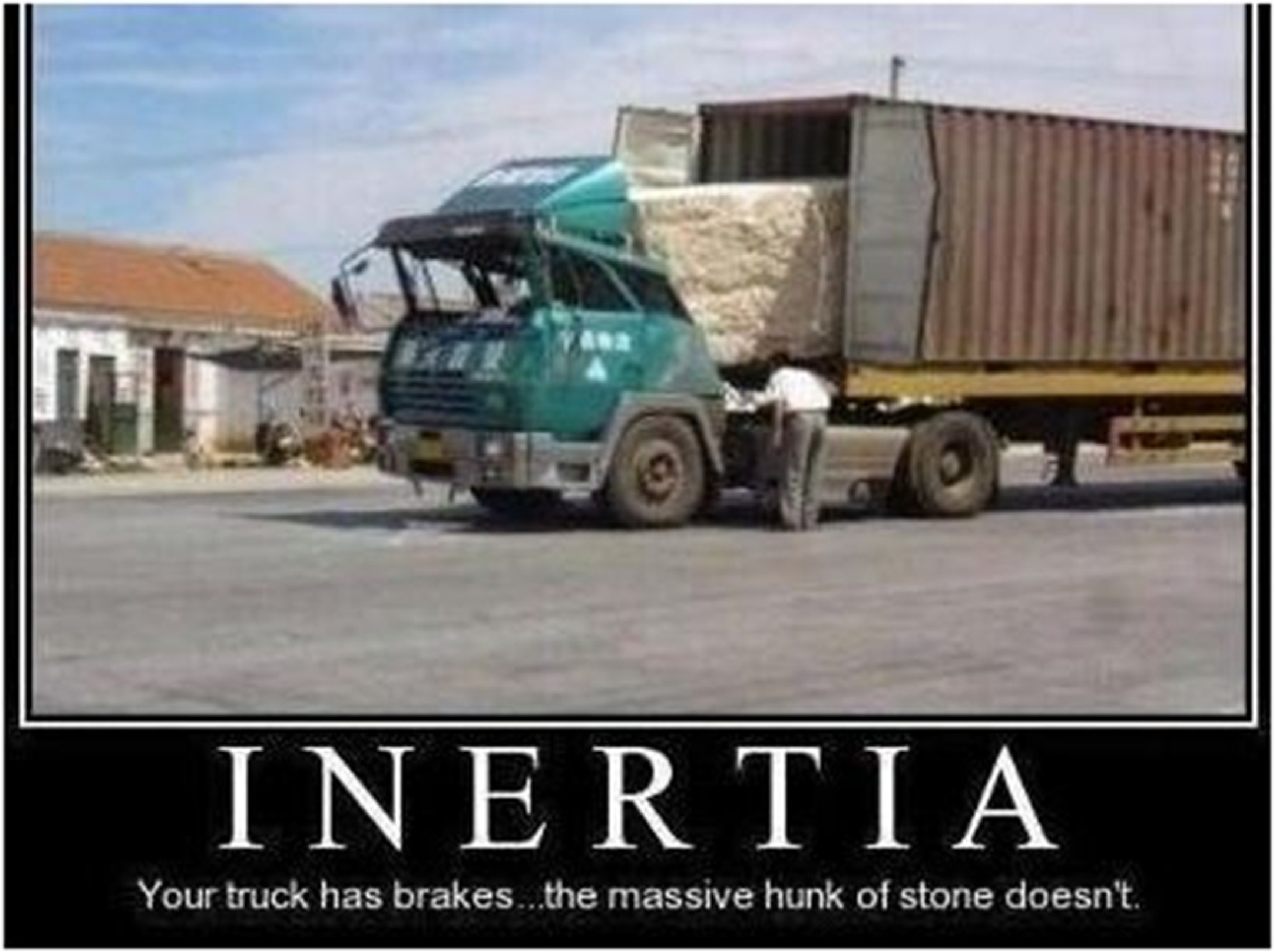
Main Ideas in Class Today

- A few definitions: Inertia and Force
- Newton's 1st Law
- Newton's 2nd Law
- Newton's 3rd Law
- Applying these Laws

