A large truck collides head-on with a small compact car. During the collision:

(A) the truck exerts a greater amount of force on the car than the car exerts on the truck.

(B) the car exerts a greater amount of force on the truck than the truck exerts on the car.

(C) neither exerts a force on the other, the car gets smashed simply because it gets in the way of the truck.

(D) the truck exerts a force on the car but the car does not exert a force on the truck.

(E) the truck exerts the same amount of force on the car as the car exerts on the truck.
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(C) neither exerts a force on the other, the car gets smashed simply because it gets in the way of the truck.

(D) the truck exerts a force on the car but the car does not exert a force on the truck.

(E) the truck exerts the same amount of force on the car as the car exerts on the truck.
An elevator is being lifted up an elevator shaft at a constant speed. All frictional effects are negligible. In this situation, forces on the elevator are such that:

(A) the upward force by the cable is greater than the downward force of gravity.

(B) the upward force by the cable is equal to the downward force of gravity.

(C) the upward force by the cable is smaller than the downward force of gravity.

(D) the upward force by the cable is greater than the sum of the downward force of gravity and a downward force due to the air.

(E) none of the above. (The elevator goes up because the cable is being shortened, not because an upward force is exerted on the elevator by the cable.)
An elevator is being lifted up an elevator shaft at a constant speed. All frictional effects are negligible. In this situation, forces on the elevator are such that:

(A) the upward force by the cable is greater than the downward force of gravity.

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(C) the upward force by the cable is smaller than the downward force of gravity.

(D) the upward force by the cable is greater than the sum of the downward force of gravity and a downward force due to the air.

(E) none of the above. (The elevator goes up because the cable is being shortened, not because an upward force is exerted on the elevator by the cable.)
Two metal balls are the same size but one weighs twice as much as the other. The balls are dropped from the roof of a single story building at the same instant of time. The time it takes the balls to reach the ground below will be:

(A) about half as long for the heavier ball as for the lighter one.
(B) about half as long for the lighter ball as for the heavier one.
(C) about the same for both balls.
(D) considerably less for the heavier ball, but not necessarily half as long.
(E) considerably less for the lighter ball, but not necessarily half as long.
Two metal balls are the same size but one weighs twice as much as the other. The balls are dropped from the roof of a single story building at the same instant of time. The time it takes the balls to reach the ground below will be:

(A) about half as long for the heavier ball as for the lighter one.

(B) about half as long for the lighter ball as for the heavier one.

(C) about the same for both balls.

(D) considerably less for the heavier ball, but not necessarily half as long.

(E) considerably less for the lighter ball, but not necessarily half as long.
Two speedboats are moving on a lake. Boat A goes from traveling 15 m/s east to 20 m/s north in 10 seconds. Boat B goes from 10 m/s west to 15 m/s west in 10 seconds. Which of the following is (are) true for the average acceleration of the boats ($a_A$ and $a_B$) in the 10-second interval described here?

A. $a_A$ has the same magnitude as $a_B$, but not the same direction.
B. $a_A$ has a greater magnitude than $a_B$.
C. $a_A$ has a smaller magnitude than $a_B$.
D. $a_A$ has the same magnitude as $a_B$, and they are in the same direction.
E. $a_A$ is vertical and $a_B$ is horizontal.
Two speedboats are moving on a lake. Boat A goes from traveling 15 m/s east to 20 m/s north in 10 seconds. Boat B goes from 10 m/s west to 15 m/s west in 10 seconds. Which of the following is (are) true for the average acceleration of the boats ($a_A$ and $a_B$) in the 10-second interval described here?

A. $a_A$ has the same magnitude as $a_B$, but not the same direction.
B. $a_A$ has a greater magnitude than $a_B$.
C. $a_A$ has a smaller magnitude than $a_B$.
D. $a_A$ has the same magnitude as $a_B$, and they are in the same direction.
E. $a_A$ is vertical and $a_B$ is horizontal.
A truck is originally driving north. It slows down as it turns a corner, as shown in the top-view drawing. At point B, the truck is driving west. Which of the following statements is (are) CORRECT about the average acceleration $a_{\text{ave}}$ of the truck between A and B?

A. $a_{\text{ave}}$ points NorthEast because of the centrifugal force.
B. $a_{\text{ave}}$ points SouthWest because of the centripetal force.
C. $a_{\text{ave}}$ points East because the truck slows down.
D. $a_{\text{ave}}$ points South because the truck slows down.
E. We need more information to know the exact direction of $a_{\text{ave}}$. 
A truck is originally driving north. It slows down as it turns a corner, as shown in the top-view drawing. At point B, the truck is driving west. Which of the following statements is (are) CORRECT about the average acceleration $a_{ave}$ of the truck between A and B?

