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.
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.

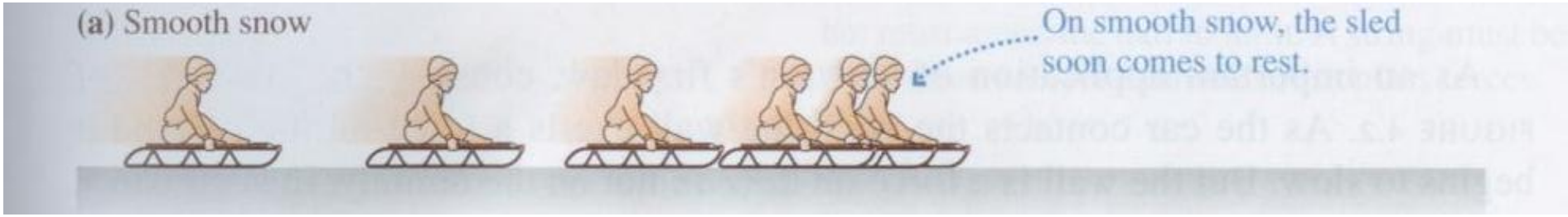
Natural motion so Zero net Force

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.

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

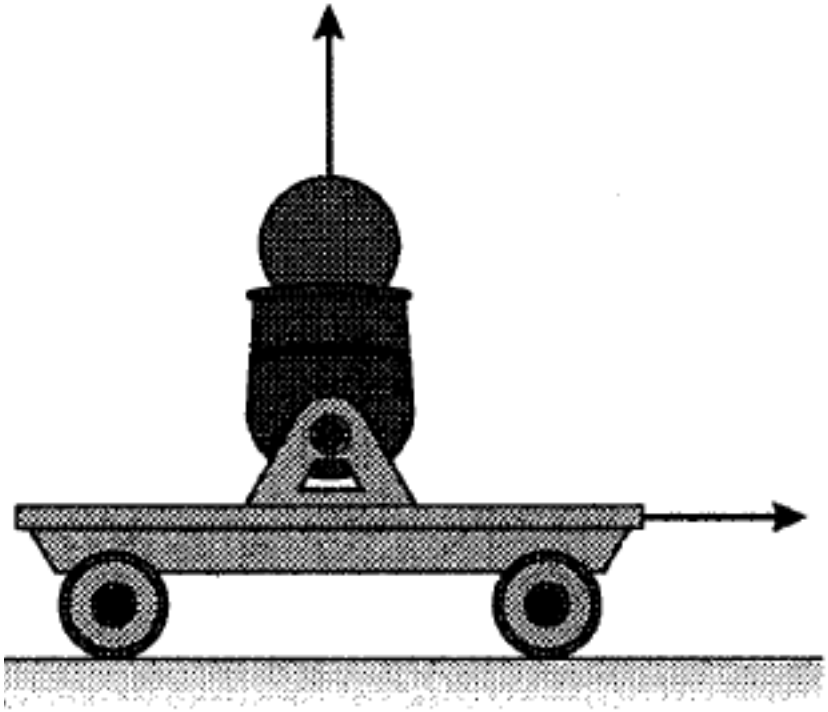
A. **Continuously increases**
B. Will be double the speed but still constant.
C. Is greater and constant, but not necessarily twice as great.
D. Is greater and constant for awhile and increases thereafter.
E. Increases for awhile and constant thereafter.

What will happen if the cart rolls at a constant velocity and then shoots a ball straight up?

A. The ball will land behind the cart.

B. The ball will land in the cart.

C. The ball will land in front of the cart.

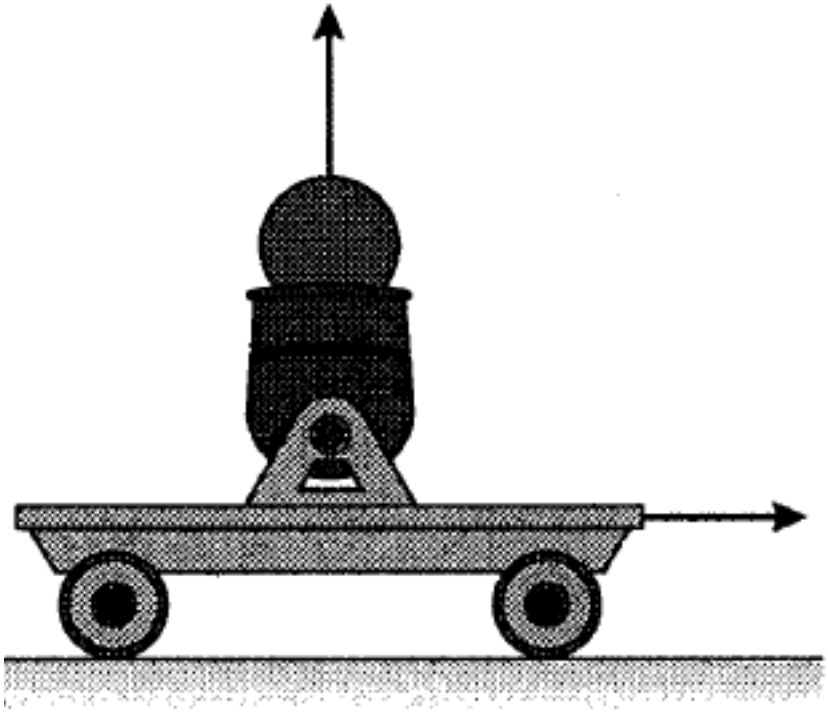


What will happen if the cart rolls at a constant speed and then shoots a ball straight up?

