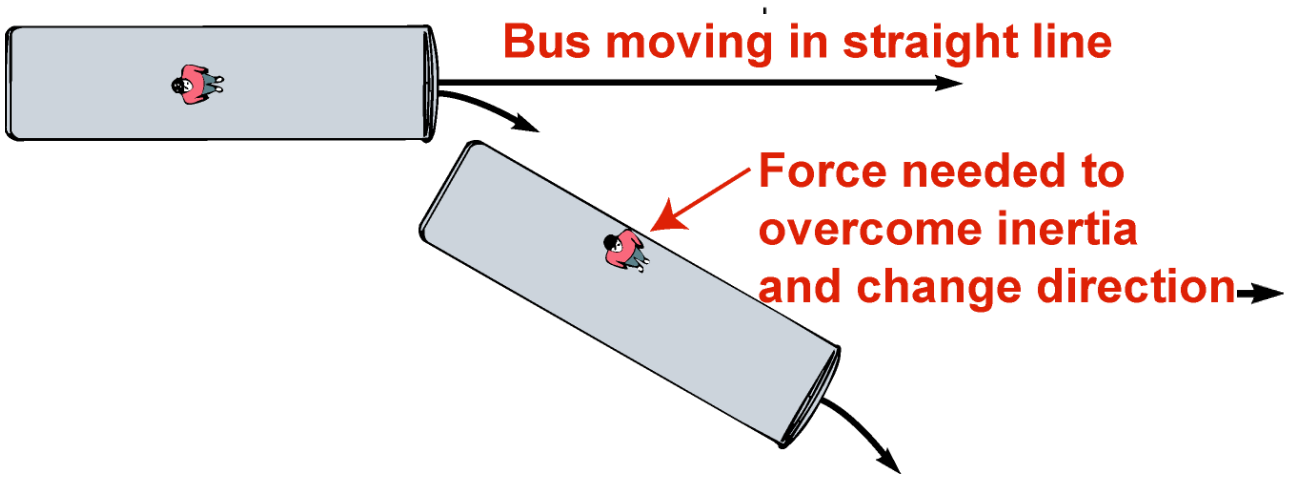
Newton’s Laws

Physical Science 115

Newton's 1st Law of Motion

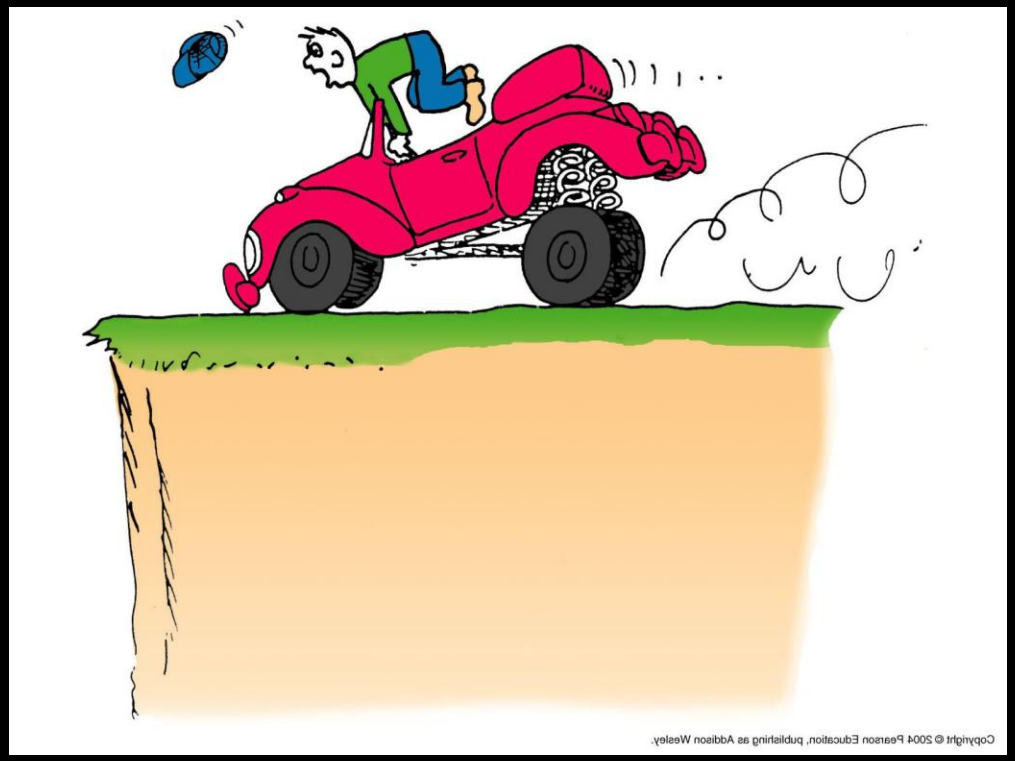
- "The law of inertia"
- Every object retains its state of rest or its state of uniform straight-line motion unless acted upon by an unbalanced force.
- Inertia resists any changes in motion.