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D. $a_{ave}$ points South because the truck slows down.
E. We need more information to know the exact direction of $a_{ave}$.
A 0.5-kg ball is suspended from a ceiling by two strings. The ball is at rest. How does the tension in string 1 compare to the tension in string 2?

a) The tension in string 1 is greater than the tension in string 2.

b) The tension in string 1 is twice the tension in string 2, and is equal to ½ the weight of the ball.

c) The tension in string 1 is equal to the tension in string 2

d) The tension in string 1 is less then the tension in string 2.

e) It is impossible to know how the tensions compare without being given the length of each rope.
A 0.5-kg ball is suspended from a ceiling by two strings. The ball is at rest. How does the tension in string 1 compare to the tension in string 2?

a) The tension in string 1 is greater than the tension in string 2.
b) The tension in string 1 is twice the tension in string 2, and is equal to \( \frac{1}{2} \) the weight of the ball.

c) The tension in string 1 is equal to the tension in string 2

d) The tension in string 1 is less than the tension in string 2.

e) It is impossible to know how the tensions compare without being given the length of each rope.
A gymnast weighing 500 N is suspended by two ropes from the ceiling as shown. The gymnast is at rest. Which of the following statements about the magnitude of the tension in the rope on the left are correct?

a) The tension is equal to 250 N.

b) The tension is greater than 250 N.

c) The tension is less than 250 N.

d) It is impossible to know anything about the tension in either rope without knowing the angles from the ceiling.

e) It is impossible to know anything about the tension in either rope without knowing the length of the ropes.
A gymnast weighing 500 N is suspended by two ropes from the ceiling as shown. The gymnast is at rest. **Which of the following statements about the magnitude of the tension in the rope on the left are correct?**

a) The tension is equal to 250 N.

b) The tension is greater than 250 N.

c) The tension is less than 250 N.

d) It is impossible to know anything about the tension in either rope without knowing the angles from the ceiling.

e) It is impossible to know anything about the tension in either rope without knowing the length of the ropes.
A boy throws a steel ball straight up. Consider the motion of the ball only after it has left the boy's hand but before it touches the ground, and assume that forces exerted by the air are negligible. For these conditions, the force(s) acting on the ball is (are):

(A) a downward force of gravity along with a steadily decreasing upward force.

(B) a steadily decreasing upward force from the moment it leaves the boy's hand until it reaches its highest point; on the way down there is a steadily increasing downward force of gravity as the object gets closer to the earth.

(C) an almost constant downward force of gravity along with an upward force that steadily decreases until the ball reaches its highest point; on the way down there is only a constant downward force of gravity.

(D) an almost constant downward force of gravity only.

(E) none of the above. The ball falls back to the ground because of its natural tendency to rest on the surface of the earth.
A boy throws a steel ball straight up. Consider the motion of the ball only after it has left the boy's hand but before it touches the ground, and assume that forces exerted by the air are negligible. For these conditions, the force(s) acting on the ball is (are):

(A) a downward force of gravity along with a steadily decreasing upward force.

(B) a steadily decreasing upward force from the moment it leaves the boy's hand until it reaches its highest point; on the way down there is a steadily increasing downward force of gravity as the object gets closer to the earth.

(C) an almost constant downward force of gravity along with an upward force that steadily decreases until the ball reaches its highest point; on the way down there is only a constant downward force of gravity.

(D) an almost constant downward force of gravity only.

(E) none of the above. The ball falls back to the ground because of its natural tendency to rest on the surface of the earth.
The figures below show six identical curling stones (the playing pieces in the sport of curling) that are being pushed horizontally along the ice by the thrower. For each stone, the instantaneous velocity and acceleration of the stones are given. The positive direction is to the right. Assume the ice is frictionless for the curling stones. **Rank these stones on the basis of the magnitude of the force the thrower is exerting on them at the instant shown.**

1. C, F, A, D = E, B
2. F, D = C, B, A = E
3. F, C, D, A = B, E
4. C = F, A = D, B = E
5. A = C = F, B = D = F
The figures below show six identical curling stones (the playing pieces in the sport of curling) that are being pushed horizontally along the ice by the thrower. For each stone, the instantaneous velocity and acceleration of the stones are given. The positive direction is to the right. Assume the ice is frictionless for the curling stones. Rank these stones on the basis of the magnitude of the force the thrower is exerting on them at the instant shown, from SMALLEST to LARGEST