A. The ball will land behind the cart.

B. The ball will land in the cart.

C. The ball will land in front of the cart.



Newton's 3rd Law

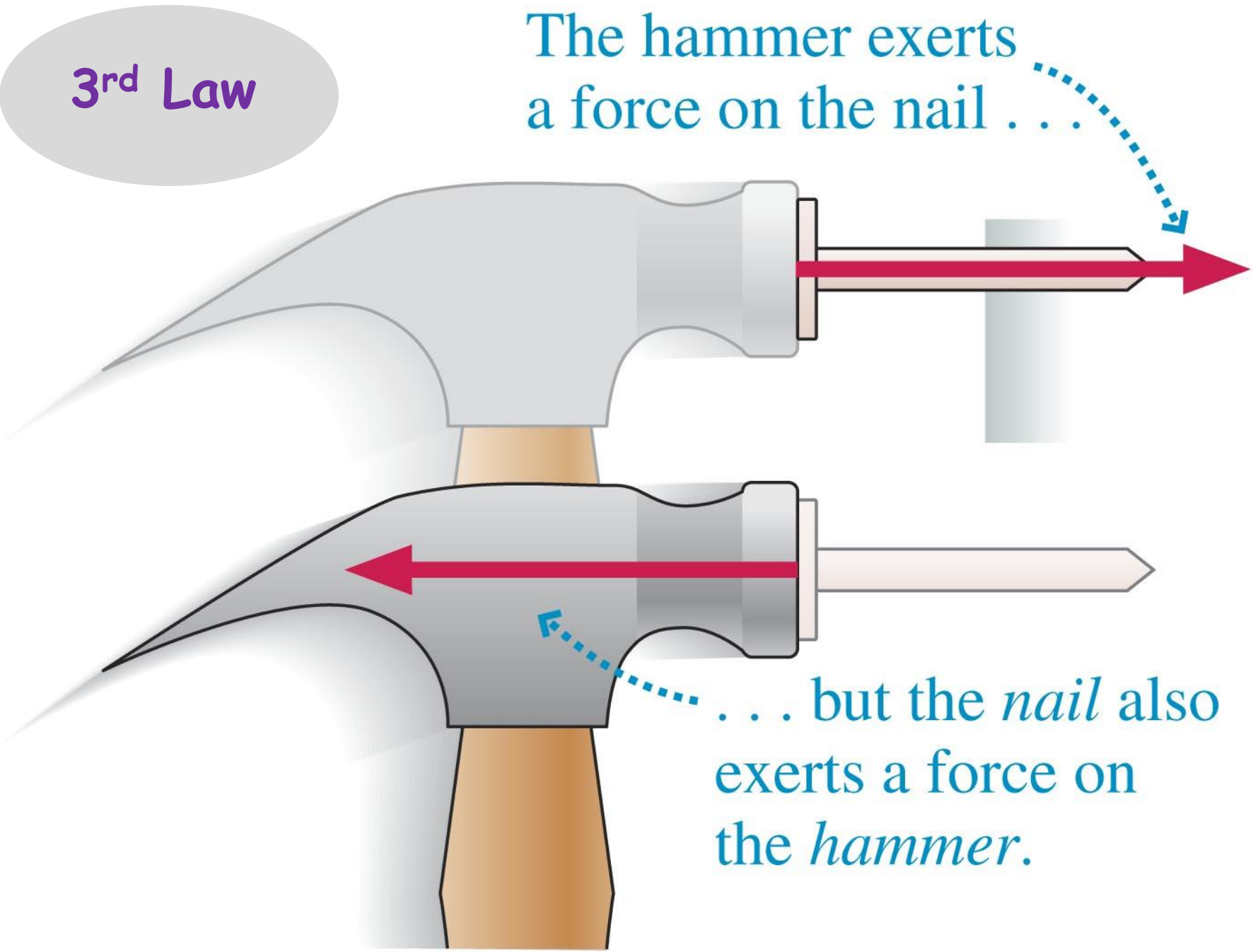
Every force has an equal and opposite force