Inertia

- The property of objects to maintain their state of motion.
- Resistance to changes in motion.
- “sluggishness”
- “laziness”

Objects in motion stay in motion



When you slam on the breaks, you fly forward. Is there a force pulling you forward?

More Examples of Inertia (objects at rest stay at rest)

Why will the coin drop into the glass when a force accelerates the card?

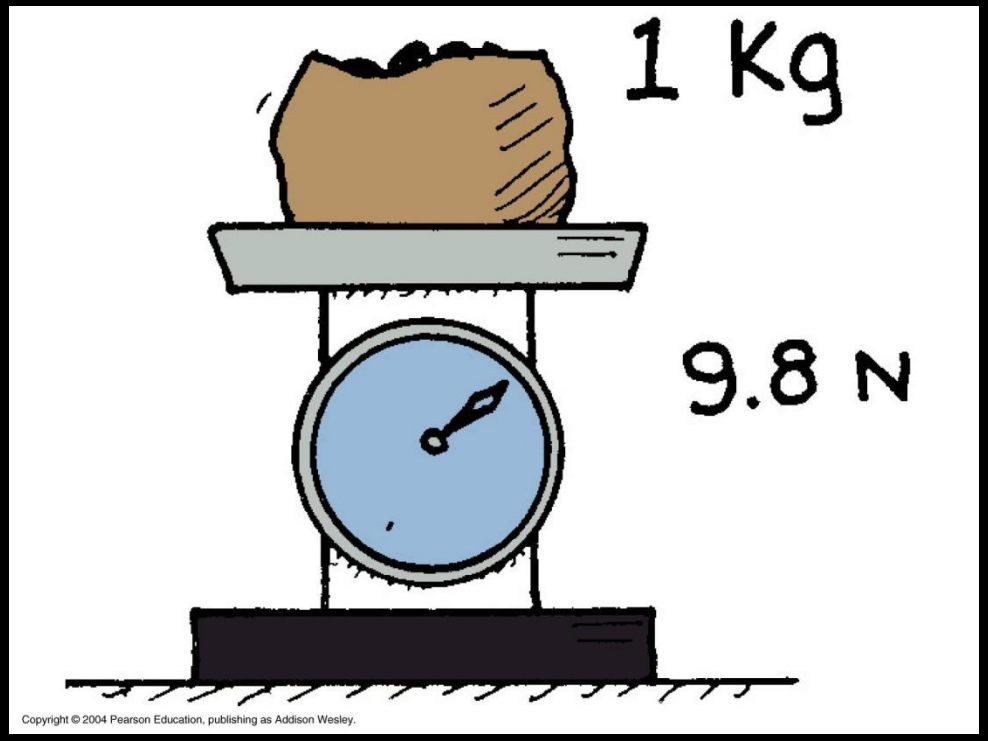
Why is it that a slow continuous increase in the downward force breaks the string above the massive ball, but a sudden increase breaks the lower string?

Why does the downward motion and sudden stop of the hammer tighten the hammerhead?

Weight

- the force exerted on a body by the pull of the earth or some other large body.