Extra Practice: 4.3, 4.7, 4.11, 4.13, 4.17
Examples 4.1 and 4.2 in the chapter

Every object has **inertia**, or the tendency of an object to continue in its original direction at its original speed. Inertia = mass (I have lots)



Inertia

Q25

Every object has inertia, or the tendency of an object to continue in its original direction at its original speed. Inertia = mass

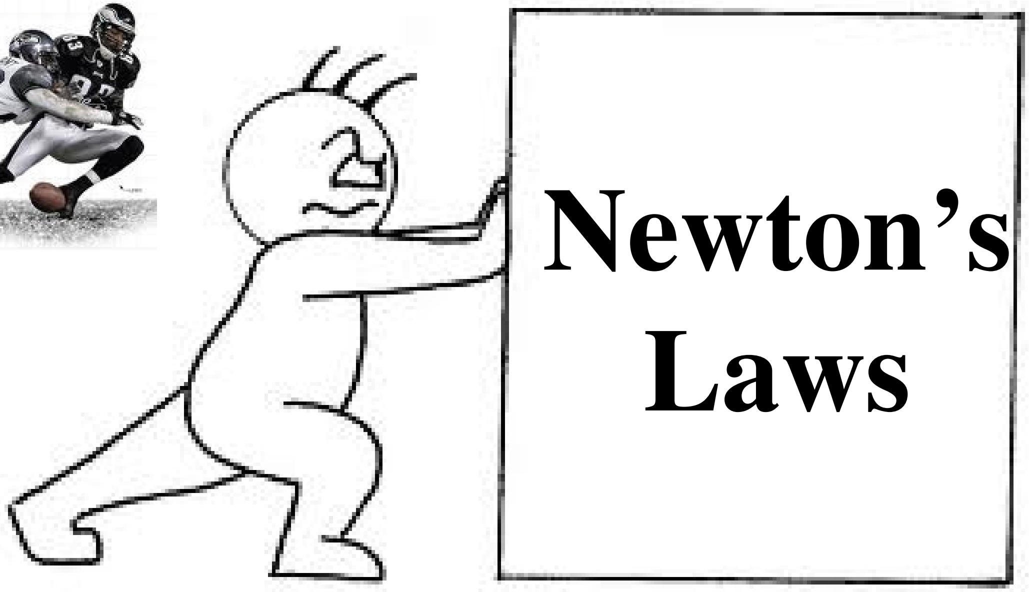
For the majority of the time, do we want *our* football guards (guys who guard quarterback) to have high or low inertia?

A) High (a lot of inertia)

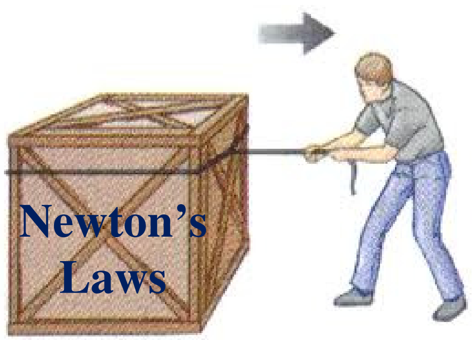
B) Low (little inertia)

How about our running backs (they run the ball)?

How do I move things?



- Force: any kind of push or pull on an object
  - Forces are vectors - have direction and magnitude
- Newton's Laws (Isaac Newton, 1642-1727) explain why objects behave the way they do when a force is applied to them



Am I experiencing any forces currently?

Newton's First Law

- The velocity of an object does not change unless a force acts on the object
  - If an object slows down or speeds up, it is because a force acts on it
    - Book pushed on table slows down from friction
  - If an object changes direction, **even if its speed remains the same**, it is because a force acts on it
    - Object moving in a circle at constant speed - force must cause change in velocity's direction

Newton’s First Law

Earth’s rotation has very small effect (ignore since even less than air resistance!)