You push on a Wall

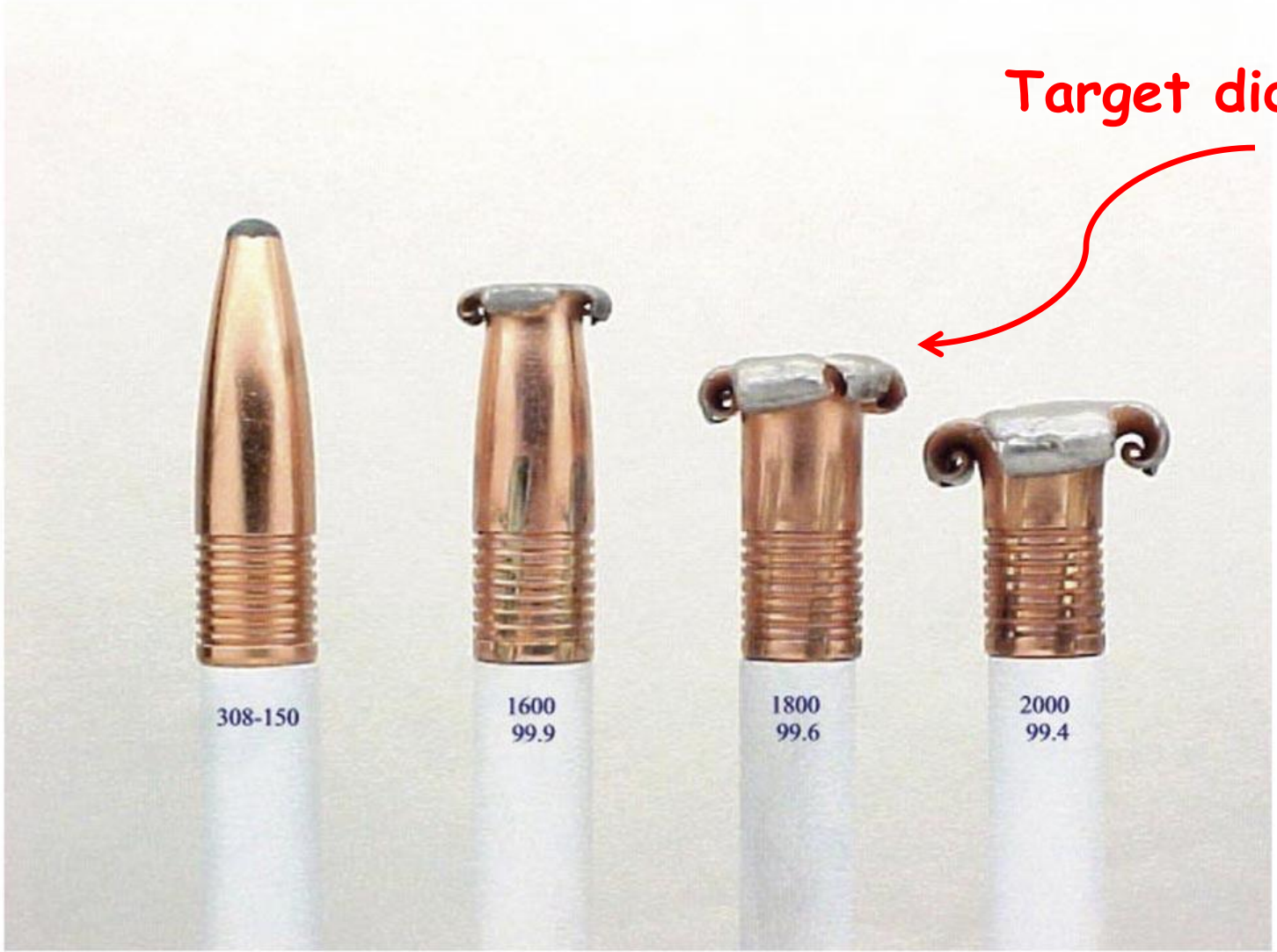
- don’t fall through

- Wall pushes on you

3rd Law



Bullet



Walking

The person pushes backward against the surface. The surface pushes forward on the person.

