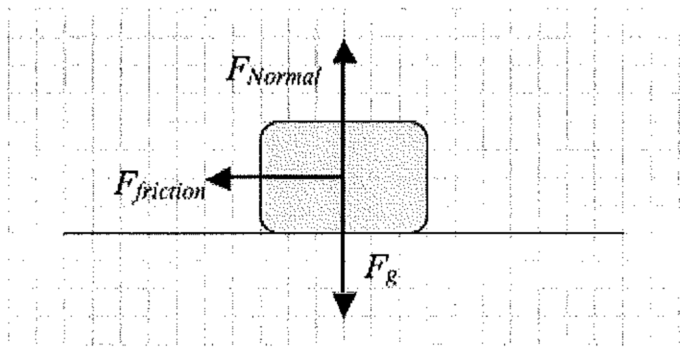
Question:



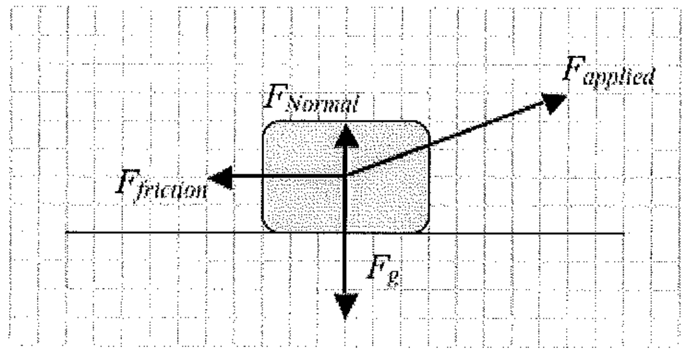
The free-body diagram shows all forces acting on a box supported by a horizontal surface, where the length of each force vector is proportional to its magnitude. Which statement below is correct?

a. The box must be moving to the left, due to the Force of friction acting in that direction.
b. The box must be accelerating to the right, as indicated by the Force of friction in the opposite direction.
c. The box must be moving to the right, as indicated by the Force of friction in the opposite direction.
d. The diagram is drawn incorrectly: there can be no Force of friction unless the box is moving.
e. None of these statements is correct.

Answer:

The correct answer is *c*. The diagram suggests that the box is currently moving to the right, and in the process of slowing down due to a force of friction that is causing it to accelerate in the opposite direction (slowing down the box).

Question:



The free-body diagram shows forces acting on a box supported by a horizontal surface, where the length of each force vector is proportional to its magnitude. Which statement below is correct?

a. The box is accelerating downwards because the force of gravity is greater than the normal force.
b. The box is accelerating to the right, but not upwards.
c. The box is accelerating upwards, but not to the right.
d. The box is accelerating upwards *and* to the right.
e. None of the statements above is correct.

Answer:

The correct answer is *b*. The box has a net force in the positive-x direction, but the forces in the y-direction are balanced.

Question:

A certain elevator with passengers loaded into has a total weight of 10,000 Newtons, or 10 kN, all of which is supported by a strong cable. If the elevator is able to slide up and down without friction, which of the following statements is true?

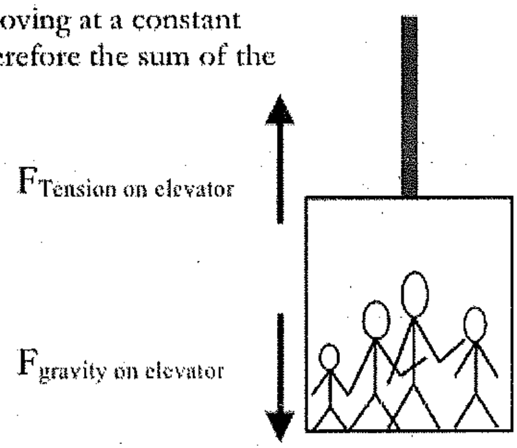
a. When lowering the elevator at a constant speed, the tension in the cable is less than 10 kN.
b. When lowering the elevator at a constant speed, the tension in the cable is greater than 10 kN.
c. When raising the elevator at a constant speed, the tension in the cable is greater than 10 kN.
d. When raising the elevator at a constant speed, the tension in the cable is less than 10 kN.
e. None of the above is true

Answer:

The correct answer is *e*. When the elevator is moving at a constant speed up or down, it is not accelerating, and therefore the sum of the forces acting on the elevator is zero.

$$F_{net} = ma = 0$$

We can calculate the force of tension in the cable, then, by adding its force to the others acting on the elevator:



$$F_{net} = ma$$
$$F_{cable} - F_{gravity} = ma = 0$$
$$F_{cable} = F_{gravity}$$
$$F_{cable} = 10kN$$

Note in the diagram that the forces are equal, *even when the elevator is moving at constant velocity*. It's true that an elevator initially at rest has to be accelerated to begin moving it upwards. At that point the tension in the cable *will* need to be greater than 10kN, but just during the acceleration—once it's moving at a constant velocity, the tension is back to 10kN.

Likewise, if the elevator is initially at rest and then *lowered*, it will be accelerating downwards for a moment and the tension in the cable will be less than 10kN during that time.

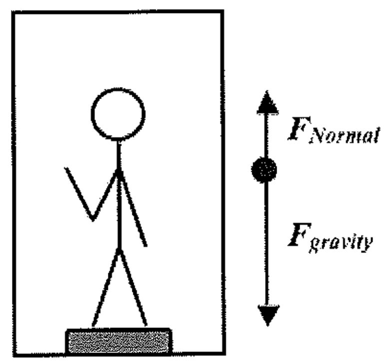
Question:

A person with a weight of 500 Newtons is standing on a spring scale in an elevator, which indicates a force of only 250 Newtons. Which description might explain this situation?

a. The elevator is moving upward at a constant velocity of 5 m/s.
b. The elevator is moving upward, and accelerating downward at 5 m/s^2.
c. The elevator is moving upward, and accelerating upward at 5 m/s^2.
d. The elevator is moving downward, and accelerating upwards at 5 m/s^2.
e. The elevator is moving downward at a constant velocity of 5 m/s.

Answer:

The correct answer is *b*. A free-body diagram of the forces acting on the person includes a weight of 500 N and a Normal force (as measured by the spring scale) of 250 N upwards. We can determine the person's mass as approximately 50 kg:



$$F_g = W = mg$$

$$500N = m(10)$$

$$m = 50kg$$

Then use Newton's Second Law to determine the acceleration.

$$F_{net} = ma$$

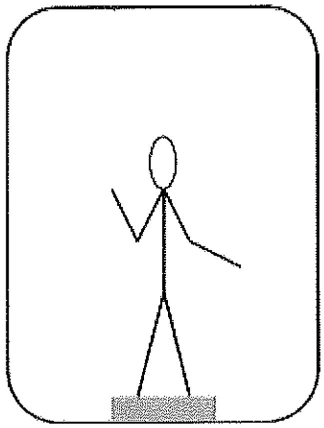
$$F_{Normal} - F_g = ma$$

$$a = \frac{F_{Normal} - F_g}{m} = \frac{250N - 500N}{50kg} = -5m/s^2$$

Thus, the acceleration is 5 m/s^2 downwards. The only one of the possibilities given that fills this requirement is answer *b*.