1. C,F,A,D=E,B
2. F,D=C,B,A=E
3. F,C,D,A=B,E
4. C=F,A=D,B=E
5. A=C=F,B=D=F
In each of the six figures below, a cart that has a motor and brakes is traveling either up or down an incline at a constant speed. The carts are identical but they carry either a 2 kg or 4 kg load and are on one of two inclines. Incline angles, cart masses, and speeds are given in each figure. **Rank these situations on the basis of the magnitude of the net force acting on the cart.**

1. A, C, B, D, F, E
2. A = B = C = D = E = F
3. A = E, C = F, B, C
5. A = C, B = D, E = F
In each of the six figures below, a cart that has a motor and brakes is traveling either up or down an incline at a constant speed. The carts are identical but they carry either a 2 kg or 4 kg load and are on one of two inclines. Incline angles, cart masses, and speeds are given in each figure. Rank these situations on the basis of the magnitude of the net force acting on the cart.

1. A,C,B,D,F,E
2. A=B=C=D=E=F
3. A=E,C=F,B,C
5. A=C,B=D,E=F
The figures below show systems containing a block initially held at rest on a frictionless surface. In each system, the block is attached to the end of a spring, which is stretched to the right. The mass and spring constant are given for each system, as well as the distance the spring is initially stretched. When the mass is released, the spring will accelerate the block.

**Which block will experience the greatest acceleration?**
The figures below show systems containing a block initially held at rest on a frictionless surface. In each system, the block is attached to the end of a spring, which is stretched to the right. The mass and spring constant are given for each system, as well as the distance the spring is initially stretched. When the mass is released, the spring will accelerate the block.

**Which block will experience the greatest acceleration?**
The figures below show systems containing a block initially held at rest on a frictionless surface. In each system, the block is attached to the end of a spring, which is stretched to the right. The mass and spring constant are given for each system, as well as the distance the spring is initially stretched. When the mass is released, the spring will accelerate the block.

Which block will experience the smallest acceleration?

A

![Diagram A]

5 N/m

0.4 m

1 kg

B

![Diagram B]

5 N/m

0.2 m

2 kg

C

![Diagram C]

4 N/m

0.2 m

5 kg

D

![Diagram D]

1 N/m

0.5 m

1 kg

E

![Diagram E]

4 N/m

0.5 m

4 kg

F

![Diagram F]

1 N/m

0.5 m

5 kg
The figures below show systems containing a block initially held at rest on a frictionless surface. In each system, the block is attached to the end of a spring, which is stretched to the right. The mass and spring constant are given for each system, as well as the distance the spring is initially stretched. When the mass is released, the spring will accelerate the block.

Which block will experience the smallest acceleration?
Shown below are boxes that are being pulled by ropes along frictionless surfaces, accelerating toward the left. All of the boxes are identical, and the accelerations of the boxes are indicated in each figure. **Rank the magnitude of the tension in these ropes.**

A. \( B > A = D > C = E > F \)

B. \( A > B = C > D = E = F \)

C. \( B > A > D > C > E > F \)

D. \( A = B = C = D = E = F \)

E. Can not be determined with the information given
Shown below are boxes that are being pulled by ropes along frictionless surfaces, accelerating toward the left. All of the boxes are identical, and the accelerations of the boxes are indicated in each figure. **Rank the magnitude of the tension in these ropes.**

A. $B > A = D > C = E > F$
B. $A > B = C > D = E = F$
C. $B > A > D > C > E > F$
D. $A = B = C = D = E = F$
E. Can not be determined with the information given
A 1kg object is moving at a constant velocity of 3 m/s. Its FBD is shown below. Which of the following describes this motion?

1. \[ F_1 + F_2 + F_3 = 0 \]
   \[ F_2 \cos 30\degree + F_1 \cos 45\degree = 0 \]

2. \[ F_1 \sin 45\degree + F_2 \sin 30\degree - F_3 = 0 \]
   \[-F_2 \cos 30\degree + F_1 \cos 45\degree = 0 \]

3. \[ F_1 \sin 45\degree + F_2 \sin 30\degree - F_3 = (1 \text{ kg})(3 \text{ m/s}) \]
   \[-F_2 \cos 30\degree + F_1 \cos 45\degree = (1 \text{ kg})(3 \text{ m/s}) \]

4. \[ F_1 + F_2 + F_3 = (1 \text{ kg})(3 \text{ m/s}) \]
   \[ F_2 \cos 30\degree + F_1 \cos 45\degree = (1 \text{ kg})(3 \text{ m/s}) \]

5. \[ F_1 \sin 45\degree + F_2 \sin 30\degree - F_3 - F_2 \cos 30\degree = 0 \]
A 1 kg object is moving at a **constant velocity** of 3 m/s. Its FBD is shown below. Which of the following describes this motion?