Newton’s 1st law is only valid in an

inertial reference frame

(non-accelerating reference frame)

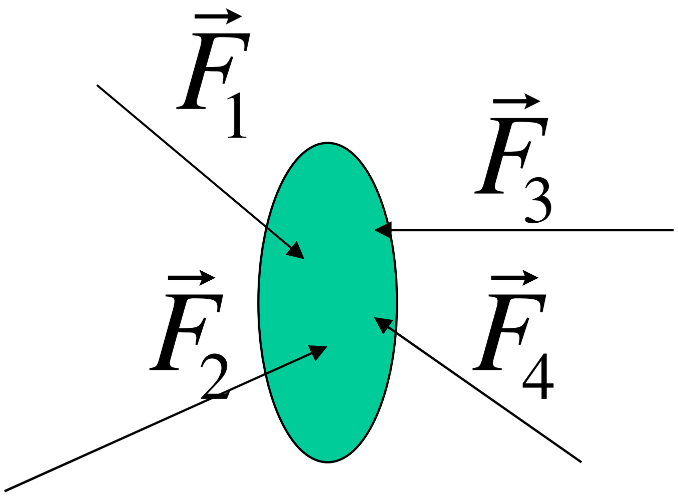
Ex: Stuff moving in a car when coming to a quick stop or sharp curve (car is accelerating)

To motivate Newton's 2^{nd} Law

When I try to move things, how does that depend on the object's mass?

Newton's Second Law

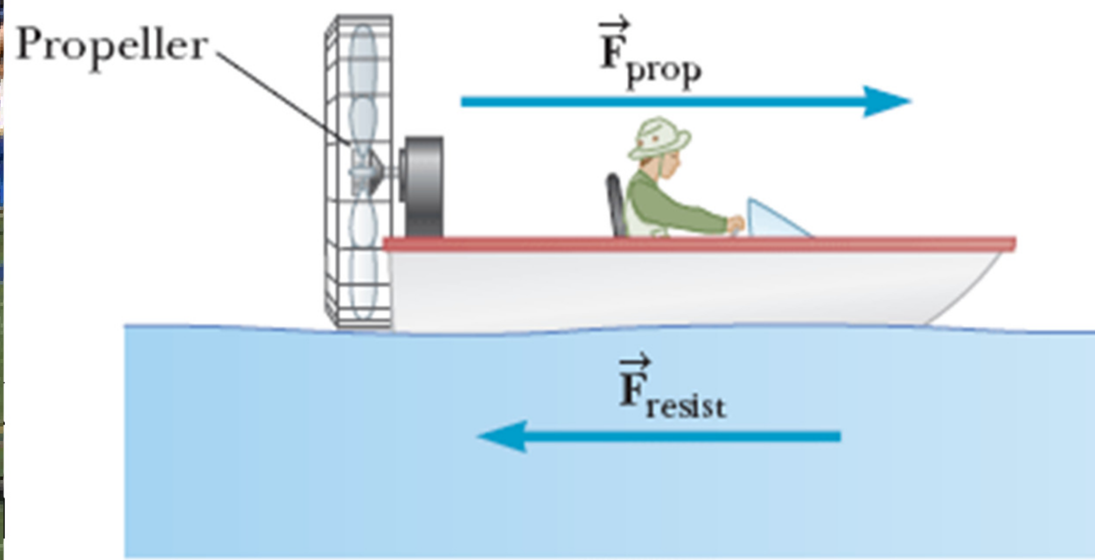
- The acceleration of an object is proportional to the net force (<u>sum of forces</u>) on the object