NOTE: Although answer *b* is the only possibility of the answers given that is correct, there are two other possible answers that weren't listed: the elevator could be moving downward and accelerating downward, and the elevator could be at rest (momentarily), but accelerating downward.

Question:

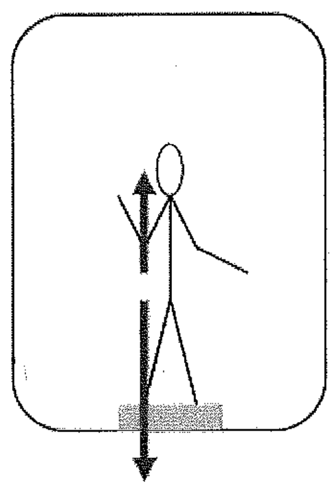


A student with a mass of 50 kg performs an experiment by taking a scale into an elevator, setting it on the floor, and standing on it. At first the scale indicates a weight of about 500 Newtons, but then the elevator starts to accelerate downwards at 4 m/s^2. The weight indicated on the scale during this period of acceleration is

a. still 500 Newtons
b. 200 Newtons
c. 300 Newtons
d. 700 Newtons
e. 400 Newtons

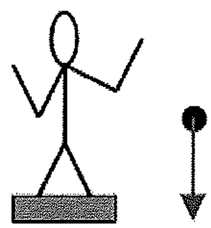
Answer:
The correct answer is *c*. Although the student's weight hasn't changed, her ***apparent weight*** has changed, as indicated by the spring scale. When the elevator begins to accelerate downwards, you can imagine that the scale, because it too is starting to accelerate downwards, pushes up *less* on the student. (You may also imagine that if the elevator were to be freely-falling, the scale couldn't push up on the student at all–in that case, the students apparent weight would be zero.)

To determine exactly what the scale reads, we need to figure out the force that it's pushing up on the student with (sometimes called the *Normal force*). We can anticipate that the net Force is downwards because the acceleration is downwards.



$$F_{net} = ma$$
$$F_{Normal} - F_{gravity} = ma$$
$$F_{Normal} - mg = ma$$
$$F_{Normal} = ma + mg$$
$$F_{Normal} = (50kg)(-4m/s^2) + (50kg)(\sim 10m/s^2)$$
$$F_{Normal} = -200 + 500 = 300N$$

Question:



A person standing on a bathroom scale that is falling downwards, and accelerating at 9.8 m/s^2, sees a value of 0 indicated on the scale. This is because:

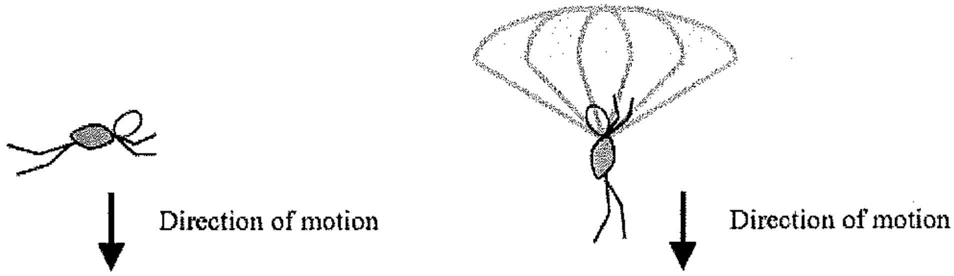
a. the scale must be broken
b. there is no force of gravity acting on the person
c. there is no gravity field acting on the person
d. there is no Normal force acting on the person
e. the person no longer has any mass

Answer:

The correct answer is ***d***. While the Force of gravity continues to act on the person—and is responsible for his or her acceleration downwards—the scale is accelerating downwards too. A bathroom scale can be thought of as measuring the Normal force on the person, which is the force of the floor pushing up on someone in a normal, non-accelerating, bathroom. Here, the floor doesn't push up on the person at all, so it's reasonable to expect that the scale reads zero.

We sometimes refer to an object in this situation as "weightless," although that term certainly doesn't mean that the force of gravity is no longer acting on the object. Perhaps the best way of describing this is to say that the *apparent weight* of the object is zero. The value of such a term is especially useful in situation where the elevator is accelerating down at ½ **g**, or accelerating upwards at some rate. In these cases, the bathroom scale will again indicate some value that doesn't indicate the true Force of gravity (or "weight") of the person, but instead the *apparent weight.*

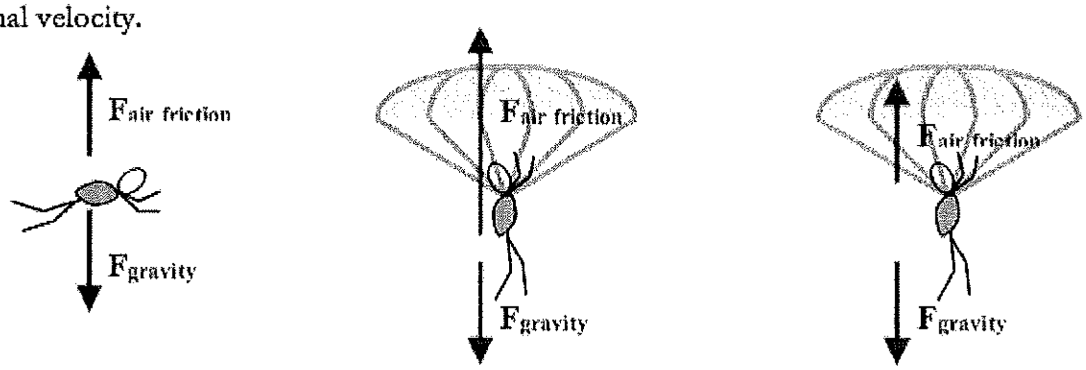
Question:



A skydiver with an unopened parachute is falling at his ***terminal velocity***. When he opens the parachute, which statement is true?

a. As the parachute opens, the net force on the skydiver is still in the downward direction.
b. As the parachute opens, there is an increased force of air friction, but it's less than the force of gravity.
c. As the parachute opens, the skydiver will begin to move upwards.
d. After the skydiver reaches a new terminal velocity, the net force on him is downward.
e. none of the above statements are true.

