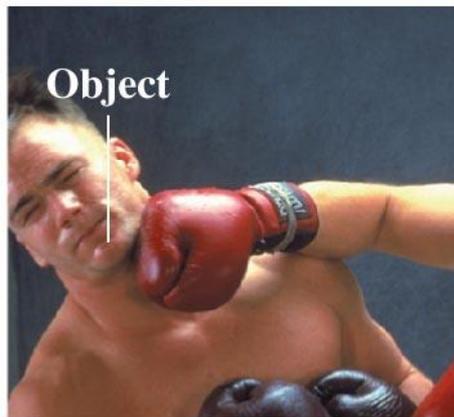


**Speed, acceleration, friction,
inertia, force, gravity**

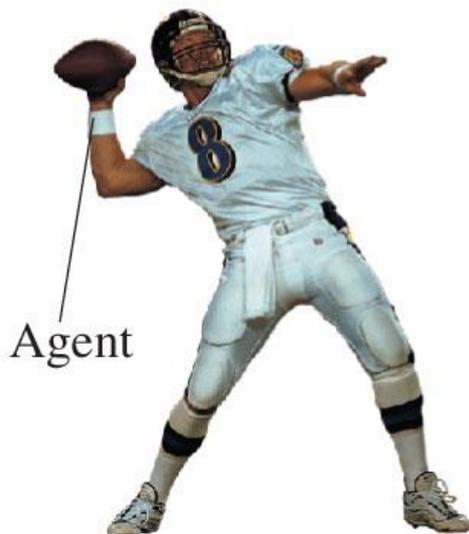
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What is a Force

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



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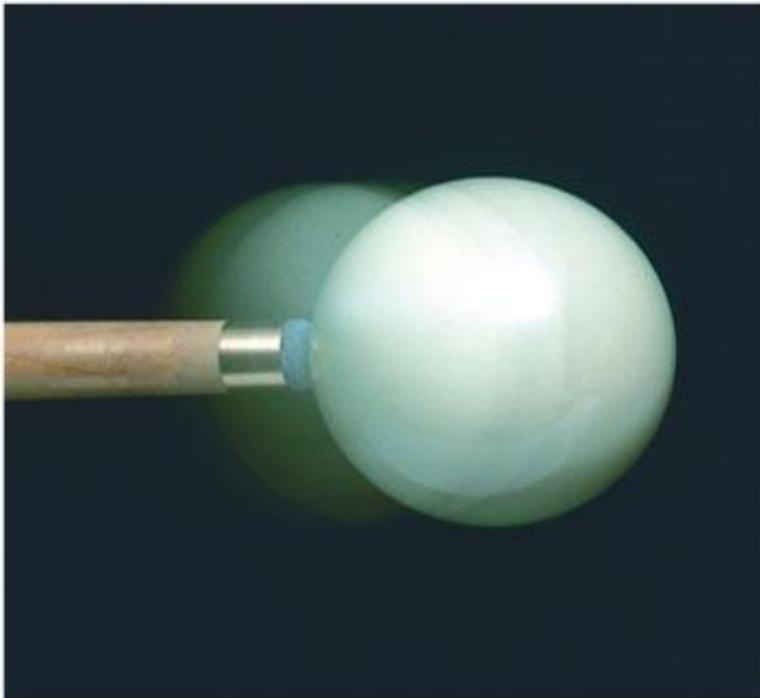


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What is a Force

- 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.)



Magnitude and Direction

Magnitude is the amount.

Speed: the amount is the rate

Displacement: the amount is the distance

Force: the amount is the strength of the
push/pull

Velocity = 100 mi/hr North

Which part of this is the magnitude?

- A. 100
- B. 100 mi/hr
- C. North
- D. 100 mi/hr North
- E. None of the above

Velocity = 100 mi/hr North

Which part of this is the magnitude?

A. 100

B. 100 mi/hr

C. North

D. 100 mi/hr North

E. None of the above

Velocity = 100 mi/hr North

Which part of this is the direction?

- A. 100
- B. 100 mi/hr
- C. North
- D. 100 mi/hr North
- E. None of the above

Velocity = 100 mi/hr North

Which part of this is the direction?

