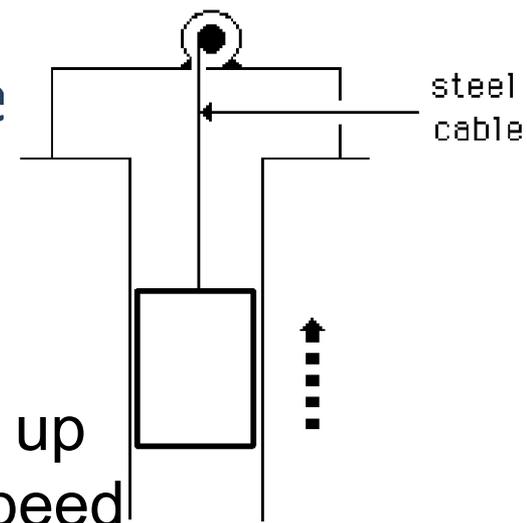


2/5/14

Chapter 4 – Forces and Newton's
Laws of Motion

An elevator is being lifted up an elevator shaft at a constant speed by a steel cable as shown in the figure below. All frictional effects including air resistance 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. none of the above.



Elevator going up
at a constant speed

Newton's First Law

Consider an object with no force acting on it.

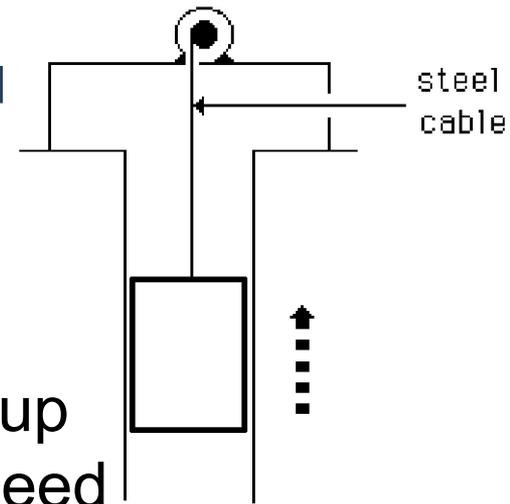
If it is at rest, it will remain at rest;

If it is moving, it will continue to move in a straight line at a constant speed.

The natural state of an object - its behavior if free of external influences - is *uniform motion with constant velocity!*

An elevator is being lifted up an elevator shaft at a constant speed by a steel cable as shown in the figure below. All frictional effects including air resistance 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.
- A. none of the above.



Elevator going up
at a constant speed

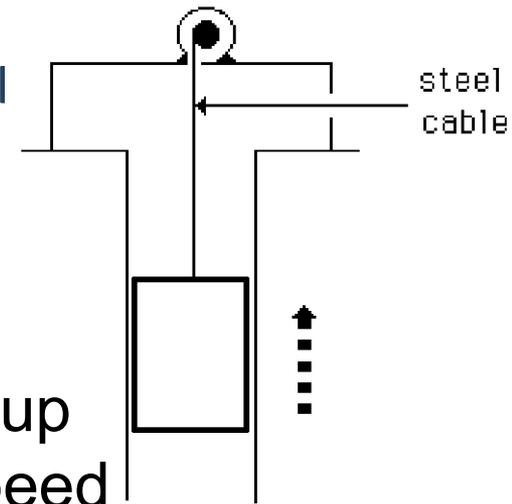
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A. none of the above.



Elevator going up
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If it is at rest, it will remain at rest;

If it is moving, it will continue to move in a straight line at a constant speed.

The natural state of an object - its behavior if free of external influences - is *uniform motion* with constant velocity!

At rest is $v = 0$



A large box is pulled with a constant horizontal force. As a result, the box moves across a level floor at a constant speed.

The pull:

- A. has the same magnitude as the weight of the box.
- B. is greater than the weight of the box.
- C. has the same magnitude as the total force which resists the motion of the box.
- D. is greater than the total force which resists the motion of the box.
- E. is greater than either the weight of the box or the total force which resists its motion.

A large box is pulled with a constant horizontal force. As a result, the box moves across a level floor at a **constant speed**.