One Kilogram Weighs 9.8 Newtons

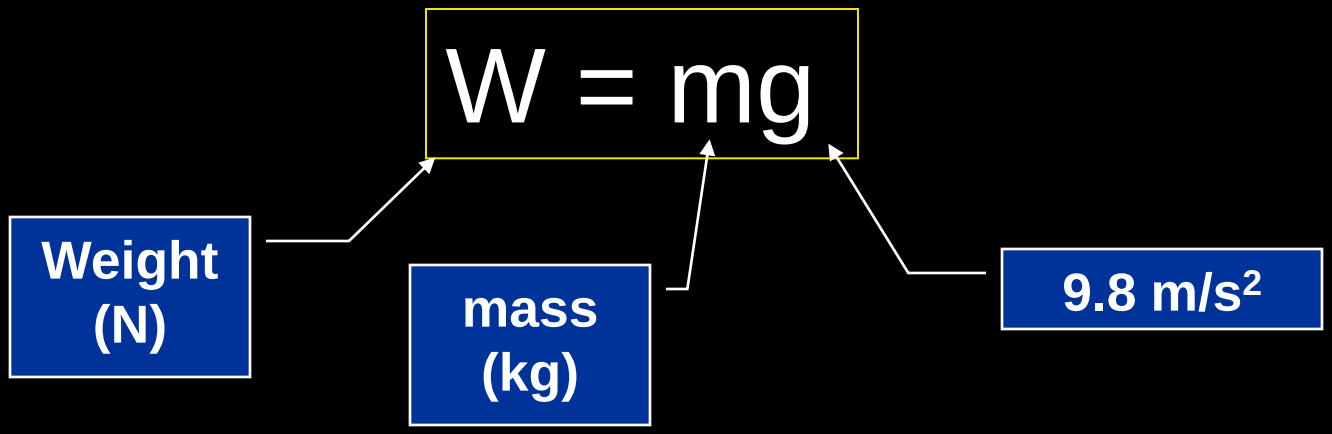


1 kg = 9.8 N

1 kg = 2.2 lbs

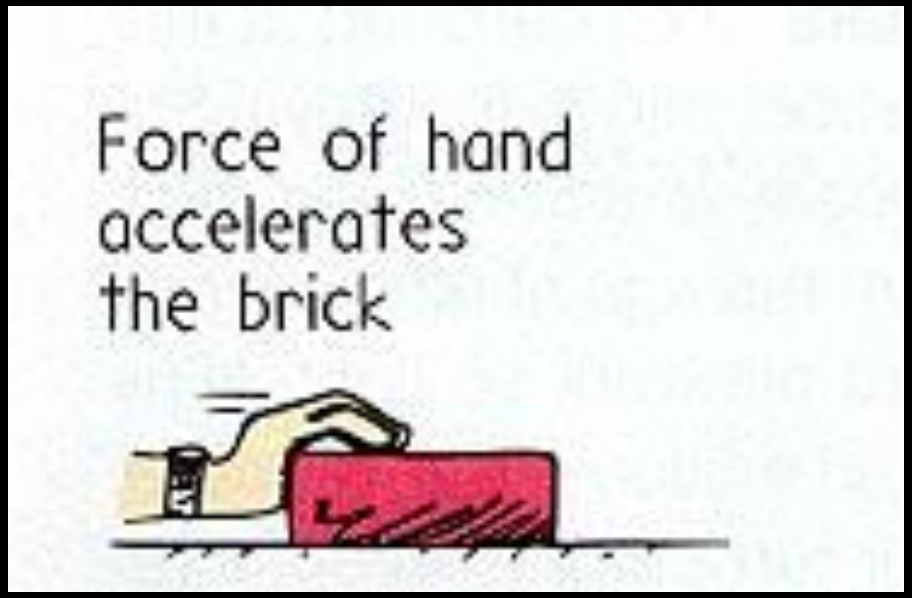
1 lb = 4.5 N

How do we define weight?