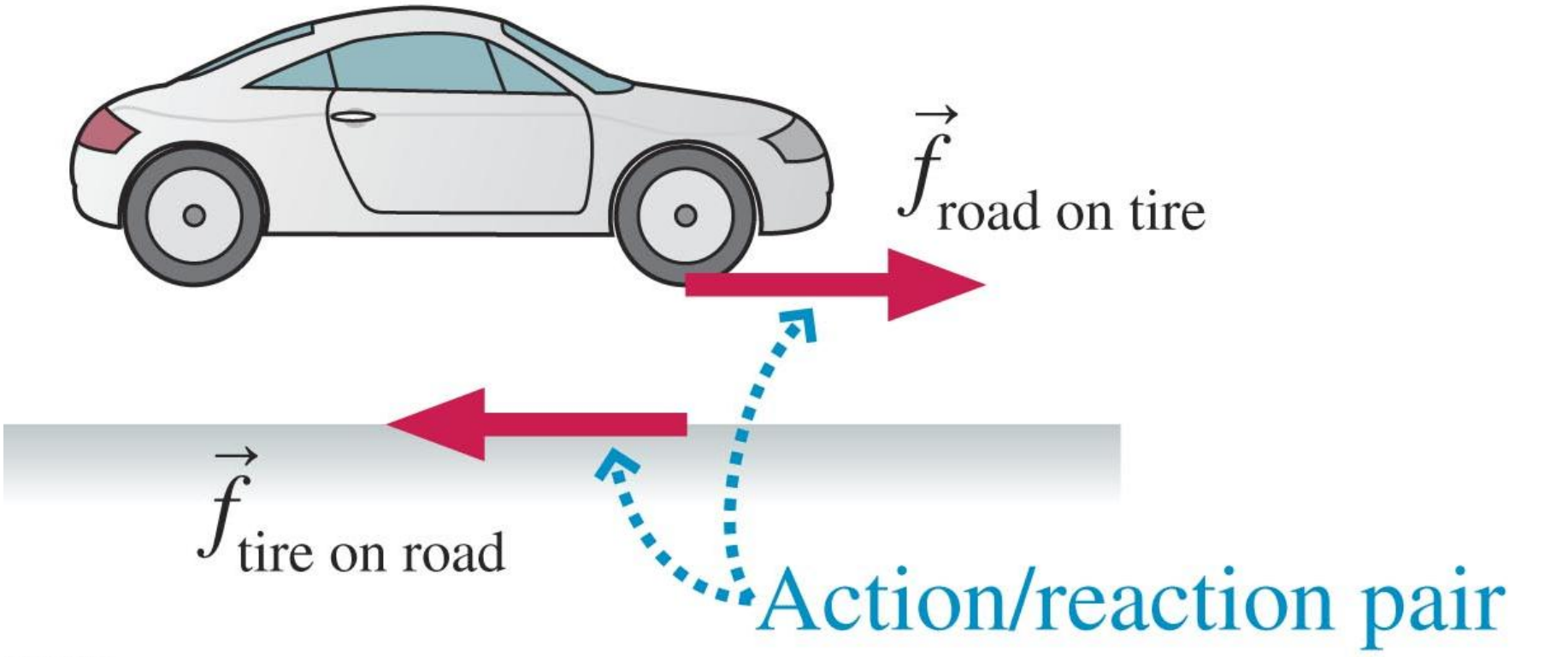
$\vec{f}_{\text{surface on person}}$

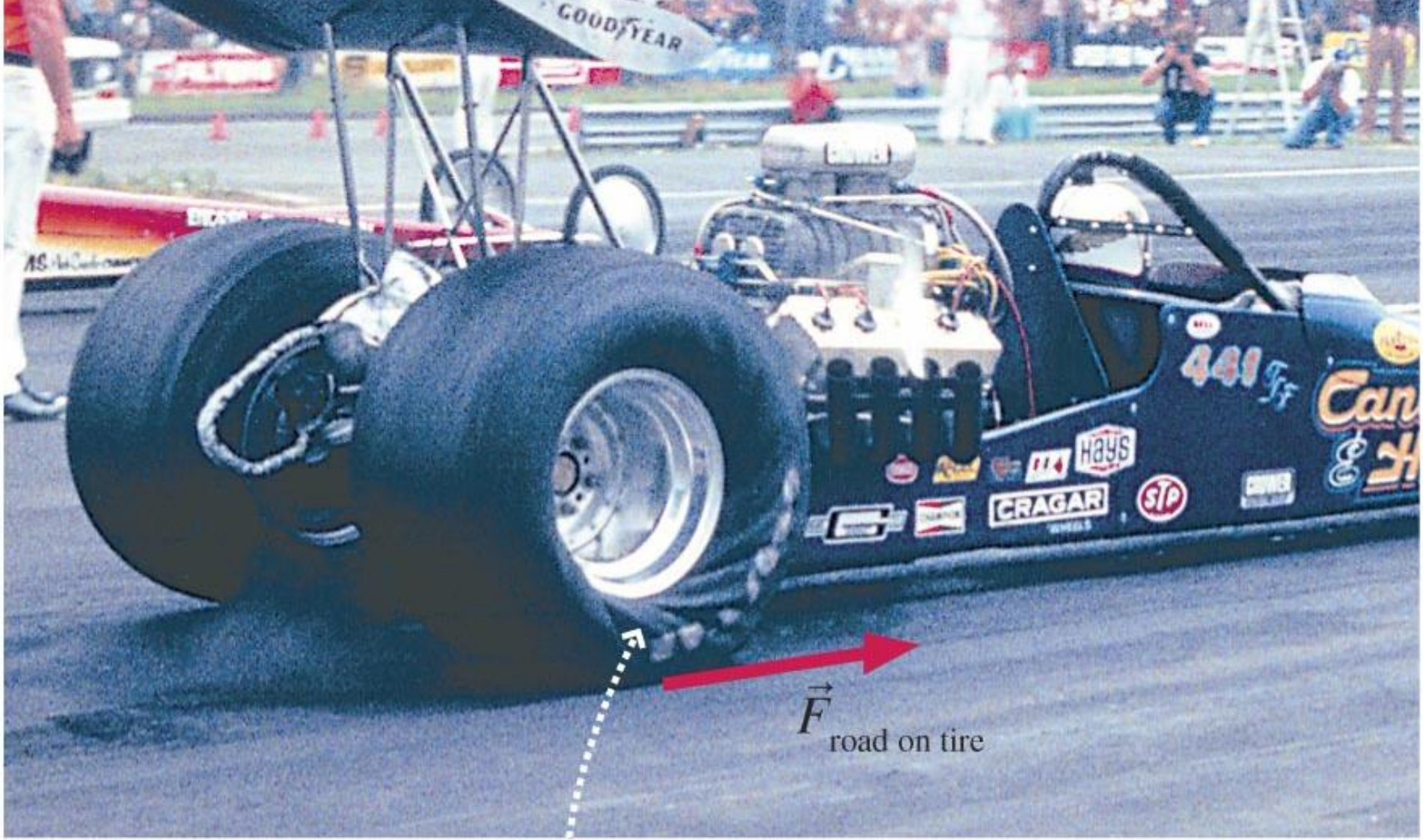
$\vec{f}_{\text{person on surface}}$

Force Pair

Propulsion

The tire pushes backward against the road. The road pushes forward on the tire.





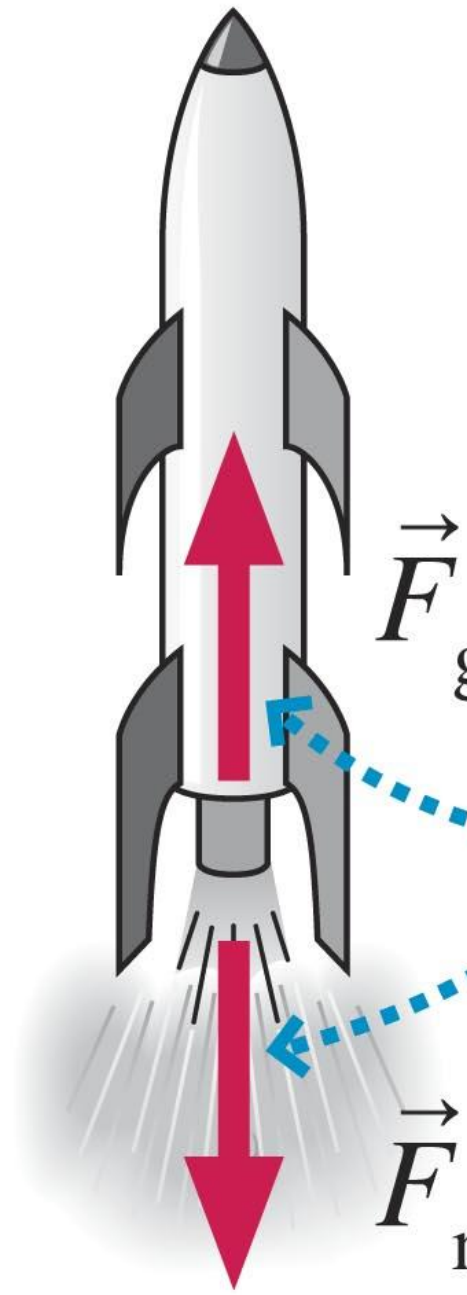
You can *see* that the force of the road on the tire points forward by the way it twists the rubber of the tire.

Rocket/Jet Engine

What pushes a rocket forward?

A. Engine shooting gas out
B. Surrounding air pushing back
C. Hot gasses pushing forward
D. Other

The rocket pushes the hot gases backward. The gases push the rocket forward.



$\vec{F}$ gases on rocket

Action/reaction pair

$\vec{F}$ rocket on gases

Rocket/Jet Engine

What pushes a rocket forward?

A. Engine shooting gas out
B. Surrounding air pushing back
C. Hot gasses pushing forward
D. Other

Walking

The person pushes backward against the surface. The surface pushes forward on the person.