Answer:
The correct answer is ***e***. The opening of the parachute momentarily increases the force of air friction upwards, causing the skydiver to ***decelerate*** (accelerate in the upward direction) even as he continues to travel downwards–thus, the skydiver is slowing down to a new, smaller, terminal velocity.



At terminal velocity, the net Force is zero.

As parachute opens at high terminal velocity, Force of air friction is momentarily greater than Force of gravity.

Once skydiver as decelerated, Force of air friction and Force of gravity are again the same.

At these terminal velocities, the net Force is always zero, so the object isn't accelerating downwards–it's ***moving*** downwards at constant velocity.

C

Question:

A certain elevator with passengers loaded into has a total weight of 10,000 Newtons, or 10 kN, all of which is supported by a strong cable. If the elevator is able to slide up and down without friction, which of the following statements is true?

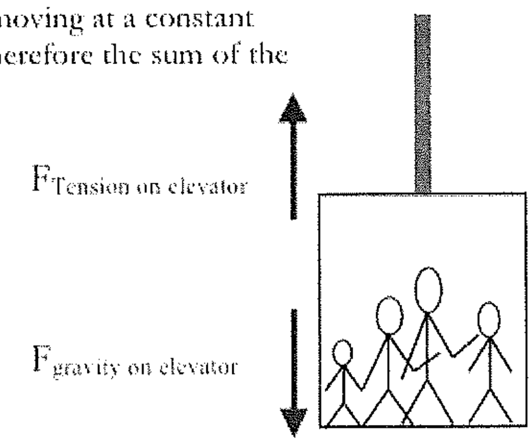
a. When lowering the elevator at a constant speed, the tension in the cable is less than 10 kN.
b. When lowering the elevator at a constant speed, the tension in the cable is greater than 10 kN.
c. When raising the elevator at a constant speed, the tension in the cable is greater than 10 kN.
d. When raising the elevator at a constant speed, the tension in the cable is less than 10 kN.
e. None of the above is true

Answer:

The correct answer is *e*. When the elevator is moving at a constant speed up or down, it is not accelerating, and therefore the sum of the forces acting on the elevator is zero.

$$F_{net} = ma = 0$$

We can calculate the force of tension in the cable, then, by adding its force to the others acting on the elevator:



$$F_{net} = ma$$

$$F_{cable} - F_{gravity} = ma = 0$$

$$F_{cable} = F_{gravity}$$

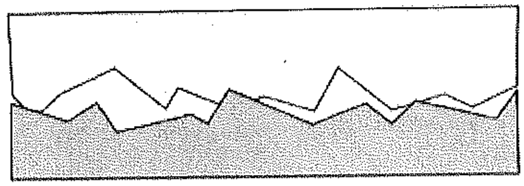
$$F_{cable} = 10kN$$

Note in the diagram that the forces are equal, *even when the elevator is moving at constant velocity*. It's true that an elevator initially at rest has to be accelerated to begin moving it upwards. At that point the tension in the cable *will* need to be greater than 10kN, but just during the acceleration—once it's moving at a constant velocity, the tension is back to 10kN.

Likewise, if the elevator is initially at rest and then *lowered*, it will be accelerating downwards for a moment and the tension in the cable will be less than 10kN during that time.

Question:

Microscopic view of two "smooth" surfaces in contact and sliding against each other.



When two solid objects have surfaces that slide against each other, there is usually a *friction force* between the objects. Which statement is *false* ?

a. The friction force depends on the type of surfaces in contact.
b. The friction force opposes the motion of the objects.
c. The friction force depends in part on how fast the objects are sliding against each other.
d. The friction force does *not* depend on the surface area of the objects.
e. The friction force results from small irregularities in the two surfaces .

Answer:
The correct answer is *c*. The sliding friction force does *not* typically depend on how fast the objects are sliding against each other.

All the other statements are true. Friction force does depend on the type of surfaces: tire rubber on pavements has a much greater friction force than an icy hockey puck on the surface of an ice rink. Friction forces *do* oppose the sliding of the objects. The force of sliding friction does *not* depend on surface area. And the force of sliding friction *is* due to microscopic irregularities in the two surfaces, which cause the "nooks and crannies" of the two surfaces to bump across each other as the objects slide.

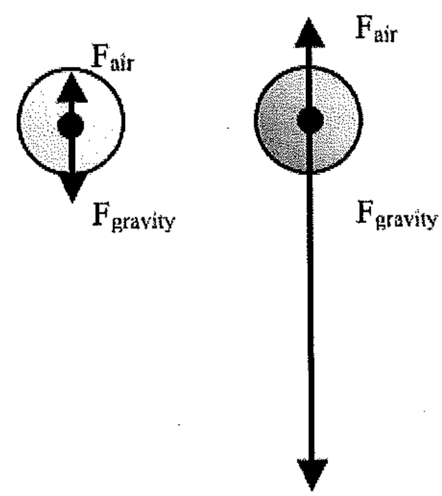
Question:

Two spheres–a light ping-pong ball and a heavy steel sphere, both with the same radius–are released 45 meters above the surface of the earth, at which time they fall through the air. Which of the following statements is true?

a. The light and heavy spheres will both land at the same time because the force of gravity is equal on both of them.
b. The light and heavy spheres will both land at the same time because acceleration is equal for all objects falling through the air.
c. The light and heavy spheres will both land at the same time because they have the same aerodynamic shape.
d. The heavy sphere will land first because it experiences less air friction as it falls.
e. The heavy sphere will land first because it has a greater net force acting on it.

Answer:

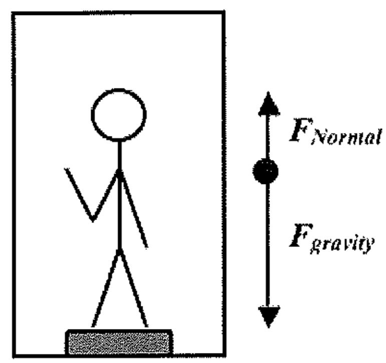
The correct answer is *e*. Two spheres falling in a vacuum would experience the same acceleration and land at the same time, but here, falling through the air, friction is a factor. Air friction varies according to a number of factors depending on how it is modeled, but *velocity* is an important factor. The heavier sphere, as it falls faster and faster, encounters more air molecules at a greater rate, and actually experiences a *greater* force of air friction than the ping-pong ball. However, the heavier sphere also has a greater force of gravity acting on it. Thus, with a greater net force acting on it, the steel sphere lands first.



