acts on the block A to pull the system. Find the difference in the tensions in strings connecting A and B and, B and C.

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