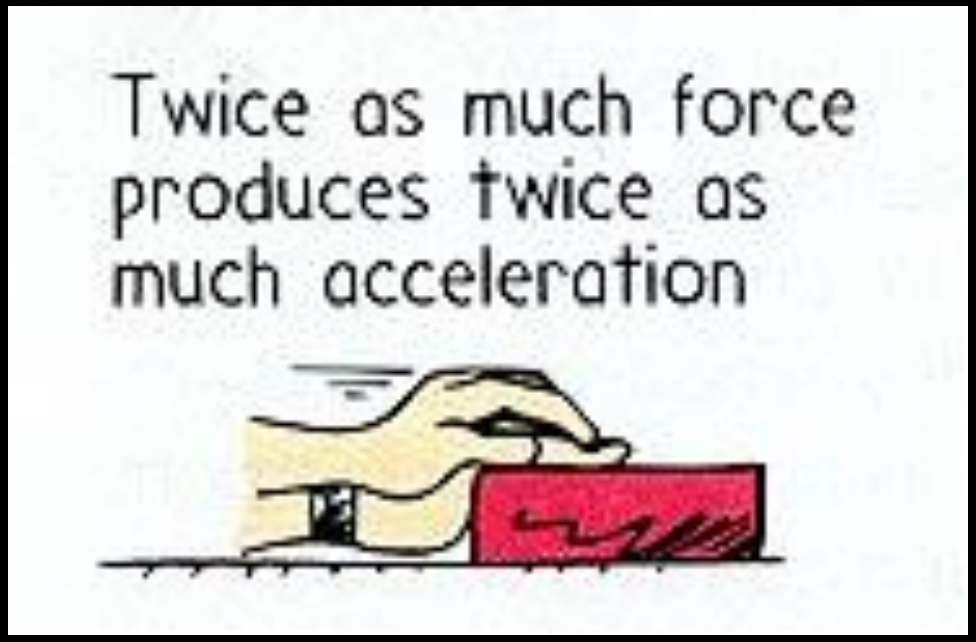


Example: How much does a 10 kg object weight?

Answer: 98 Newtons



How is force related to acceleration?



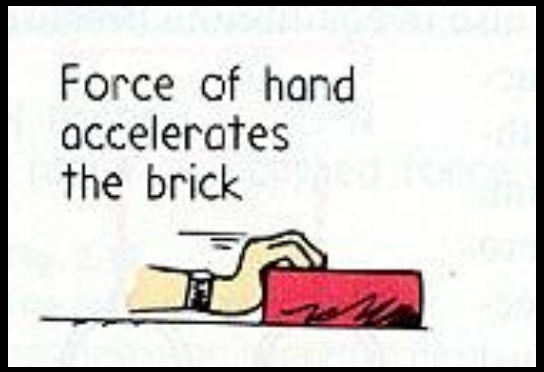
If a heavy object like a kilogram weight and a paperclip is dropped from the same height, they will both reach the ground at the same time.

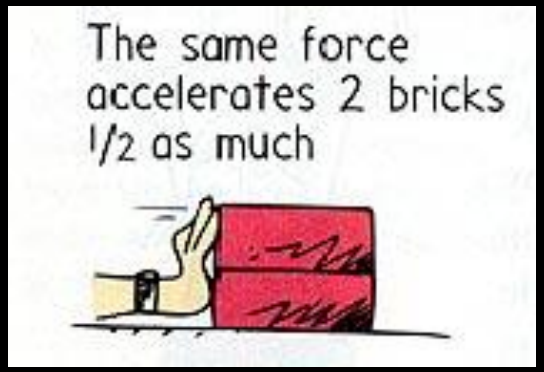
Since the kilogram weight is heavier than the paperclip , this means that there is more gravitational force acting on the heavier object.