Question:
A person with a weight of 500 Newtons is standing on a spring scale in an elevator, which indicates a force of only 250 Newtons. Which description might explain this situation?

a. The elevator is moving upward at a constant velocity of 5 m/s.
b. The elevator is moving upward, and accelerating downward at 5 m/s^2.
c. The elevator is moving upward, and accelerating upward at 5 m/s^2.
d. The elevator is moving downward, and accelerating upwards at 5 m/s^2.
e. The elevator is moving downward at a constant velocity of 5 m/s.

Answer:
The correct answer is ***b***. A free-body diagram of the forces acting on the person includes a weight of 500 N and a Normal force (as measured by the spring scale) of 250 N upwards. We can determine the person's mass as approximately 50 kg:



$$F_g = W = mg$$
$$500N = m(10)$$
$$m = 50kg$$

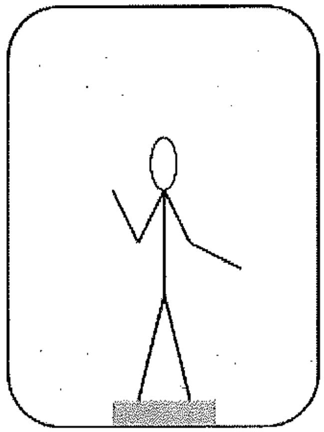
Then use Newton's Second Law to determine the acceleration.

$$F_{net} = ma$$
$$F_{Normal} - F_g = ma$$
$$a = \frac{F_{Normal} - F_g}{m} = \frac{250N - 500N}{50kg} = -5m/s^2$$

Thus, the acceleration is 5 m/s^2 downwards. The only one of the possibilities given that fills this requirement is answer *b*.

NOTE: Although answer *b* is the only possibility of the answers given that is correct, there are two other possible answers that weren't listed: the elevator could be moving downward and accelerating downward, and the elevator could be at rest (momentarily), but accelerating downward.

Question:



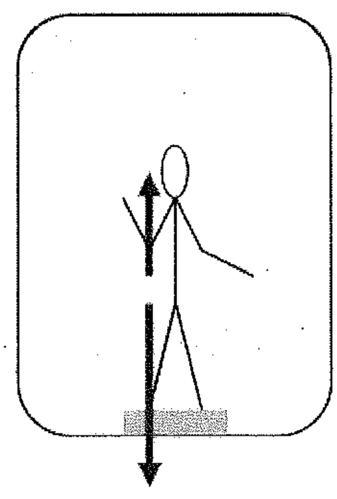
A student with a mass of 50 kg performs an experiment by taking a scale into an elevator, setting it on the floor, and standing on it. At first the scale indicates a weight of about 500 Newtons, but then the elevator starts to accelerate downwards at 4 m/s^2. The weight indicated on the scale during this period of acceleration is

a. still 500 Newtons
b. 200 Newtons
c. 300 Newtons
d. 700 Newtons
e. 400 Newtons

Answer:

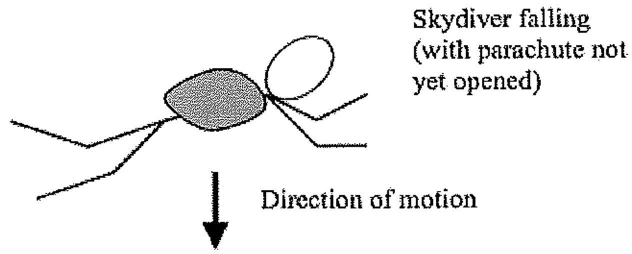
The correct answer is *c*. Although the student's weight hasn't changed, her *apparent weight* has changed, as indicated by the spring scale. When the elevator begins to accelerate downwards, you can imagine that the scale, because it too is starting to accelerate downwards, pushes up *less* on the student. (You may also imagine that if the elevator were to be freely-falling, the scale couldn't push up on the student at all–in that case, the students apparent weight would be zero.)

To determine exactly what the scale reads, we need to figure out the force that it's pushing up on the student with (sometimes called the *Normal force*). We can anticipate that the net Force is downwards because the acceleration is downwards.



$$F_{net} = ma$$
$$F_{Normal} - F_{gravity} = ma$$
$$F_{Normal} - mg = ma$$
$$F_{Normal} = ma + mg$$
$$F_{Normal} = (50kg)(-4m/s^2) + (50kg)(\sim 10m/s^2)$$
$$F_{Normal} = -200 + 500 = 300N$$

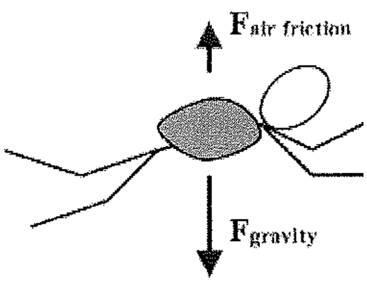
Question:



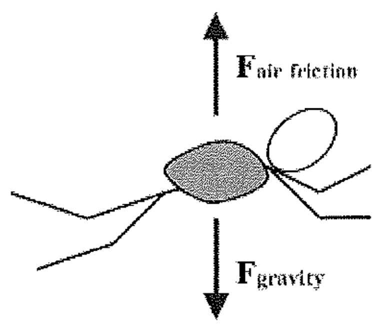
A skydiver who drops from a plane will accelerate downwards for awhile, and then reach a final *terminal velocity*. Which statement is true?

a. At terminal velocity, the skydiver continues to accelerate at 9.8 m/s^2 downwards.
b. At terminal velocity, the skydiver continues to accelerate, but at less than 9.8 m/s^2, due to air friction.
c. At terminal velocity, air friction is no longer a factor in the skydiver's fall.
d. At terminal velocity, the velocity of the skydiver is 0.
e. At terminal velocity, the force of gravity is balanced by the force of air friction.

Answer:
The correct answer is *e*. The skydiver will fall with an initial acceleration of 9.8 m/s^2, but that acceleration will decrease as the force of air friction increases, causing a decreasing net acceleration.



Before terminal velocity
(net Force down, so
accelerating down)



At terminal velocity
(net Force of zero, so no
further acceleration)

Air friction increases as velocity increases, due to an increased number of interactions with the molecules in the air. At *terminal velocity*, the forces of gravity and air friction are balanced, so there is no longer any net force on the skydiver, and thus no net acceleration. The skydiver continues to fall, of course–she just isn't *accelerating*.

Question:

A large object is raised to a height above the earth's surface and released so that it falls, and experiences air friction during its descent. Which of the following statements is correct?

a. Air friction is at a maximum when the ball is first released.
b. Air friction doesn't depend on the shape of the object.
c. An object of the same size and greater mass will experience less air friction.
d. Air friction increases as the object's speed increases.
e. The acceleration of the object is greatest just before it hits the ground.