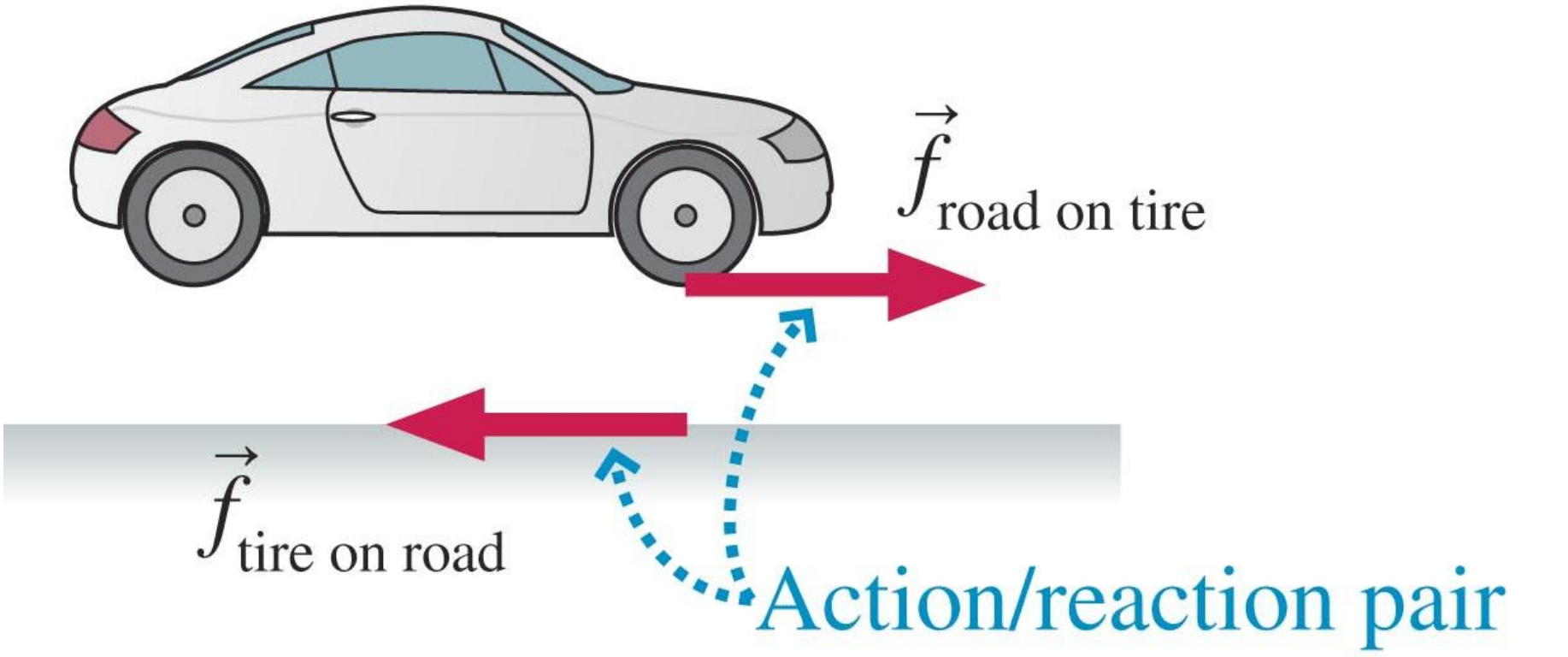
$\vec{f}_{\text{surface on person}}$

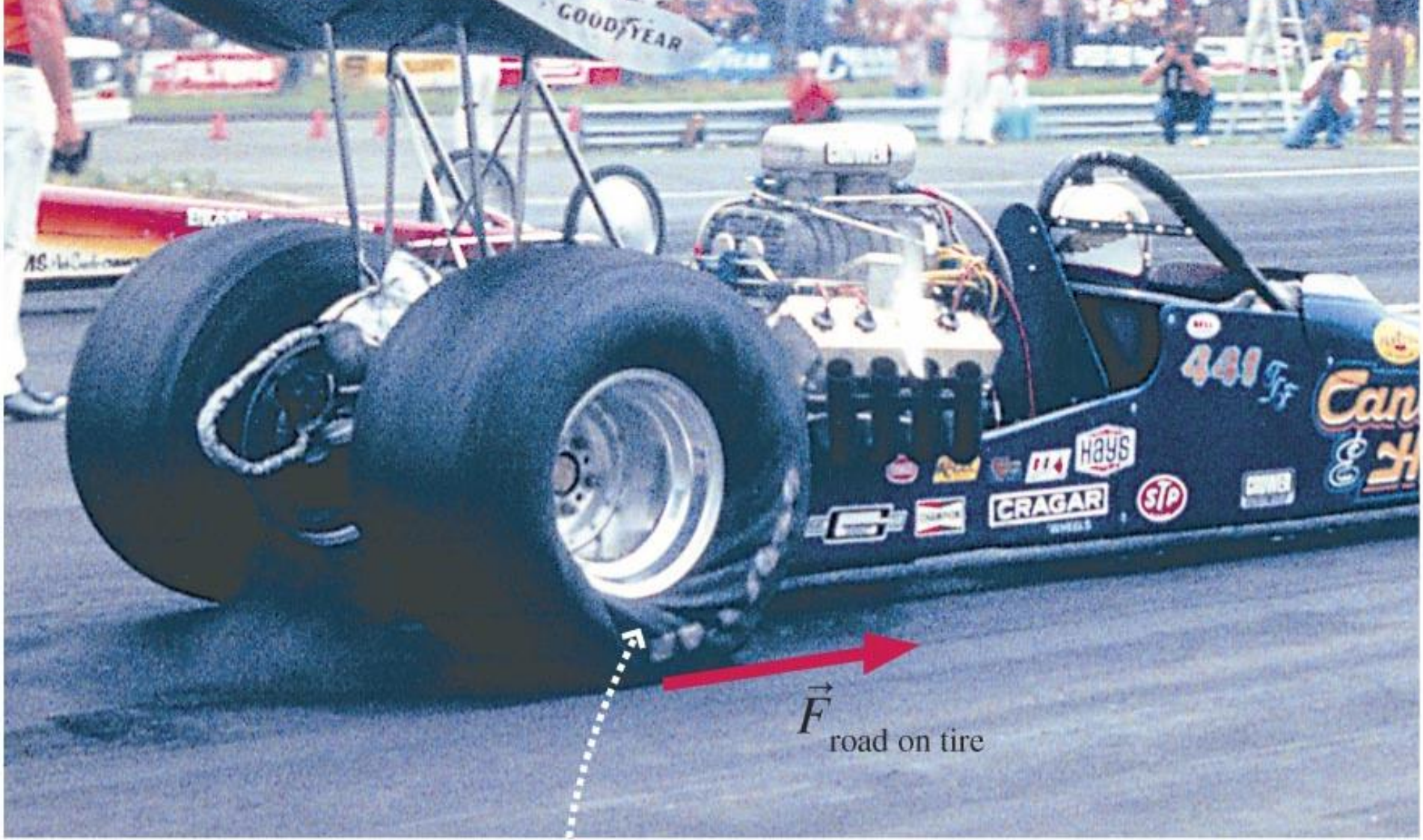
$\vec{f}_{\text{person on surface}}$

Force Pair

Propulsion

The tire pushes backward against the road. The road pushes forward on the tire.