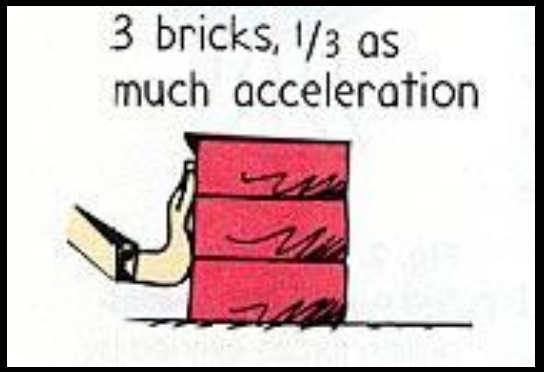
Why doesn’t the heavy weight accelerate to the ground before the paperclip does?

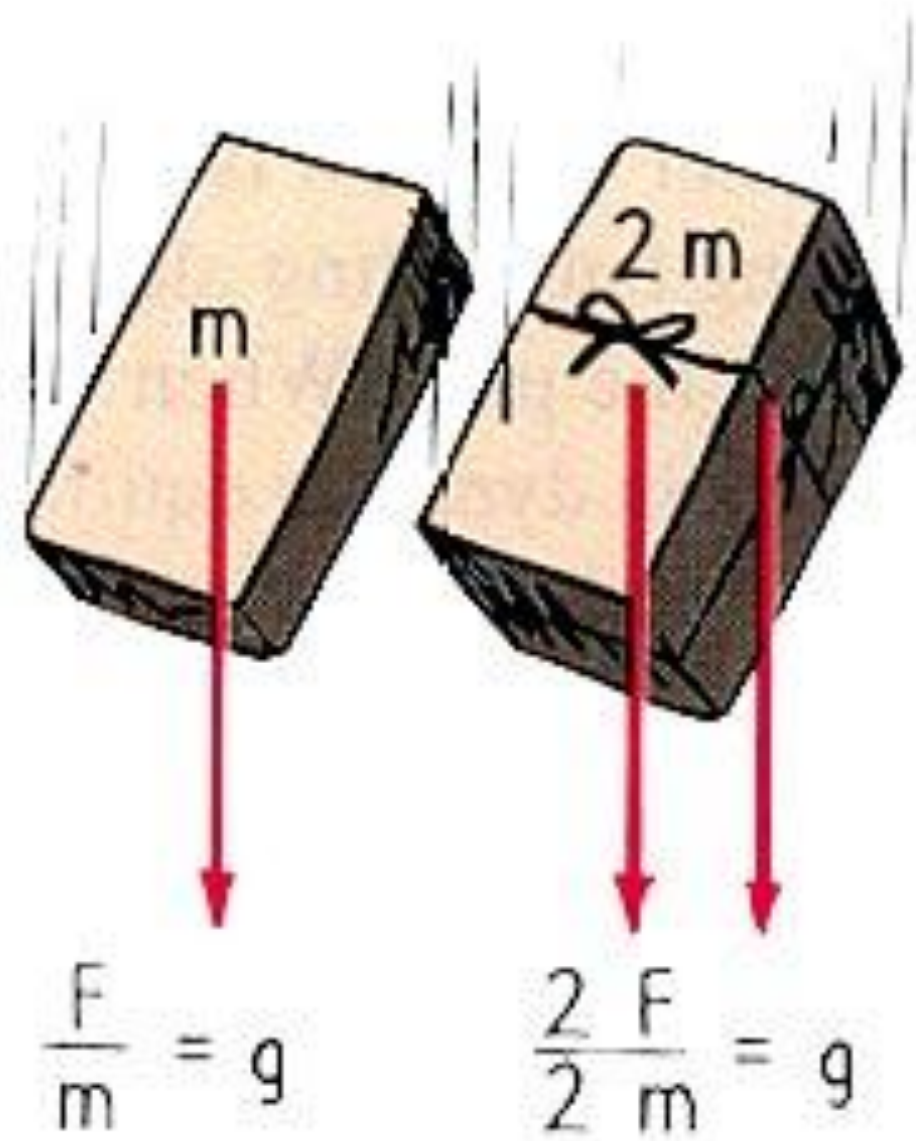
- Answer: Because of the mass.

- Acceleration is inversely proportional to mass.
- More mass => less acceleration.