Answer:

The correct answer is *d*. The drag force of air friction varies according to the velocity of the object through the air, the cross-sectional area exposed to the air, the density of the substance through which it's falling, and its shape, as expressed by a *drag coefficient*. The net force acting on the object (and therefore its acceleration) is greatest when the ball is first released, before air friction has an effect.

Question:

A particle falls through the air, where it experiences a friction force *f* that varies with velocity *v* according to the equation *f*=*bv*, where *b* is a constant value. Which of the following expressions indicates the speed of the object as a function of time *t*?

a. $v = \left(\frac{mg}{b}\right)\left(e^{-bt/m}\right)$

b. $v = \left(\frac{mg}{b}\right)\left(1 - e^{-bt/m}\right)$

c. $v = \left(\frac{b}{mg}\right)\left(e^{-bt/m}\right)$

d. $v = \left(\frac{b}{mg}\right)\left(1 - e^{-bt/m}\right)$

e. $v = \left(\frac{mg}{b}\right)\left(e^{-mt/b}\right)$

Answer:

The correct answer is ***b***. The initial analysis of the forces acting on the falling particle looks like this:

$$F_{net} = ma$$

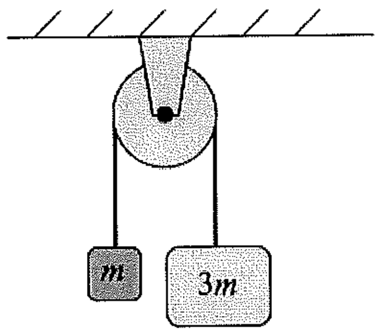
$$F_g - R = ma$$

$$mg - bv = m\frac{dv}{dt}$$

$$\frac{dv}{dt} = g - \frac{bv}{m}$$

The solution to this differential equation is determined by converting it to the equivalent expression $\frac{1}{v - \frac{mg}{b}}dv = -\left(\frac{b}{m}\right)dt$, and integrating the left side with respect to *v* and the right side with respect to *t*. The solution to this integration yields $v = \left(\frac{mg}{b}\right)\left(1 - e^{-bt/m}\right)$.

Question:



Two objects, one of mass *m* and the other of mass 3*m*, are connected by a light string and hung over a frictionless pulley of negligible mass as shown. When the blocks are released from rest, what is the tension in the string connected to the mass *m*?

a. $3mg$

b. $\frac{5}{2}mg$

c. $2mg$

d. $\frac{3}{2}mg$

e. $\frac{5}{4}mg$

Answer:

The correct answer is *d*. The acceleration of the system can be determined by using Newton's Second Law, $\mathbf{F}_{net}=m\mathbf{a}$:

$$\mathbf{F}_{net} = m\mathbf{a}$$

Taking down on the right to be in the positive direction:

$$-\mathbf{F}_m + \mathbf{F}_{3m} = (m + 3m)\mathbf{a}$$

$$-m\mathbf{g} + 3m\mathbf{g} = 4m\mathbf{a}$$

$$2m\mathbf{g} = 4m\mathbf{a}$$

$$\mathbf{a} = \frac{\mathbf{g}}{2}$$

Now use a free-body analysis of mass *m* to determine the tension in the string:

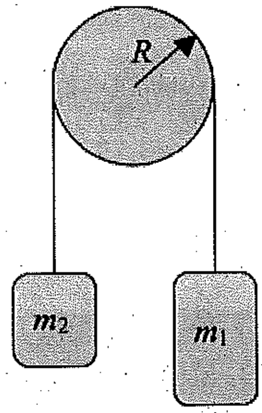
$$\mathbf{F}_{net} = m\mathbf{a}$$

$$T - mg = ma$$

$$T = m\mathbf{a} + m\mathbf{g}$$

$$T = m\left(\frac{\mathbf{g}}{2}\right) + m\mathbf{g} = \frac{3}{2}m\mathbf{g}$$

Question:



Two masses are hung are connected by a light cord and hung from a frictionless pulley of negligible mass as shown. Mass m_1 = 3.00kg, and mass m_2 = 2.00kg. When the two masses are released from rest, the resulting acceleration of the two masses is approximately:

a. 1 m/s²
b. 2 m/s²
c. 4 m/s²
d. 6 m/s²
e. 8 m/s²

Answer:
The correct answer is ***b***. This is a Newton's Second Law problem, using $F_{net} = ma$, where F_{net} = the net force acting on the pulley, and *m* refers to the total mass of the system.

$$F_{net} = ma$$

$$a = \frac{F_{net}}{m}$$

$$a = \frac{F_3 - F_2}{m}$$

$$a = \frac{3kg(g) - 2kg(g)}{(2kg + 3kg)}$$

$$a = \frac{1}{5}g \approx 2m/s^2$$

Question:
Two masses, $M > m$, are connected by a light string hanging over a pulley of negligible mass. When the masses are released from rest, the magnitude of the acceleration of the masses is:

a. $\left(\dfrac{M+m}{M-m}\right)g$

b. $\left(\dfrac{M-m}{M+m}\right)g$

c. $\left(\dfrac{M}{M+m}\right)g$

d. $\left(\dfrac{m}{M+m}\right)g$

e. $\left(\dfrac{M-m}{M}\right)g$

Answer:
The correct answer is *b*. We can analyze this situation by drawing a picture and doing a free-body diagram for each of the two masses, as shown here. Because the pulley has negligible mass, the force of Tension between the two masses is equal (by Newton's 3rd Law), and we can use Newton's 2nd Law to determine the acceleration of the system:

$M: \quad F_{net} = ma = Ma$

$\quad Mg - F_{Tension} = Ma$ (where "down" is positive)

$m: \quad F_{net} = ma$

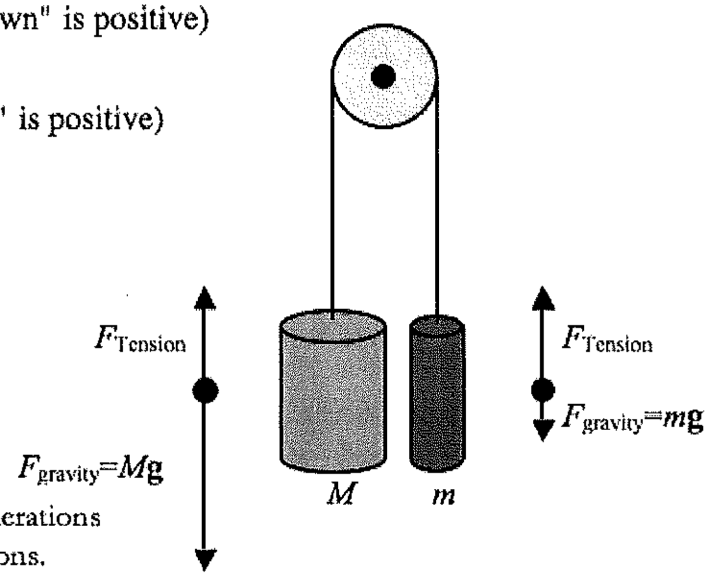
$\quad F_{Tension} - mg = ma$ (where "up" is positive)