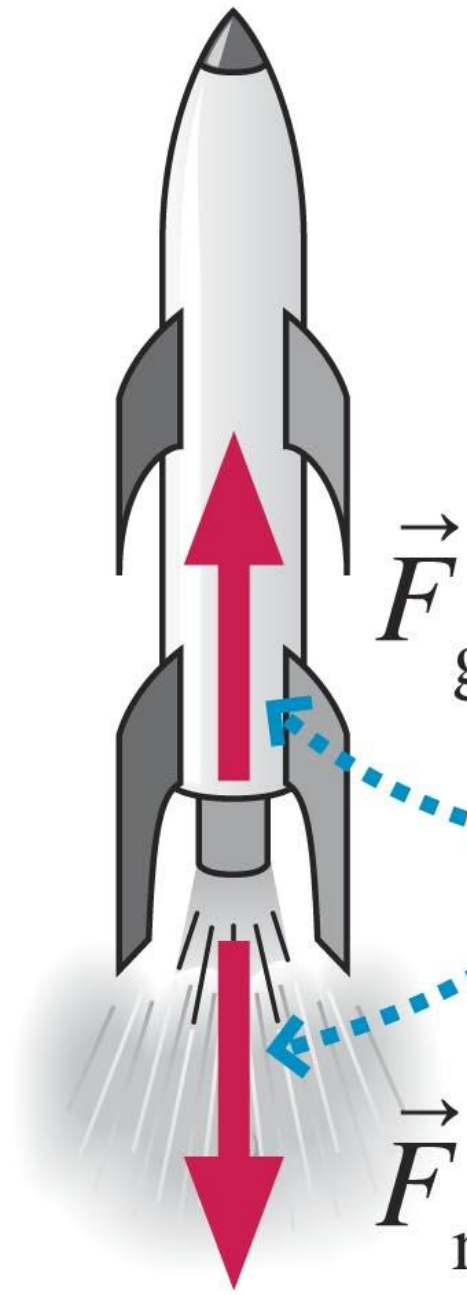
You can *see* that the force of the road on the tire points forward by the way it twists the rubber of the tire.

Rocket/Jet Engine

What pushes a rocket forward?

A. Engine shooting gas out
B. Surrounding air pushing back
C. Hot gasses pushing forward
D. Other

The rocket pushes the hot gases backward. The gases push the rocket forward.



$\vec{F}$ gases on rocket

Action/reaction pair

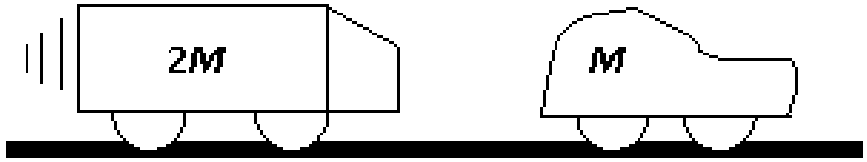
$\vec{F}$ rocket on gases

Rocket/Jet Engine

What pushes a rocket forward?

A. Engine shooting gas out
B. Surrounding air pushing back
C. Hot gasses pushing forward
D. Other

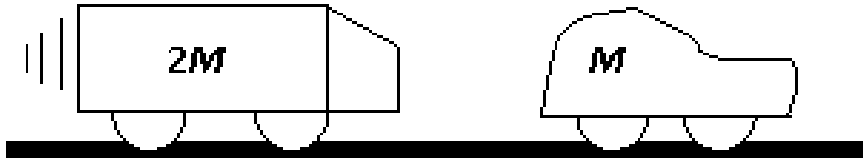
A 2000 kg truck hits a 1000 kg car.



How does the force felt by the truck compare to the force felt by the car?

A. Force felt by truck is greater than force felt by car
B. Force felt by car is greater than force felt by truck
C. Force felt by each is equal
D. Not enough info

A 2000 kg truck hits a 1000 kg car.



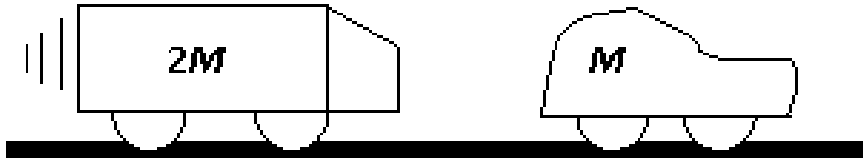
Suppose the **truck** slows down by **5 m/s** during the collision.

Does it sound reasonable to say the **car** speeds up by **10 m/s**?

A. Yes

B. No

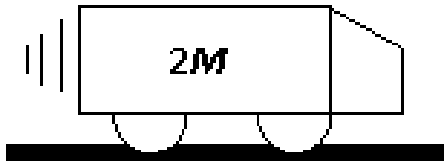
acceleration



Acceleration of the truck is less than (exactly half) the acceleration of the car

Equal force felt by each!

Force = mass x acceleration

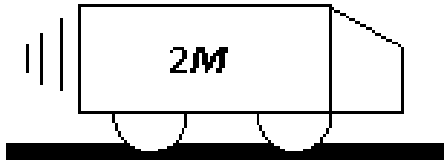


More mass less acceleration

Less mass more acceleration

Equal force felt by each!