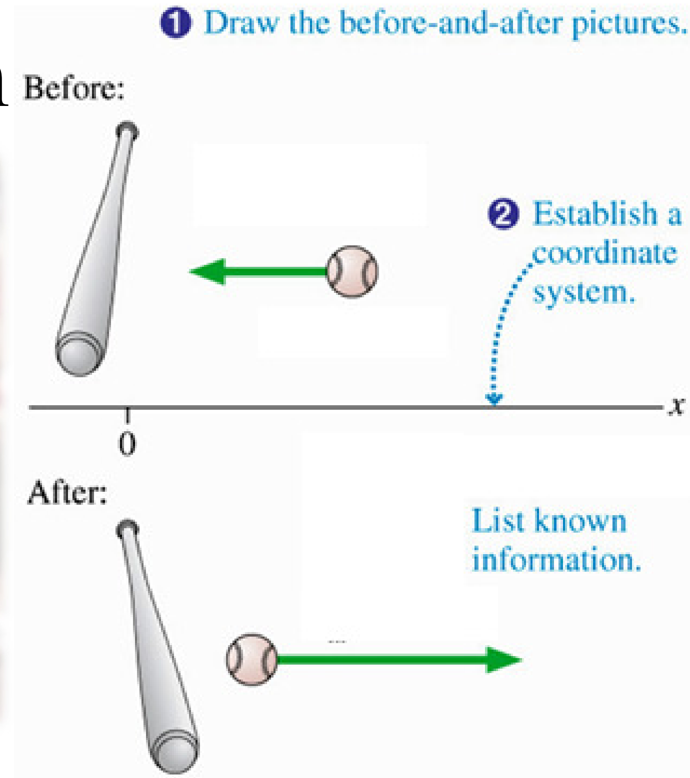
$$\vec{F}_{net} = \vec{F}_1 + \vec{F}_2 + \vec{F}_3 + \ldots = \sum \vec{F}_i$$

$$\vec{F}_{net} = \sum \vec{F}_i = m\vec{a}$$

m = mass (scalar)



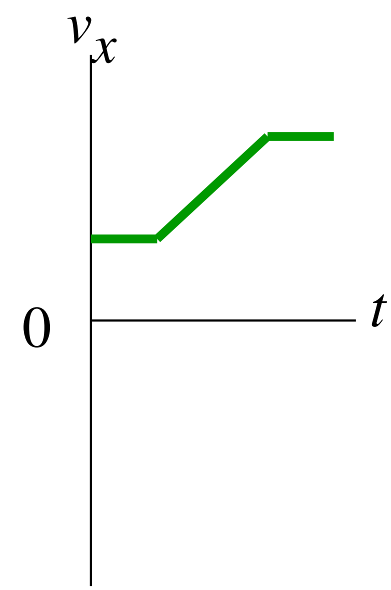
Example word problem



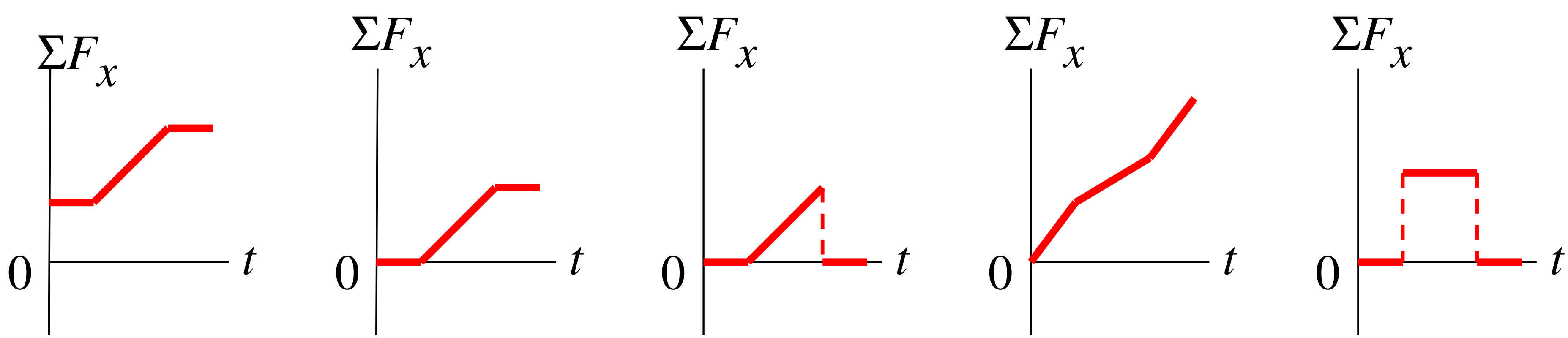
A 0.2 kg baseball is thrown towards a baseball hitter at 30 m/s and travels in the other direction at 20 m/s after being hit. The ball is in contact with the bat for about 0.1 seconds.

What is the average force the bat exerts on the ball?