A. 100

B. 100 mi/hr

C. North

D. 100 mi/hr North

E. None of the above

Velocity: Speed with Direction

Newton's first law

An object at rest remains at rest

An object in motion remains in motion in a straight
line

=uniform motion at constant velocity

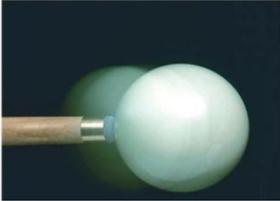
**Natural motion is
Uniform motion**



Object



Agent



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)



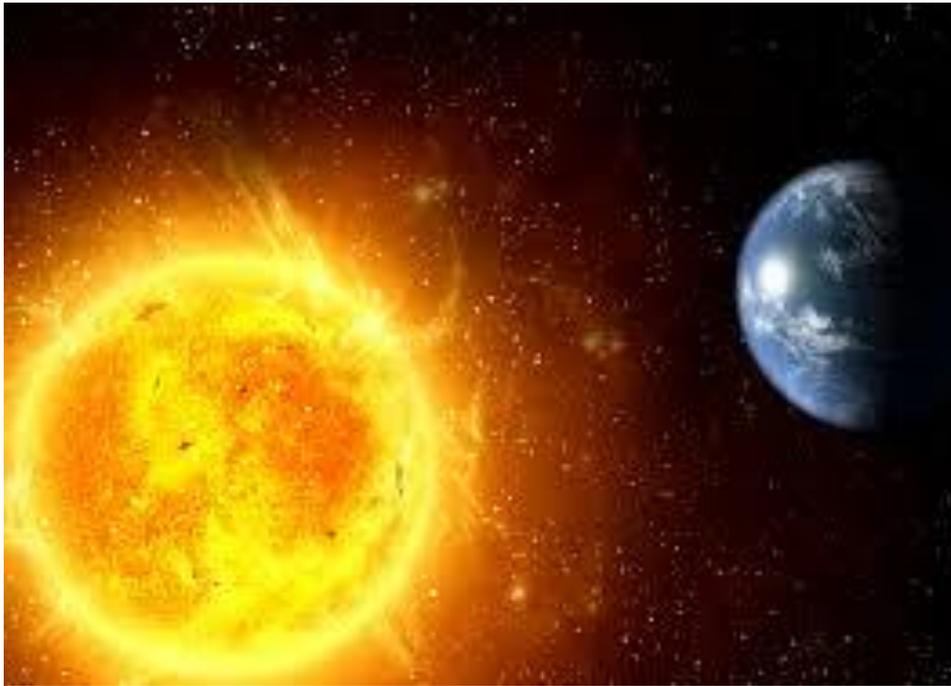
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Gravity

- Mass attracts mass



Gravity

- Mass attracts mass



Gravity

- Mass attracts mass



Gravity

- Mass attracts mass



- Is the hand throwing the ball a contact force or long range force?



- A. Contact force
- B. Long Range Force
- C. Both
- D. Neither

- Is the hand throwing the ball a contact force or long range force?



- A. Contact force**
- B. Long Range Force
- C. Both
- D. Neither

Catalog of Forces

- Push
- Pull
- Friction
- Gravity (weight)
- Magnetism
- Electrostatic
- Spring (could be a push or a pull)

Catalog of Forces

- Normal Force
- Drag
- Thrust

What do forces do?

They cause acceleration

$$\text{acceleration} = \text{Force/mass}$$

Acceleration = change in speed per time

Cause and Effect

Force is the Cause

Acceleration is the Effect

- After the ball is no longer touching the hand, can the boy change his mind about how hard he throws it?



A. Yes

B. No

- After the ball is no longer touching the hand, can the boy change his mind about how **hard** he throws it/pushes it? = Force



A. Yes

B. No



Would Dear Demi still have won if the Owner rode her? (Assume he's as skilled as the Jockey.)

- A. NO
- B. YES
- C. Maybe



Jockey, Owner, Trainer



Would Dear Demi still have won if the Owner rode her? (Assume he's as skilled as the Jockey.)

A. NO

B. YES

C. Maybe



Jockey, Owner, Trainer



What is the same if the Owner rides?

What is different if the Owner rides?

Precise language

- **Force** is what the horse exerts
- **Mass** is how much stuff which tells us about **inertia**
- **Acceleration** is the result – change in speed

What do forces do?

They cause acceleration

$$\text{acceleration} = \text{Force/mass}$$

Acceleration = change in speed per time

What if you put the same engine in a big truck and in a little car?

Which will accelerate more?

A. Car

B. Truck

C. Both the same



- Engine provides the **Force**

$$\text{acceleration} = \text{Force}/\text{mass}$$

What if you put the same engine in a big truck and in a little car?

Which will accelerate more?

A. Car

B. Truck

C. Both the same



Equal forces

If you push Vin Diesel and this baby, which will accelerate more?

- A. Vin Diesel
- B. Baby
- C. Both same
- D. Not enough info



Different mass = different acceleration

If you push Vin Diesel and this baby, which will accelerate more?