Twice the force acts on twice the mass to yield the same acceleration, 9.8 m/s^2.

$$\frac{F}{m} = g$$

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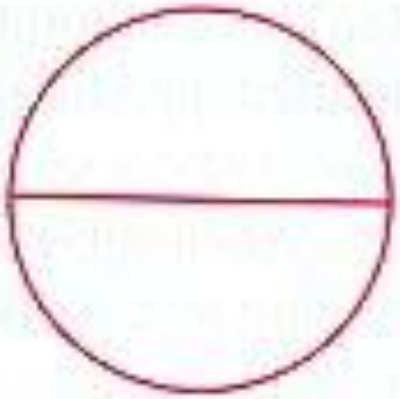

$$\frac{C}{D} = \pi$$

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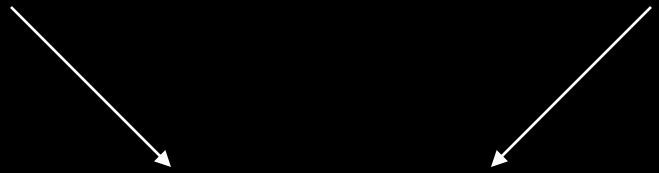
Newton's Second Law

a ~ force **a ~ 1/mass**



a = Fnet/mass

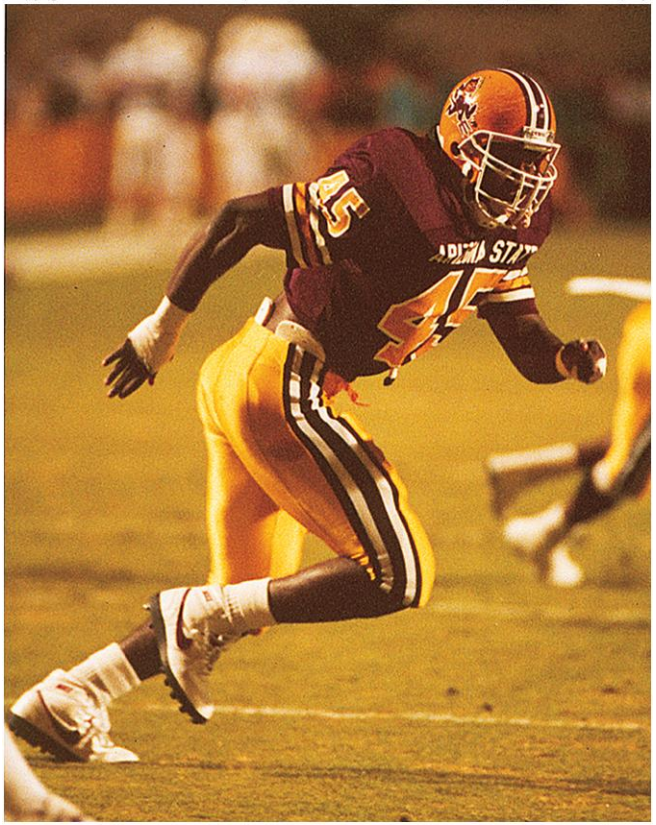
Newton's 2nd Law of Motion

- Forces cause accelerations
- Units = Newtons (N)
- Proportionality constant = mass
- More force, more acceleration
- More mass, less acceleration