Combine equations and solve:

$$Mg - (ma + mg) = Ma$$

$$(M-m)g = (M+m)a$$

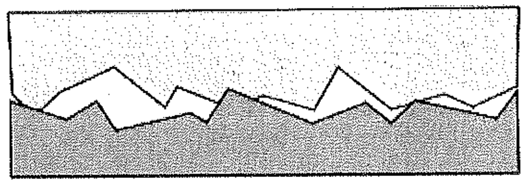
$$a = \left(\frac{M-m}{M+m}\right)g$$



Notice that we have selected different frames of reference for the two masses (for *m*, "up" is positive; for *M*, "down" is positive) so that the accelerations of the masses will have identical directions.
If we don't adjust our analysis to take the different directions into account, we'll get an incorrect result when we combine the two equations.

Question:

Microscopic view of two "smooth" surfaces in contact and sliding against each other.



When two solid objects have surfaces that slide against each other, there is usually a *friction force* between the objects. Which statement is *false* ?

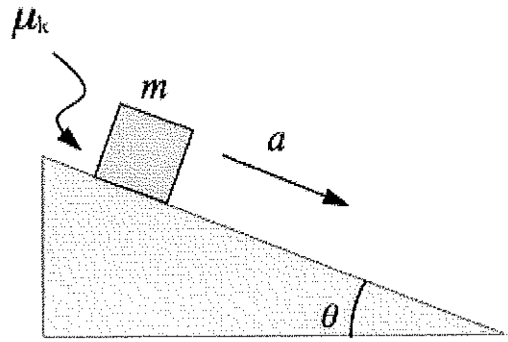
a. The friction force depends on the type of surfaces in contact.
b. The friction force opposes the motion of the objects.
c. The friction force depends in part on how fast the objects are sliding against each other.
d. The friction force does *not* depend on the surface area of the objects.
e. The friction force results from small irregularities in the two surfaces .

Answer:
The correct answer is *c*. The sliding friction force does *not* typically depend on how fast the objects are sliding against each other.

All the other statements are true. Friction force does depend on the type of surfaces: tire rubber on pavements has a much greater friction force than an icy hockey puck on the surface of an ice rink. Friction forces *do* oppose the sliding of the objects. The force of sliding friction does *not* depend on surface area. And the force of sliding friction *is* due to microscopic irregularities in the two surfaces, which cause the "nooks and crannies" of the two surfaces to bump across each other as the objects slide.

C

Question:

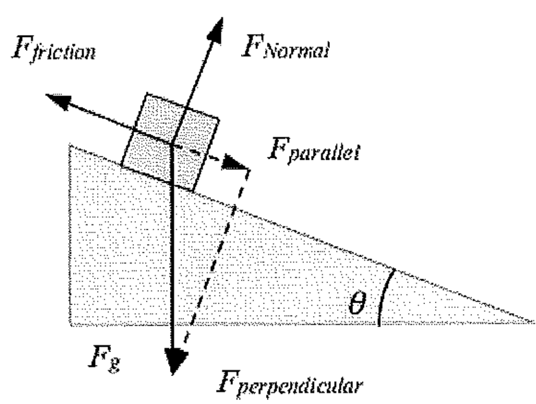


A block of mass m is placed on a plane inclined at an angle θ relative to the horizontal as shown. There is a coefficient of kinetic friction μ_k that acts as the block accelerates down the ramp. The acceleration of the mass m is

a. $mg\sin\theta - mg\cos\theta$
b. $mg\sin\theta - \mu mg\cos\theta$
c. $mg\sin\theta - \mu mg$
d. $g\sin\theta - g\cos\theta$
e. $g\sin\theta - \mu g\cos\theta$

Answer:

The correct answer is *e*. A free-body diagram of the forces acting on the block and an analysis using Newton's Second Law $F_{net} = ma$ yields the answer.



$$x - direction\ (down\ the\ ramp): F_{net} = ma$$
$$F_{parallel} - F_{friction} = ma$$
$$F_{friction} = \mu F_{Normal},\ and\ F_{Normal} = F_{perpendicular} = mg\cos\theta$$
$$mg\sin\theta - \mu mg\cos\theta = ma$$
$$a = g\sin\theta - \mu g\cos\theta$$

Question:

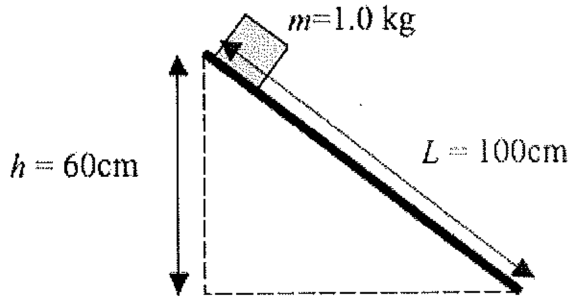
Which of the following sets of quantities affect the magnitude of the frictional force between an object and the surface it's in contact with when the object is on the verge of sliding or is actually sliding?

a. object's mass and the applied force acting on the object
b. μ of the contact materials and the object's mass
c. coefficient of friction of the contact materials and the applied force acting on the object
d. μ of the contact materials and the normal force acting on the object
e. coefficient of friction of the contact materials and the weight of the object

Answer:

d.

Question:

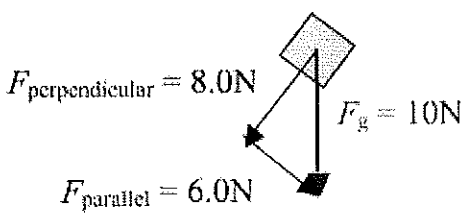


To determine the coefficient of friction between a block of mass 1.0kg and a 100cm long surface, an experimenter places the block on the surface and begins lifting one end. The block just begins to slip when the end of the surface has been lifted 60cm above the horizontal. The static coefficient of friction between the block and the surface is most nearly

a. 0.60
b. 0.75
c. 0.90
d. 1.05
e. 1.20

Answer:

The correct answer is ***b***. The ramp can be thought of as the hypotenuse of a 3-4-5 right triangle, with a corresponding 3-4-5 right triangle as part of the free-body diagram for the block.