- A. Vin Diesel
- B. Baby**
- C. Both same
- D. Not enough info



Cause and Effect

Force is the Cause

Acceleration is the Effect

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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(a) Smooth snow



On smooth snow, the sled soon comes to rest.

A person is sitting on a sled moving at a constant speed. The sled hits some dry snow and begins to slow down.

If friction slows the sled, what slows the person on the sled down?

- A. Person is holding on
- B. Friction between the person and the sled
- C. A or B
- D. It's natural to slow down, nothing has to slow the person

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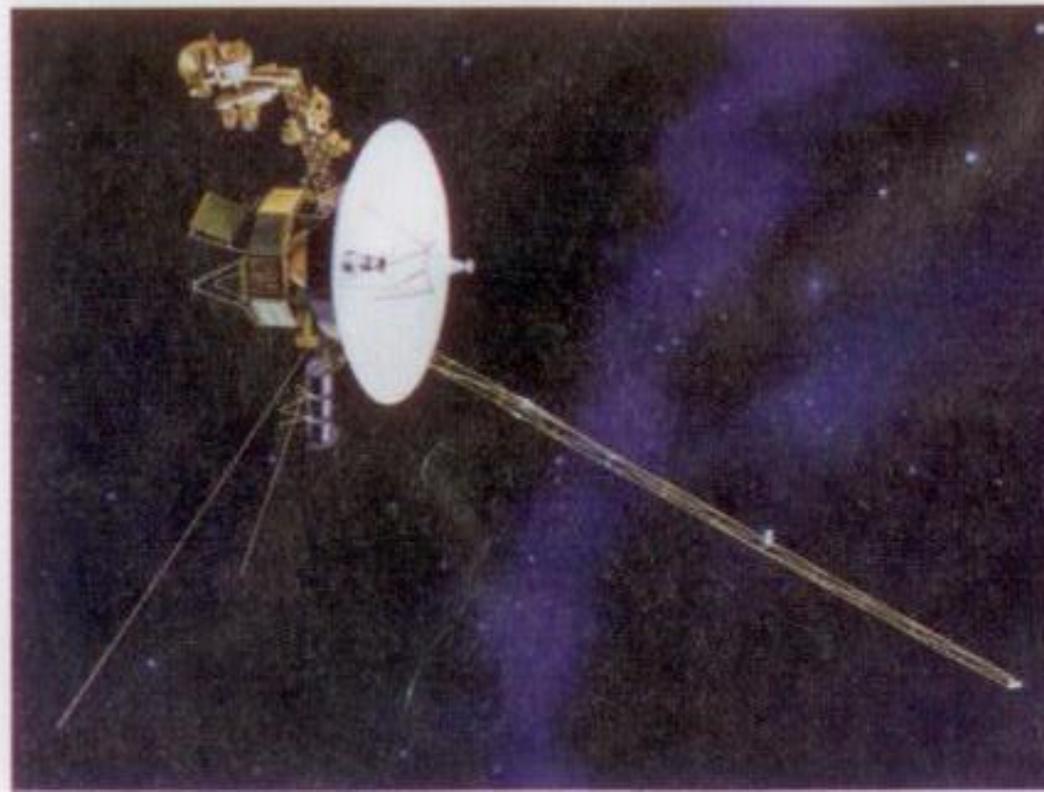
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Will it hit an asteroid or other planet?

Why doesn't it deteriorate like it would on earth?

Will it still send photos?

How is there no friction?