The graph to the right shows the velocity of an object as a function of time.



Which of the graphs below best shows the net force versus time for this object?



A. B. C. D. E.

Q26

To Motivate Newton's 3rd Law

Why does it hurt when I hit the wall?

Or fall from a high height?

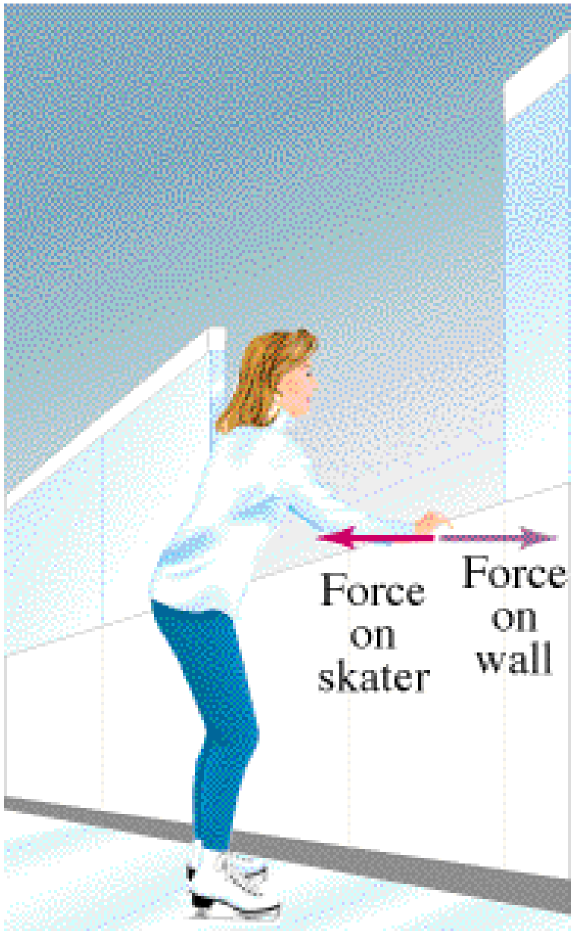
Newton’s Third Law

For every action, there is <u>ALWAYS</u> an equal and opposite reaction (<u>even</u> if it breaks!).

Why it’s dumb to hit a wall with your fist.

Newton’s Third Law

For every force an object exerts on a second object, there is an equal an opposite force exerted on the first object by the second object



A 3.00-kg rifle fires a 0.00500-kg bullet at a speed of 300 m/s. Which force is greater in magnitude:

(i) the force that the *rifle* exerts on the *bullet*; or

(ii) the force that the *bullet* exerts on the *rifle?*

A. the force that the rifle exerts on the bullet

B. the force that the bullet exerts on the rifle

C. both forces have the same magnitude

D. not enough information given to decide

Q27

Q28 When a WVU football player tackles a Marshall football player, the force the WVU player exerts on the Marshall player is ______ the force the Marshall player exerts on the WVU player.

A. Greater than

B. Less than

C. The same as

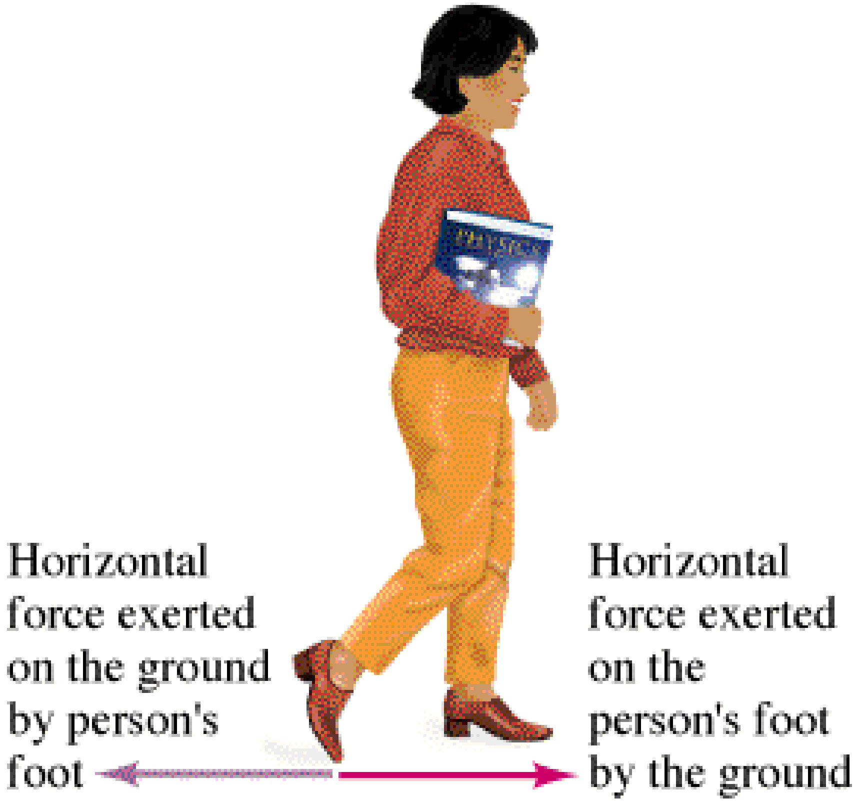
D. Depends on the acceleration of the players