$$F_{net} = ma$$

Newton’s 3rd Law of Motion

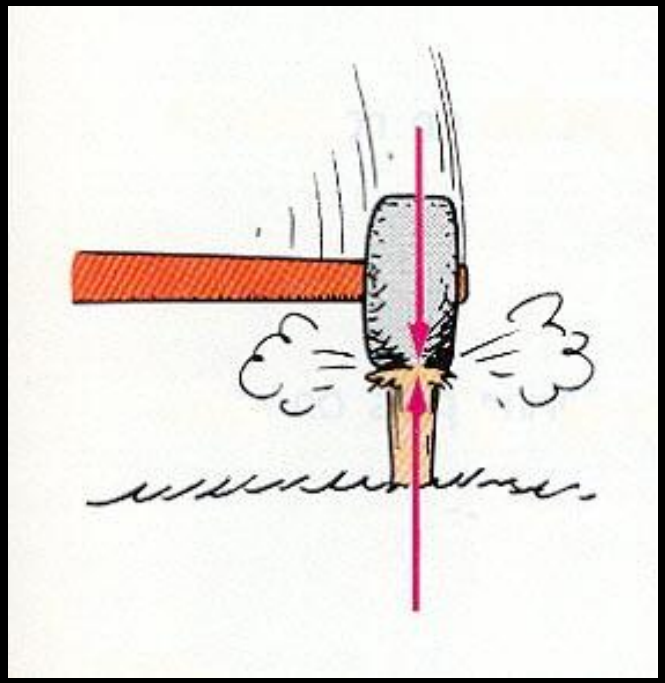
- Source of force - other objects
- 3rd law - relates forces between objects
- “Whenever two objects interact, the force exerted on one object is equal in size and opposite in direction to the force exerted on the other object.”



Newton's Third Law

- Whenever one object exerts a force on a second object, the second object exerts an equal and opposite force on the first.
- Action/Reaction forces ALWAYS comes in pairs.

3rd Law: Action/Reaction



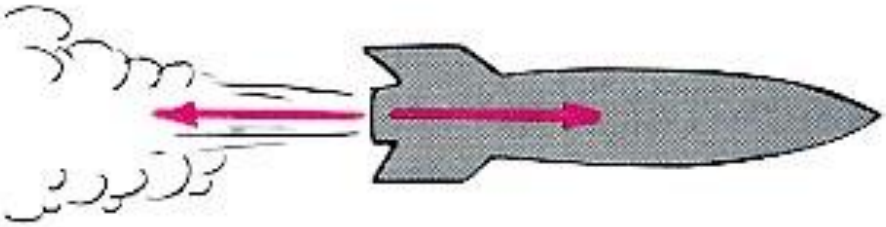
Hammer pushes on stake.
Stake pushes on hammer.

The hammer *acts*, the stake *re-acts*.