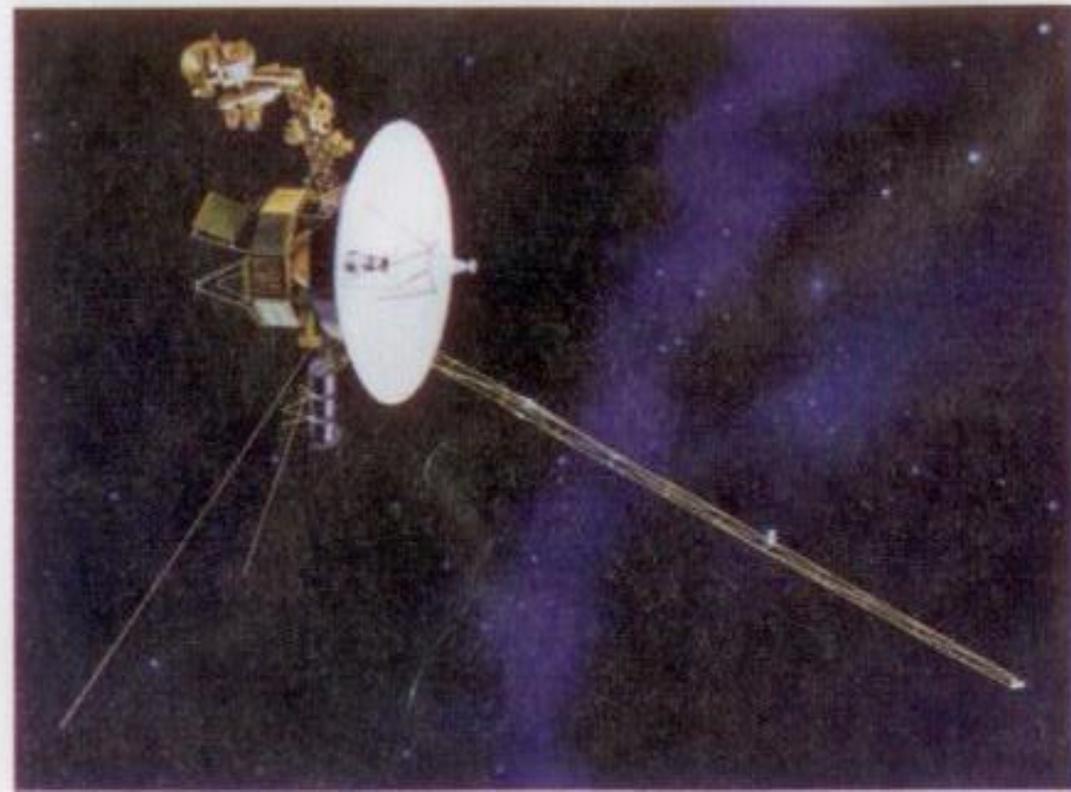
Will it hit an asteroid or other planet? **It could**

Why doesn't it deteriorate like it would on earth? **No oxygen or weather**

Will it still send photos? **Yes, still sending data.**
Nuclear power source – currently at 55%

How is there no friction?

No air in space



A book is resting on your desk. Consider the following forces:

1. A downward force of gravity.
2. An upward force exerted by the surface.

Which of the above forces are acting on the book?

- A. 1 only
- B. 2 only
- C. Both 1 and 2
- D. Neither

A book is resting on your desk. Consider the following forces:

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Which of the above forces are acting on the book?

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- C. Both 1 and 2**
- D. Neither

A bowling ball is rolling across the floor, the main force(s) acting on the ball is (are)

- A. A downward force of gravity
- B. A downward force of gravity, and a force in the direction of motion.
- C. A downward force of gravity, an upward force exerted by the surface, and a force in the direction of motion.
- D. A downward force of gravity, an upward force exerted by the surface.

A bowling ball is rolling across the floor, the main force(s) acting on the ball is (are)

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- C. A downward force of gravity, an upward force exerted by the surface, and a force in the direction of motion.
- D. A downward force of gravity, an upward force exerted by the surface.**

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**.

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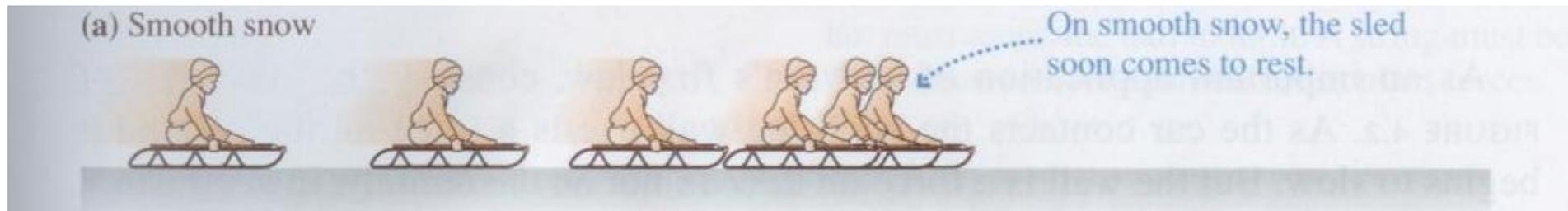
Natural motion so Zero net Force

If the pulling suddenly stops, then the box will:

- A. Immediately come to a stop
- B. Continue moving at a constant speed for awhile and then slow to a stop.
- C. Immediately start slowing to a stop.
- D. Continue at a constant speed.

If the pulling suddenly stops, then the box will:

- A. Immediately come to a stop
- B. Continue moving at a constant speed for awhile and then slow to a stop.
- C. Immediately start slowing to a stop.**
- D. Continue at a constant speed.



If, *instead*, the horizontal force pulling the box is doubled. The box's speed:

- A. Continuously increases
- B. Will be double the speed but still constant.
- C. Is greater and constant, but not necessarily twice as great.
- D. Is greater and constant for awhile and increases thereafter.
- E. Increases for awhile and constant thereafter.

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