Force = mass x acceleration



twice mass half acceleration

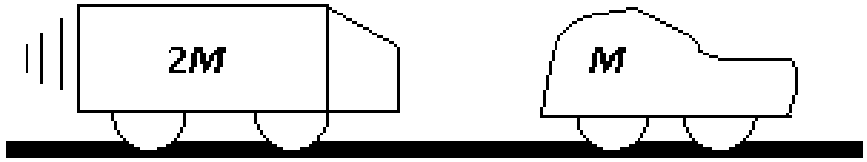
half mass twice acceleration

Cause and Effect

Force is the Cause

Acceleration is the Effect

A 2000 kg truck hits a 1000 kg car.



How does the force felt by the truck compare to the force felt by the car?

A. Force felt by truck is greater than force felt by car
B. Force felt by car is greater than force felt by truck
C. Force felt by each is equal
D. Not enough info

Push on roller blades

If David pushes Eugenia,

A. Eugenia will roll forward and David will stay where he is
B. Eugenia will roll forward and David will roll backwards
C. Eugenia will stay where she is and David will roll backwards

Push on roller blades

If David pushes Eugenia,

A. Eugenia will roll forward and David will stay where he is
B. Eugenia will roll forward and David will roll backwards
C. Eugenia will stay where she is and David will roll backwards

Push on roller blades

If David pushes Eugenia, who rolls faster?

A. David
B. Eugenia
C. Same speed

Push on roller blades

If David pushes Eugenia, who rolls faster?

A. David
B. Eugenia
C. Same speed

Cause and Effect

Force is the Cause

Acceleration is the Effect

Push on roller blades

If Eugenia pushes David,

A. David will roll forward and Eugenia will stay where she is
B. David will roll forward and Eugenia will roll backwards
C. David will stay where he is and Eugenia will roll backwards

Push on roller blades

If Eugenia pushes David,

A. David will roll forward and Eugenia will stay where she is
B. David will roll forward and Eugenia will roll backwards
C. David will stay where he is and Eugenia will roll backwards

Push on roller blades

If David pushes Eugenia, who rolls faster?

A. David
B. Eugenia
C. Same speed

Push on roller blades

If David pushes Eugenia, who rolls faster?

A. David
B. Eugenia
C. Same speed

Cause and Effect

Force is the Cause

Acceleration is the Effect

Pull on roller blades

If David pulls Eugenia,

A. Eugenia will roll forward and David will stay where he is
B. Eugenia will roll forward and David will roll forward
C. Eugenia will stay where she is and David will roll forward

Pull on roller blades

If David pulls Eugenia,

A. Eugenia will roll forward and David will stay where he is
B. Eugenia will roll forward and David will roll forward
C. Eugenia will stay where she is and David will roll forward

Pull on roller blades

If David pulls Eugenia,
who rolls faster?

A. David
B. Eugenia
C. Both Same

Pull on roller blades

If David pulls Eugenia,
who rolls faster?

A. David
B. Eugenia
C. Both Same

Pull on roller blades

If Eugenia pulls David,

A. David will roll forward and Eugenia will stay where she is
B. David will roll forward and Eugenia will roll forward
C. David will stay where he is and Eugenia will roll forward

Pull on roller blades

If Eugenia pulls David,

A. David will roll forward and Eugenia will stay where she is
B. David will roll forward and Eugenia will roll forward
C. David will stay where he is and Eugenia will roll forward

Pull on roller blades

If Eugenia pulls David, who rolls faster?

A. David
B. Eugenia
C. Both Same

Pull on roller blades

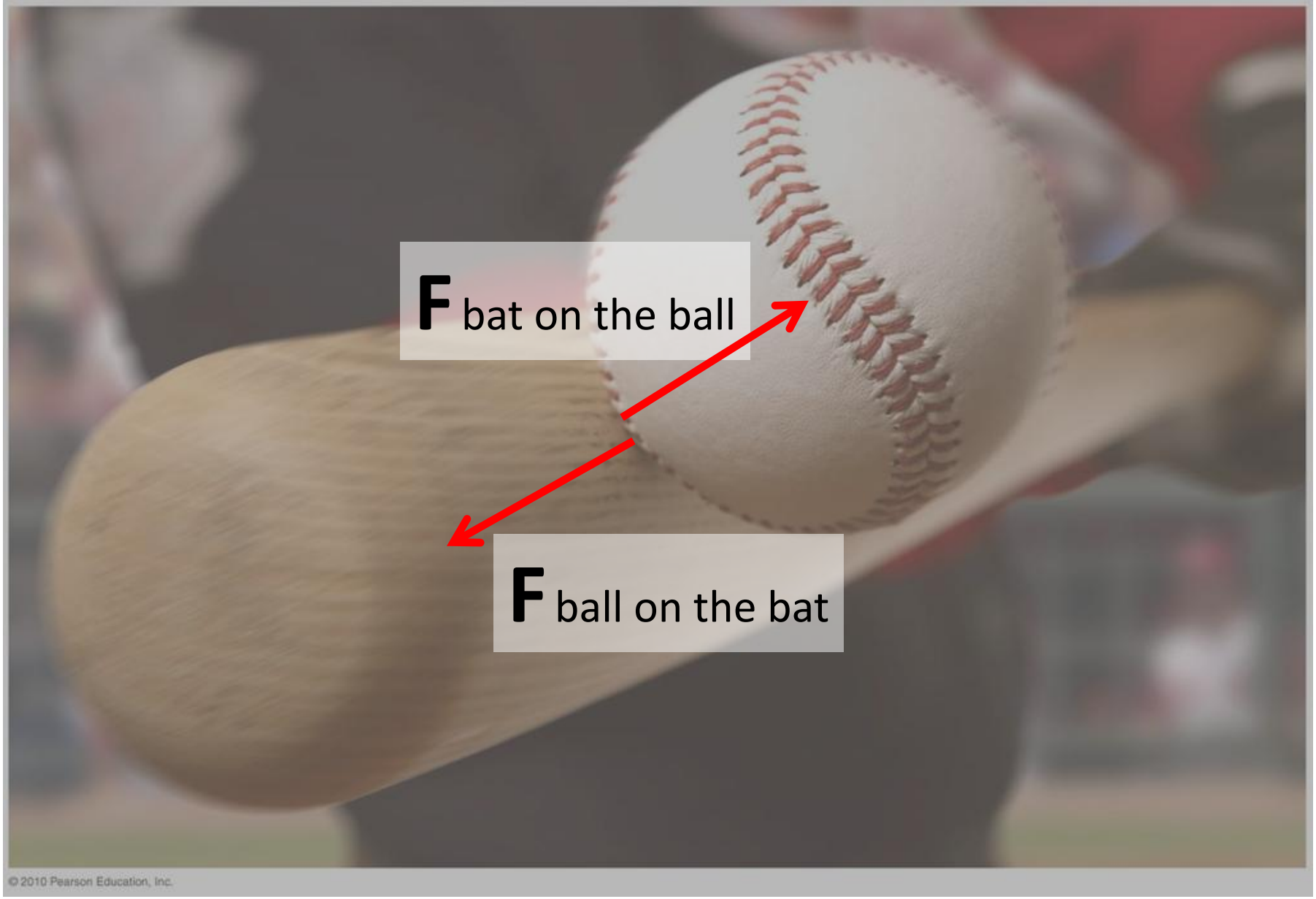
If Eugenia pulls David, who rolls faster?