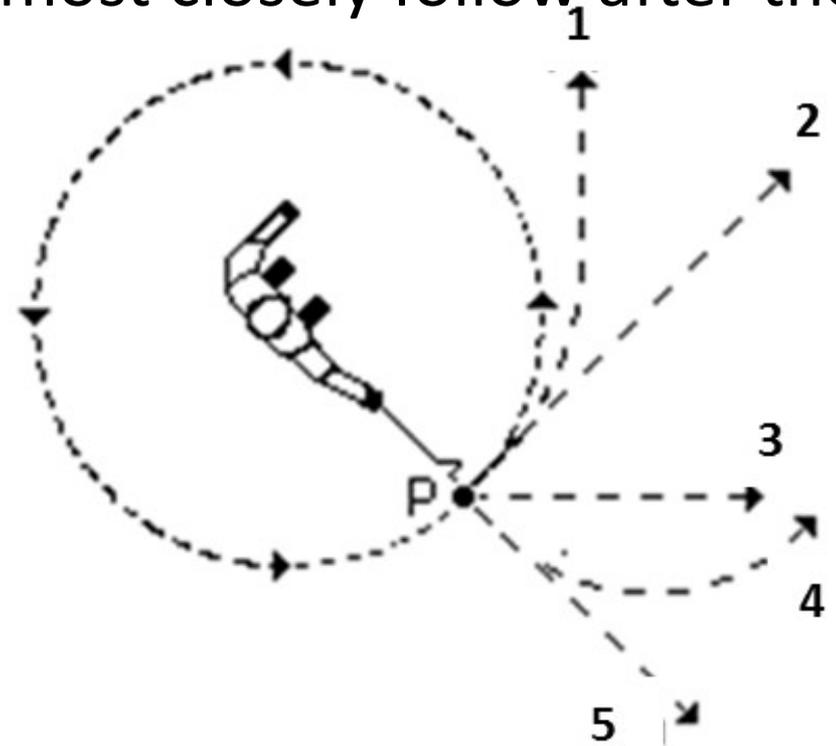
The pull:

- A. has the same magnitude as the weight of the box.
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- E. is greater than either the weight of the box or the total force which resists its motion.

A steel ball is attached to a string and is swung in a circular path in a horizontal plane as illustrated in the accompanying figure.

At the point P indicated in the figure, the string suddenly breaks near the ball.

If these events are observed from directly above as in the figure, which path would the ball most closely follow after the string breaks?



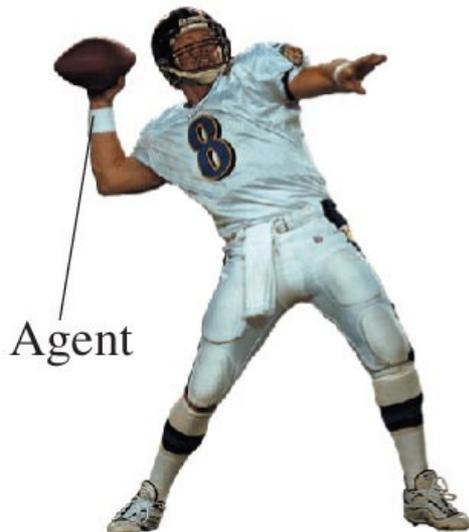
- (A) Path 1
- (B) Path 2
- (C) Path 3
- (D) Path 4
- (E) Path 5

What is a Force

- A force is a push or a pull on an object.
- A force requires an agent. Something does the pushing or pulling.



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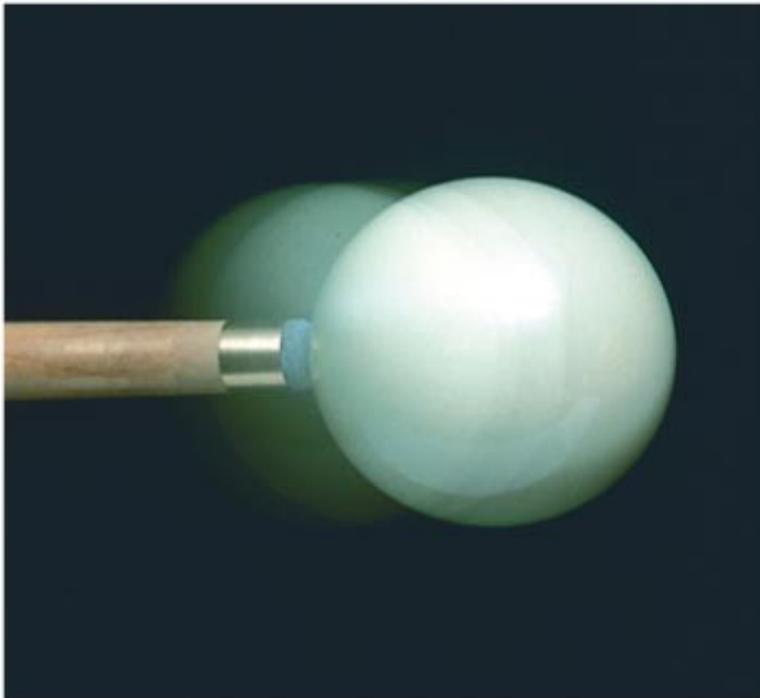