Action-Reaction Pair Examples

Action: tire pushes on road

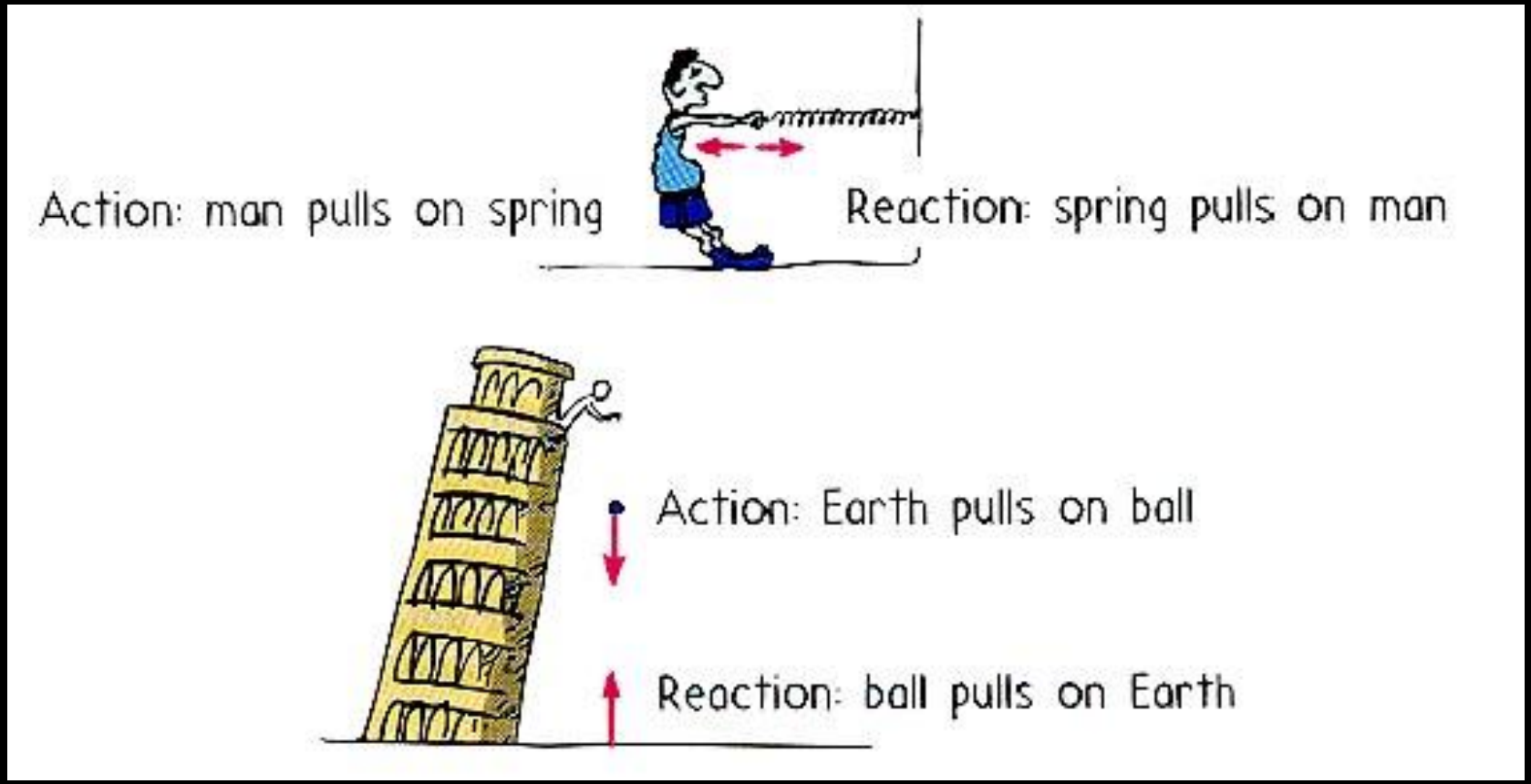
Reaction: road pushes on tire



Action: rocket pushes on gas

Reaction: gas pushes on rocket

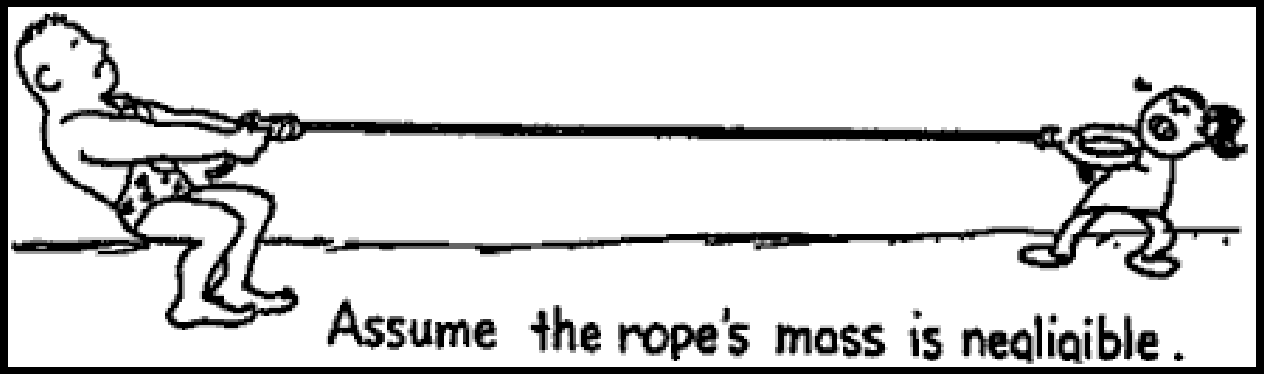
Action/Reaction Examples



Check Question

1. We know that the earth pulls on the moon. Does it follow that the moon also pulls on the earth? With the same magnitude?
2. A unfortunate bug has a head-on collision with your windshield while you are driving on the freeway. Which experiences more force? Your car, the bug, or both the same?

Tug-of-War



Who is pulling harder on the rope, Arnold Strongman or Suzy Small?

Who wins a tug-of-war, those who pull harder on the rope, or those who push harder against the floor?