E. Depends on the velocity of the players

Then why do they sometimes move?

To better understand how we obviously knock down the Marshall play yet still apply the same force, let’s break down this problem

Newton's Third Law



$$\vec{F}_{\text{net}} = \sum \vec{F}_i = m\vec{a}$$

Note: $\mathbf{F}_{PG}$ propels person forward
$\mathbf{F}_{GP}$ affects ground (Earth) - does not affect person

Does the football player have a force like this acting on him?

A car rounds a curve while maintaining a constant speed. Is there a net force on the car as it rounds the curve?

A. No—its speed is constant.
B. Yes.
C. It depends on the sharpness of the curve and the speed of the car.

Q29

Harder Clicker Questions Follow

- Do these for more the more challenging examples. One might end up on test.
- Most test questions will not be this hard.

In A World Without Friction

In the absence of friction, if I hit a golf ball into a large truck, what would happen? Truck brakes are on.

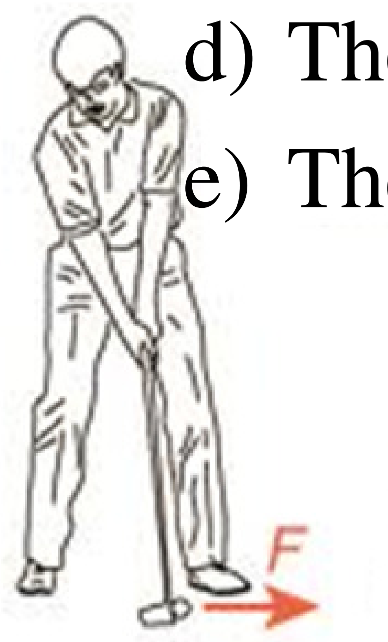
a) The truck does not move, because it is much bigger than the golf ball.

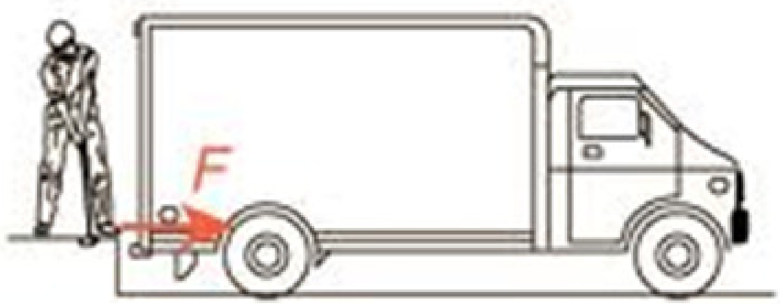
b) The truck does not move because brakes are on.

c) The truck moves slightly and comes to a stop.

d) The moves slowly at a constant speed.