1. \( F_1 + F_2 + F_3 = 0 \)
   \[ F_2 \cos 30^\circ + F_1 \cos 45^\circ = 0 \]

2. \( F_1 \sin 45^\circ + F_2 \sin 30^\circ - F_3 = 0 \)
   \[ -F_2 \cos 30^\circ + F_1 \cos 45^\circ = 0 \]

3. \( F_1 \sin 45^\circ + F_2 \sin 30^\circ - F_3 = (1 \text{ kg})(3 \text{ m/s}) \)
   \[ -F_2 \cos 30^\circ + F_1 \cos 45^\circ = (1 \text{ kg})(3 \text{ m/s}) \]

4. \( F_1 + F_2 + F_3 = (1 \text{ kg})(3 \text{ m/s}) \)
   \[ F_2 \cos 30^\circ + F_1 \cos 45^\circ = (1 \text{ kg})(3 \text{ m/s}) \]

5. \( F_1 \sin 45^\circ + F_2 \sin 30^\circ - F_3 - F_2 \cos 30^\circ = 0 \)
A block is given a push and then slides up a plane that make an incline of $\theta$ with the horizontal axis. There is friction between the block and plane that can not be neglected. The magnitude of the acceleration of the block is

1. $g$
2. $gsin \theta$
3. $gcos \theta$
4. larger than $gsin \theta$
5. smaller than $gsin \theta$
Rifles are fired horizontally from platforms at various heights. The bullets fired from these rifles are identical, but they leave the rifle barrels at different speeds as shown in the diagrams.

Rank the following scenarios according to how long the bullet is in air before it hits the ground.

a.)  $C > B > D > A > E > F$

b.)  $B > C > D > F > E > A$

c.)  $A > E > C > D > F > B$

d.)  $B = C > D > A = E = F$

e.)  $A > E > C = D = F > B$
Rifles are fired horizontally from platforms at various heights. The bullets fired from these rifles are identical, but they leave the rifle barrels at different speeds as shown in the diagrams.

Rank the following scenarios according to how long the bullet is in air before it hits the ground.

a.) $C > B > D > A > E > F$

b.) $B > C > D > F > E > A$

c.) $A > E > C > D > F > B$

d.) $B = C > D > A = E = F$

e.) $A > E > C = D = F > B$
A baseball is thrown from point S in right field to home plate. The dashed line in the diagram shows the path of the ball. For this exercise, use a coordinate system with up as the positive vertical direction and to the left as the positive horizontal direction, and with the origin at home plate.

Select the best choice from the answers below.

A) The horizontal velocity vs. time graph is B, and the vertical velocity vs. time graph is I.
B) The horizontal velocity vs. time graph is A, and the vertical velocity vs. time graph is H.
C) The horizontal acceleration vs. time graph is C, and the vertical acceleration vs. time graph is B.
D) The horizontal acceleration vs. time graph is C, and the vertical acceleration vs. time graph is I.
E) None of the answers above are correct.
A baseball is thrown from point $S$ in right field to home plate. The dashed line in the diagram shows the path of the ball. For this exercise, use a coordinate system with up as the positive vertical direction and to the left as the positive horizontal direction, and with the origin at home plate.

Select the best choice from the answers below.

A) The horizontal velocity vs. time graph is B, and the vertical velocity vs. time graph is I.

B) The horizontal velocity vs. time graph is A, and the vertical velocity vs. time graph is H.

C) The horizontal acceleration vs. time graph is C, and the vertical acceleration vs. time graph is B.

D) The horizontal acceleration vs. time graph is C, and the vertical acceleration vs. time graph is I.

E) None of the answers above are correct.
Two toy trucks roll off the ends of tables. The heights of the tables, the speeds of the trucks, and the masses of the trucks are given. Which is correct?

A. Truck A will be in the air for a LONGER amount of time than truck B
B. Truck A will be in the air for the SAME amount of time as truck B
C. Truck A will be in the air for a SHORTER amount of time than truck B
D. Can not be determined with the information provided
Two toy trucks roll off the ends of tables. The heights of the tables, the speeds of the trucks, and the masses of the trucks are given. Which is correct?

A. Truck A will be in the air for a LONGER amount of time than truck B
B. Truck A will be in the air for the SAME amount of time as truck B
C. Truck A will be in the air for a SHORTER amount of time than truck B
D. Can not be determined with the information provided