The force of friction when the block just begins to slip equal the force $F_{parallel}$, and the normal force F_{Normal} equals the force $F_{perpendicular}$. The coefficient of friction, then, can be calculated:

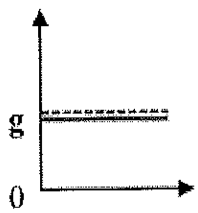
$$\mu = \frac{F_{friction}}{F_{Normal}}$$

$$\mu = \frac{6.0N}{8.0N} = 0.75$$

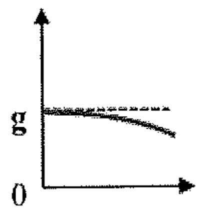
Question:

An object is dropped and accelerates downwards. As it falls it is affected by air friction, but never reaches terminal velocity during the course of its fall. The graph that could indicate the magnitude of the object's acceleration as a function of time is

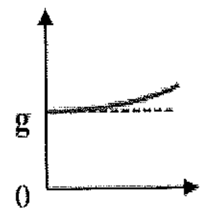
a.



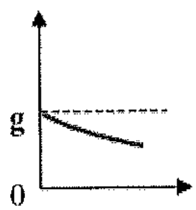
b.



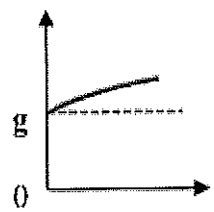
c.



d.



e.

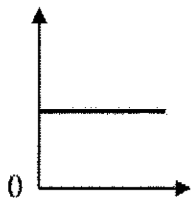


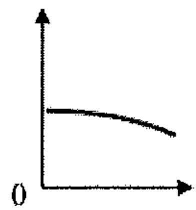
Answer:

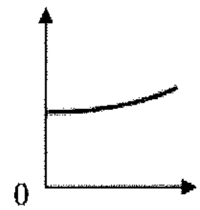
The correct answer is ***d***. The falling object, when released from rest, has an initial acceleration of 9.8 m/s^2 (if near the surface of the earth). As its velocity increases, it collides with air molecules at an increasing rate, thus reducing the rate at which it accelerates. (The acceleration is usually modeled as a function of v or v^2, depending on a number of factors.) The acceleration continues to decrease until the acceleration of the object is 0, at which point the velocity of the falling object remains constant.

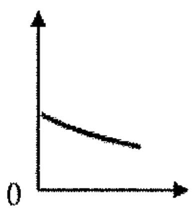
The only graph consistent with this analysis is *d*, where the acceleration curve can be seen to be approaching zero asymptotically.

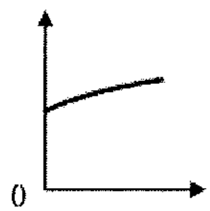
Question:
An object is dropped and accelerates downwards. As it falls it is affected by air friction, but never reaches terminal velocity during the course of its fall. The graph that could indicate the magnitude of the object's velocity as a function of time is

a.


b.


c.


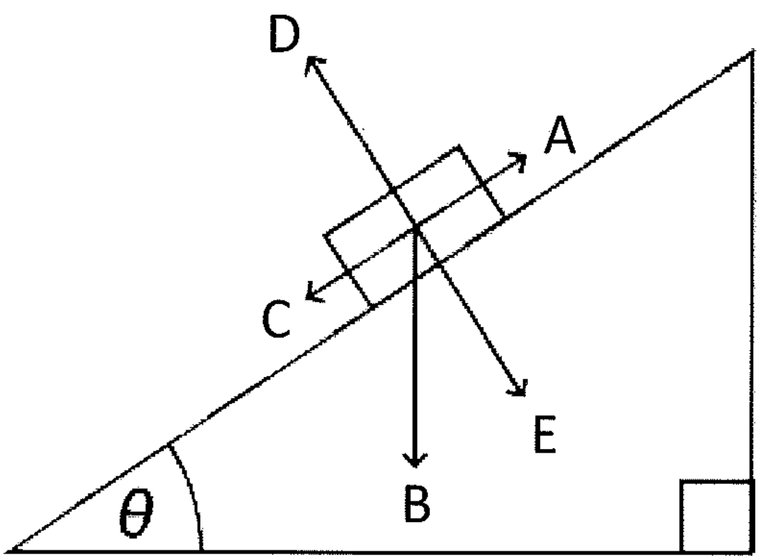
d.


e.


Answer:
The correct answer is ***e***. As the falling object accelerates, its velocity continues to increase until its velocity reaches a constant, terminal, velocity, at which point the velocity function will be a straight, flat line. The only curve that shows an increase in velocity, approaching a slope of zero, is answer ***e***.

Question:

In the diagram below, an object is at rest on an incline tilted at a certain angle θ. The free-body diagram of the object is included with the force vectors shown. Which letter sequence correctly represents the forces acting on the object in its state of rest on the incline?



a. A – mg sinΘ
B – mg cosΘ
C – mg
D– F_n
E – F_f

b. A – mg cosΘ
B – mg
C – F_f
D– F_n
E – mg sinΘ

c. A – F_f
B – mg
C – mg cosΘ
D– F_n
E – mg sinΘ

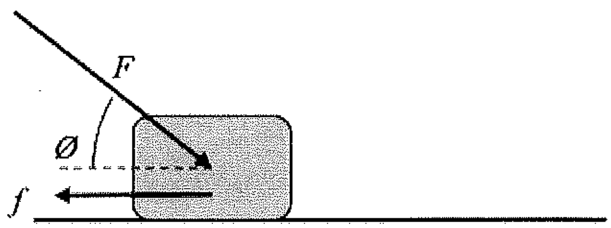
d. A – F_f
B – mg
C – mg sinΘ
D– F_n
E – mg cosΘ

e. none

Answer:

d.

Question:



A block of mass *m* is pushed across a rough surface by an applied force *F*, directed at an angle Ø relative to the horizontal as shown above. The block experiences an acceleration *a* in the +*x* direction. What is the magnitude of the friction force *f* that opposes the block's motion?

a. ma
b. $F\sin\phi + ma$
c. $F\sin\phi - ma$
d. $F\cos\phi + ma$
e. $F\cos\phi - ma$

Answer:
The correct answer is *e*. The friction force can be determined by applying Newton's Second Law $F_{net}=ma$ in the *x*-direction.

$$\sum F_x = ma$$

$$F_{applied-x} - f = ma$$

$$F\cos\phi - f = ma$$

$$f = F\cos\phi - ma$$

Question:

A ball attached to a string is whirled around in a horizontal circle having a radius **r**. If the radius of the circle is changed to **4r** and the same tension centripetal force $\mathbf{F_c}$ is applied by the string, the new speed of the ball is which of the following?