A. David
B. Eugenia
C. Both Same

Pairs of Forces

- Force of A on B and Force of B on A

- Force of truck on car
- Force of car on truck
- Force of David pulling Eugenia
- Force of Eugenia pulling David
- Force of David pushing Eugenia
- Force of Eugenia pushing David



Bat and Ball – only objects of interest

Basketball player jumps

F ground on player

F player on ground

Ball toss

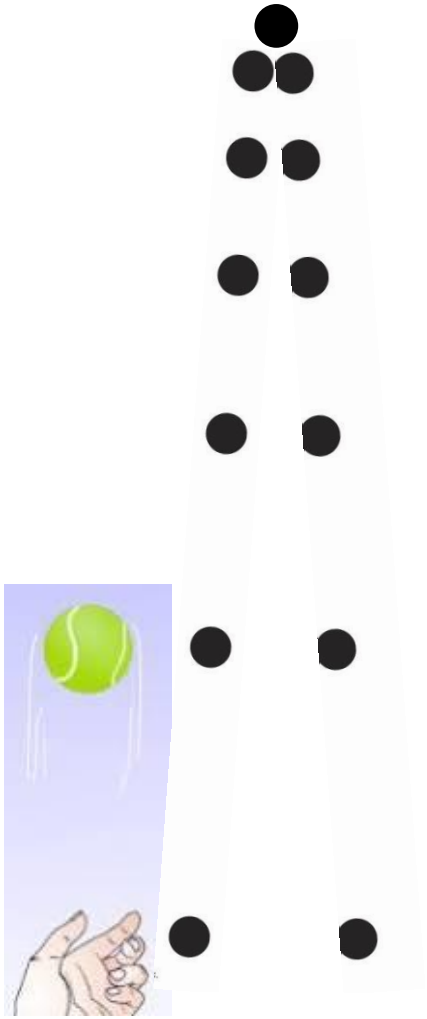
A boy tosses a tennis ball over the fence. Let's say he tosses it with a speed of 10 m/s. When the ball reaches its highest point, it's velocity is

A. zero

B. 10 m/s

C. -10 m/s

D. Not enough info



Both ways are “**free fall**” because the only force is gravity.
Physically it’s the same.

Speed changing by 9.8 m/s every second in the downward direction.

Ball toss

A boy tosses a tennis ball over the fence. Let's say he tosses it with a speed of 10 m/s. When the ball reaches its highest point, it's velocity is

A. zero

B. 10 m/s

C. -10 m/s

D. Not enough info

Ball toss

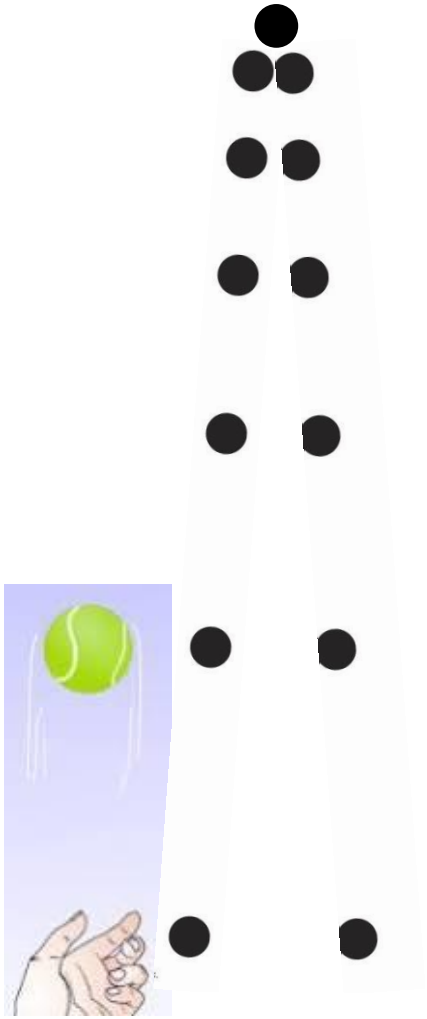
A boy tosses a tennis ball over the fence. Let's say he tosses it with a speed of 10 m/s. When the ball reaches its highest point, it's acceleration is

A. zero

B. 9.8 m/s^2

C. -9.8 m/s^2

D. Not enough info



Both ways are “**free fall**” because the only force is gravity.
Physically it’s the same.

Speed changing by 9.8 m/s every second in the downward direction.

Ball toss

A boy tosses a tennis ball over the fence. Let's say he tosses it with a speed of 10 m/s. When the ball reaches its highest point, it's acceleration is

A. zero

B. 9.8 m/s^2

C. -9.8 m/s^2

D. Not enough info