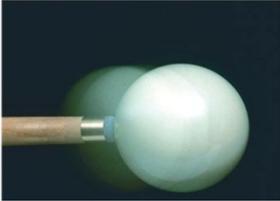
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What is a Force

- A force is a push or a pull on an object.
- A force requires an agent. Something does the pushing or pulling.
- A force is a vector. (magnitude and direction.)





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What is a Force

- A force is a push or a pull on an object.

A force requires an agent.

Something does the pushing or pulling.

A force is a vector. (magnitude and direction.)

A force is either a contact force or a long-range force. (i.e. gravity, magnetism)

Despite a very strong wind, a tennis player manages to hit a tennis ball with her racquet so that the ball passes over the net and lands in her opponent's court.

Consider the following forces:

1. A downward force of gravity.
2. A force by the "hit".
3. A force exerted by the air.

Which of the above forces is (are) acting on the tennis ball after it has left contact with the racquet and before it touches the ground?

- | | |
|-----------------|------------|
| A. 1 only. | C. 1 and 3 |
| B. 1 and 2. | D. 2 and 3 |
| E. 1, 2, and 3. | |

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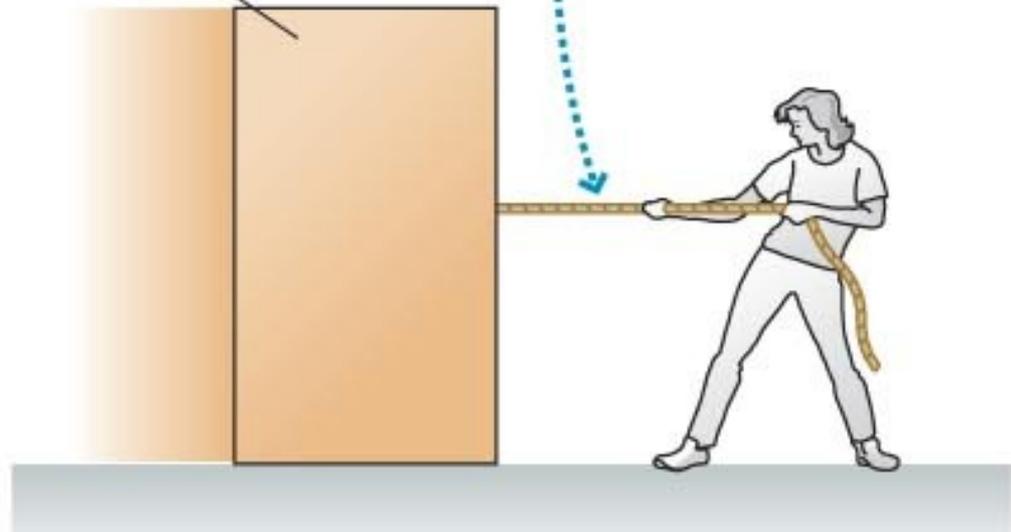
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Draw a force vector