(A) One-quarter the original speed
(B) One-half the original speed
(C) The same as the original speed
(D) Twice the original speed
(E) Four times the original speed

Answer:

D

Question:

Which of the following statements concerning circular motion is correct?

I. **The change of velocity ΔV of an object moving in a circle at constant speed is always directed toward the circle's center.**

II. **An object moving in uniform circular motion is constantly being accelerated toward the circle's center.**

III. **A centripetal force is necessary for circular motion and counteracts an object's inertial tendency to move away from the circular path along a tangent direction.**

a. I only

b. II only

c. I and II

d. II and III

e. I, II and III

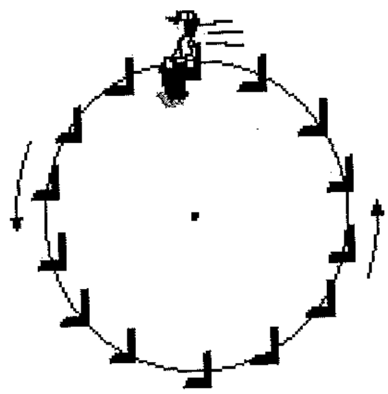
Answer:

e.

Question:

A person riding a Ferris wheel is strapped into her seat by a seat belt. The wheel is spun so that the centripetal acceleration is g. Select the correct combination of forces that act on her when she is at the top. In the table Fg = force of gravity, down; Fb = seat belt force, down; and Fs = seat force, up.

	F_g	F_b	F_s
A.	0	mg	0
B.	mg	0	0
C.	0	0	mg
D.	mg	mg	0
E.	mg	0	mg

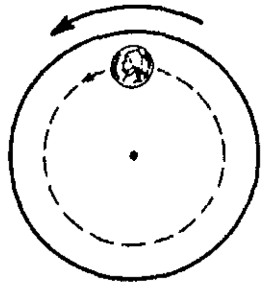


Answer:

B. Gravity continues to act downward at the top. Both the applied force from the seat belt and the normal force from the seat are zero since the acceleration is equal to ***g***. The rider's weight provides all the necessary inward centripetal force at the top point.

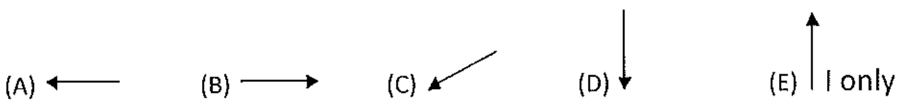
AP1

Question:



View from Above

The horizontal turntable shown above rotates in a circular path and as viewed from above. The coin on the turntable moves counterclockwise in the circle as shown. Below are possible directions of forces acting on the coin at the point shown.

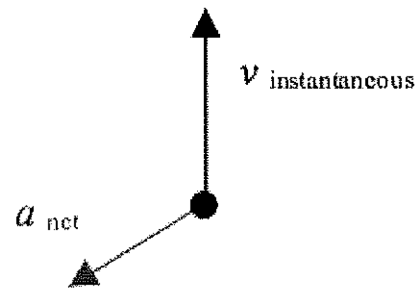


a. Which vector shows the force responsible for the coin's speed change if it is slowing down?
b. Which vector shows the force responsible for the coin's speed change if it is speeding up?
c. Which vector shows the net force responsible if the coin is speeding up?
d. Which vectors shows the force responsible for changing the coins direction?

Answer:

B, A, C, D

Question:

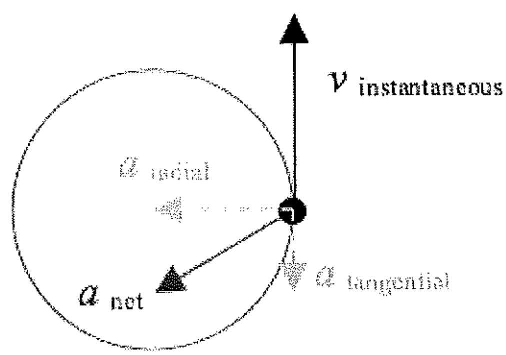


The instantaneous velocity and net acceleration for an object moving in a circular path are shown above. At this moment in time, the object is

a. speeding up in a clockwise circle
b. slowing down in a clockwise circle
c. speeding up in a counterclockwise circle
d. slowing down in a counterclockwise circle
e. traveling in a clockwise circle at constant speed

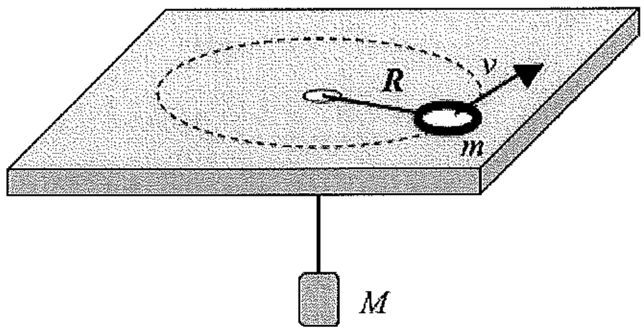
Answer:

The correct answer is *d*. The instantaneous velocity of the object is tangent to its circular path, and we know that there's a radial (centripetal) aspect of the net acceleration that points towards the center of the circular path. Thus, we can conclude that the object is traveling in a circular path that is located to its left, as shown here.



We can also see that the net acceleration must include a tangential component of acceleration that is in the opposite direction of the instantaneous velocity, implying that the object is slowing down as it travels along this circular path.

Question:



A disk of mass *m* is placed on a frictionless table, and attached to a vertically-hanging mass *M* by a string that passes through a frictionless opening in the surface. The disk is given a speed *v* so that it travels in a circle with a constant radius R. What is the speed *v* of the disk's motion?

a. $\sqrt{\frac{RMg}{m}}$

b. $\sqrt{Rg}$

c. $\sqrt{\frac{Rmg}{M}}$

d. $\sqrt{\frac{R}{m}}$

e. none of these

Answer:
The correct answer is *a*. The force of gravity acting on the hanging mass *M* supplies a centripetal force that keeps the disk *m* moving in a circle with constant radius and velocity.

$$F_c = \frac{mv^2}{r}$$

$$F_g = \frac{mv^2}{r}$$

$$Mg = \frac{mv^2}{R}$$

$$v = \sqrt{\frac{RMg}{m}}$$

Question:

Which of the following statements concerning the non-uniform circular motion of an object is correct?

- **I.** **The net force acting on the ~~on the~~ object is the centripetal force.**
- **II.** **The centripetal acceleration causes a change in the object's speed as moves along the circular path.**
- **III.** **The object could either be speeding up or slowing down along the circular path.**

a. I only
b. II only
c. III only
d. I and III only
e. I, II and III

Answer:

c.