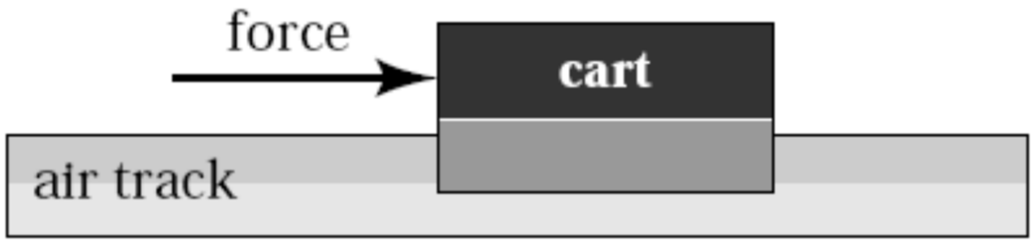
e) The truck speeds away quickly.





Q30

A constant force is exerted for a short time interval on a cart that is initially at rest on an air track. This force gives the cart a certain final speed. The same force is exerted for the same length of time on another cart, also initially at rest, that has twice the mass of the first one. The final speed of the heavier cart is

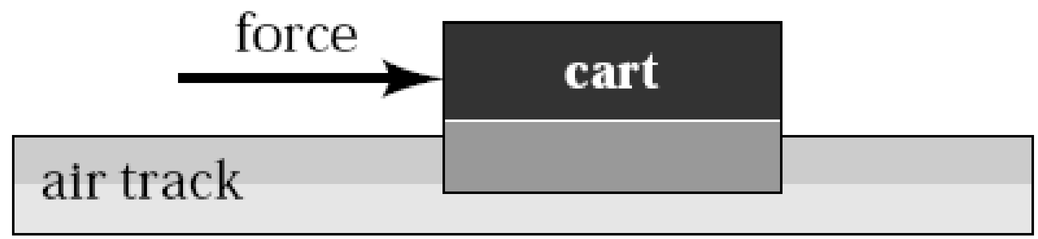


A. one-fourth
B. four times
C. half
D. double
E. the same as

that of the lighter cart.

Q31

A constant force is exerted on a cart that is initially at rest on an air track. Friction between the cart and the track is negligible. The force acts for a short time interval and gives the cart a certain final speed.



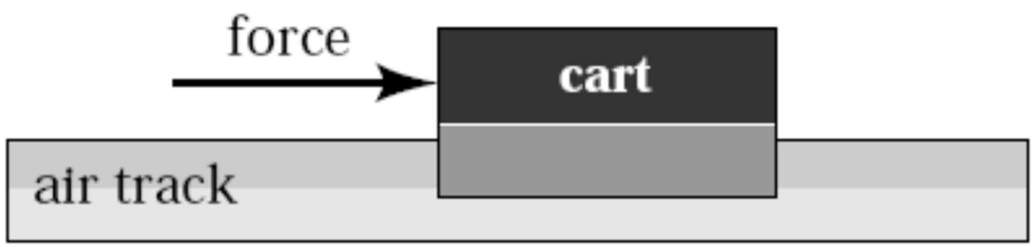
To reach the same final speed with a force that is only half as big, the force must be exerted on the cart for a time interval

A. four times as long as
B. twice as long as
C. equal to
D. half as long as
E. a quarter of

that for the stronger force.

Q32

A constant force is exerted for a short time interval on a cart that is initially at rest on an air track. This force gives the cart a certain final speed. Suppose we repeat the experiment but, instead of starting from rest, the cart is already moving with constant speed in the direction of the force at the moment we begin to apply the force. After we exert the same constant force for the same short time interval, the increase in the cart's speed



A. is equal to two times its initial speed.
B. is equal to the square of its initial speed.
C. is equal to four times its initial speed.
D. is the same as when it started from rest.
E. cannot be determined from the information provided.

Q33

Nancy the dog has a good owner. What would happen to Nancy if not strapped in and the car brakes were rapidly applied?

What force causes this change in velocity as the dog flies off of the seat (but before hitting the seat in front)?

A. A force from the bottom of the seat

B. The force from the back of the seat

C. The Dog

D. No Force, Nancy's velocity isn't changing

Q34

Clicker Answers

Chapter/Section: Clicker #=Answer

25=A, 26=E, 27=C, 28=C, 29=B, 30=D, 31=C, 32=B, 33=D, 35=D