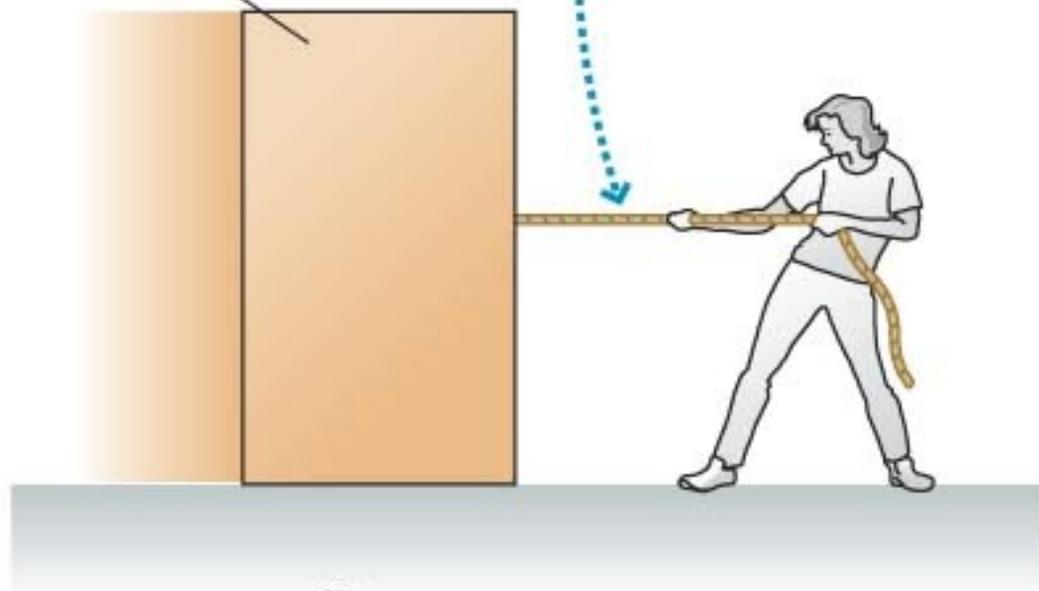
Pictorial
representation
of box

The rope is the agent.



Pictorial
representation
of box

The rope is the agent.



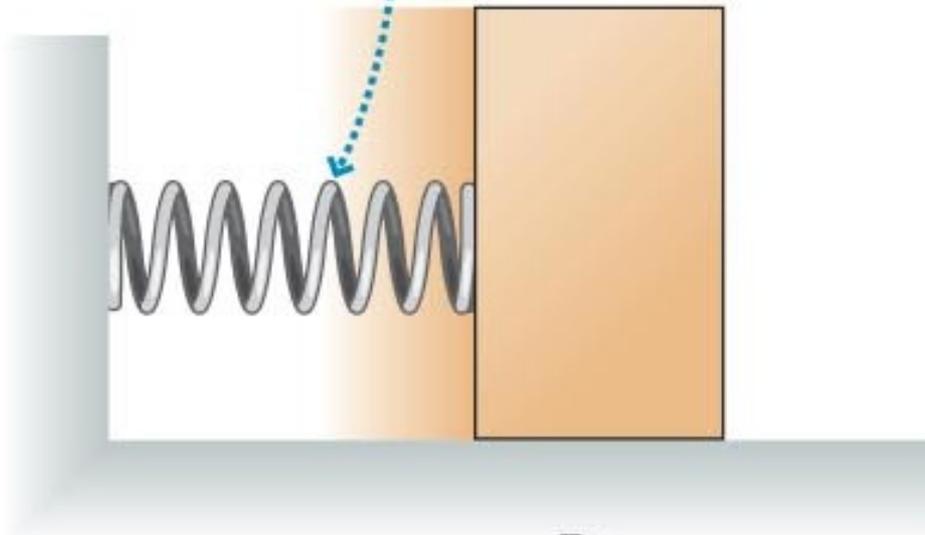
Particle
representation
of box

Box

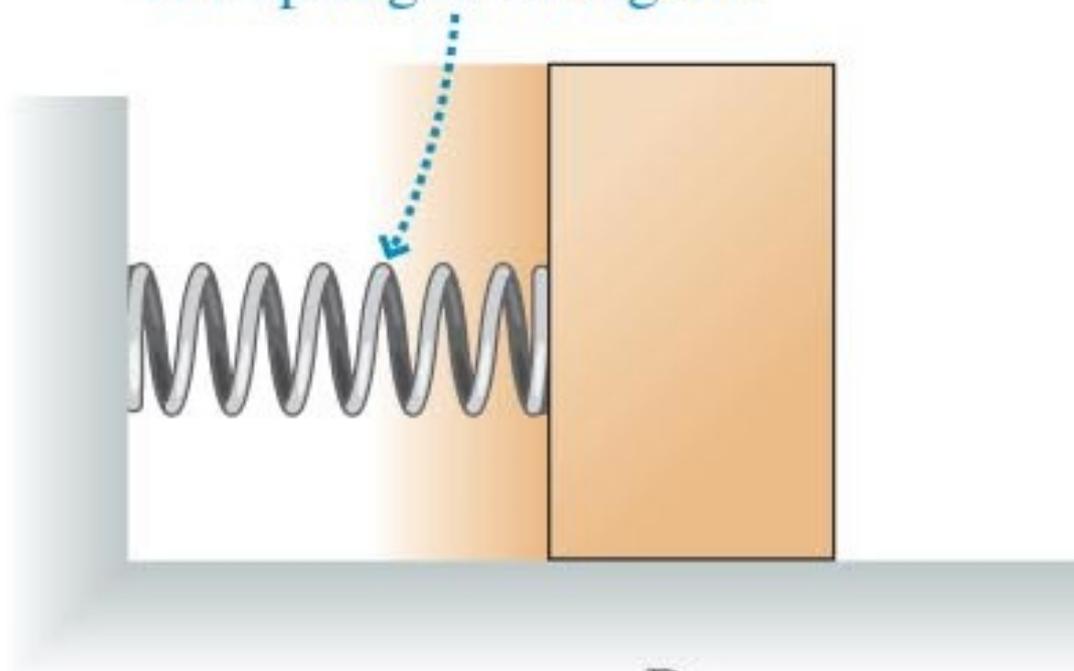


Draw a force vector

The spring is the agent.



The spring is the agent.



Box

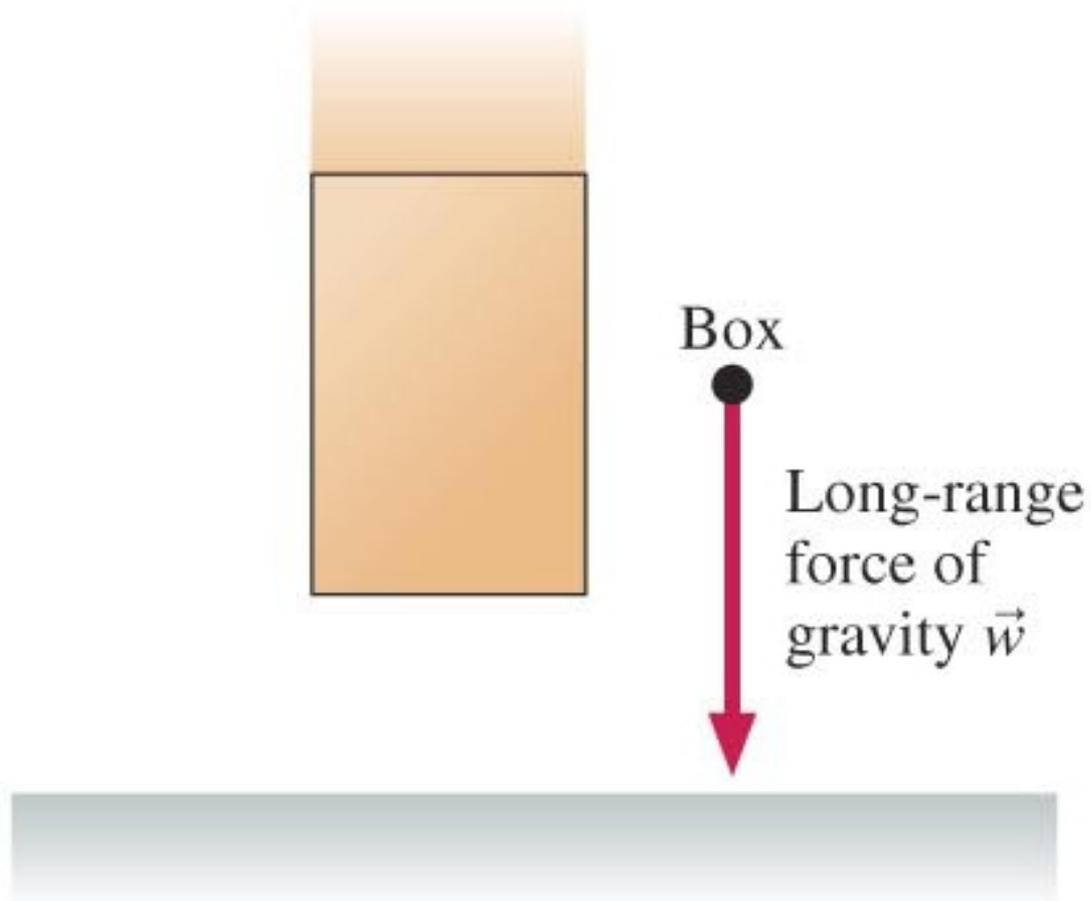


Pushing force of spring \vec{F}_{sp}

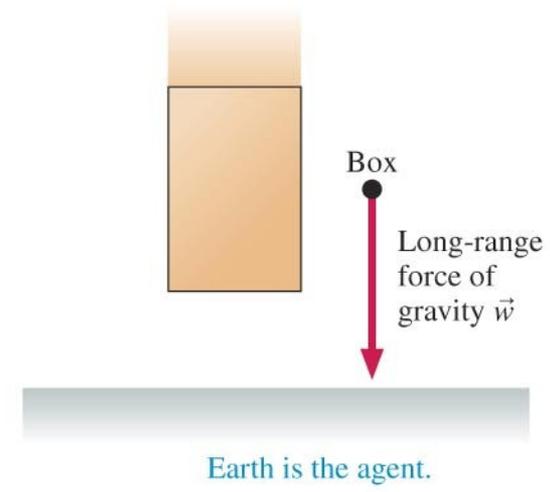
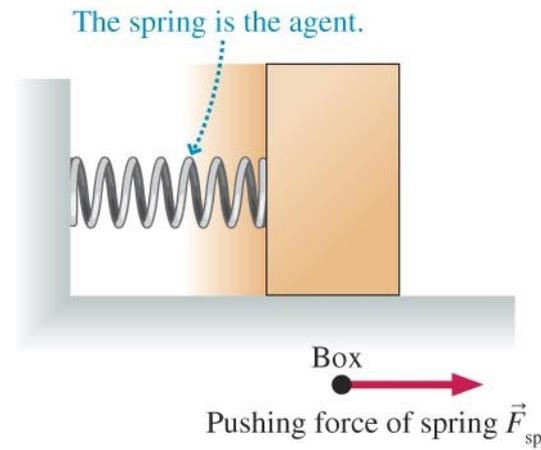
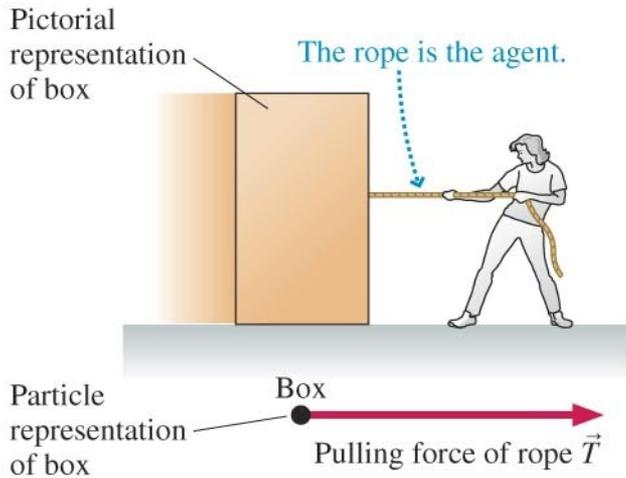
Draw a force vector



Earth is the agent.



Earth is the agent.



Identifying Forces

You've just kicked a rock, and it is now sliding across the ground about 2 meters in front of you. Which of these are forces acting on the rock? List all that apply.

- A. Gravity, acting downward
- B. The normal force, acting upward
- C. The force of the kick, acting in direction of motion
- D. Friction, acting opposite the direction of motion
- E. Air resistance, acting opposite the direction of motion.

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- E. Air resistance, acting opposite the direction of motion.

We've agreed to ignore air resistance unless a problem specifically calls for it.

Read 4.3 A short Catalog of Forces!

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. A 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. a constant downward force of gravity only.
- E. none of the above.

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