

Newton's 3rd Law

Proof of Newton's 3rd law



in 3..2..1

PunditKitchen.com

Outcome:

S2-3-07 Investigate and describe qualitatively Newton's Third Law.

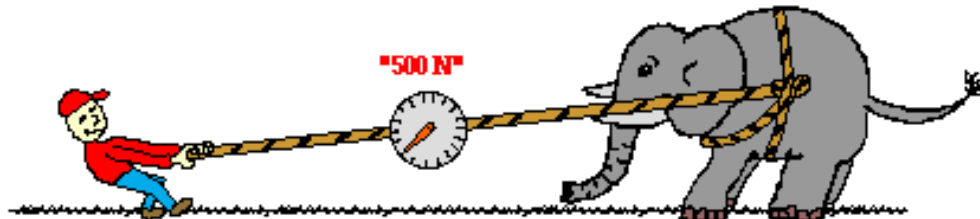
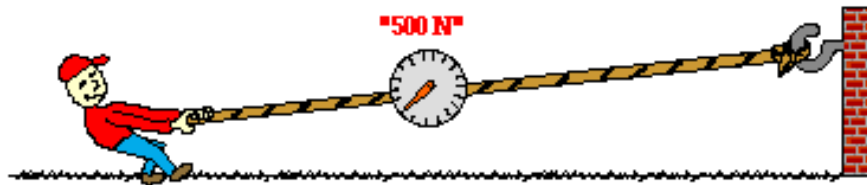
Newton's 3rd Law...

Newton's Third Law states:

"For every action there is an equal, but opposite reaction."

FORCES always occur in PAIRS, and are either BALANCED or UNBALANCED.

Remember that UNBALANCED forces cause ACCELERATION, but there will be NO ACCELERATION if the forces are BALANCED.



Newton's 3rd Law...

Example 1:

You prepare to jump while on a skateboard...

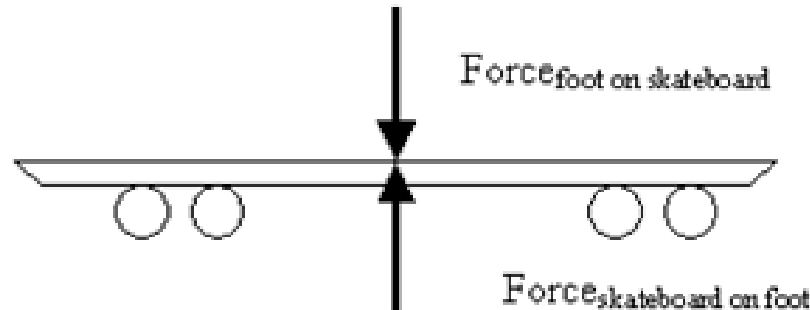
As you jump:

ACTION:

- Your **FEET PUSH DOWN** on the upper surface of the skateboard

REACTION:

- The skateboard **PUSHES UP** on your **FEET** with an **EQUAL** but **OPPOSITE** force (you seem to "**STICK**" to the skateboard for a moment)

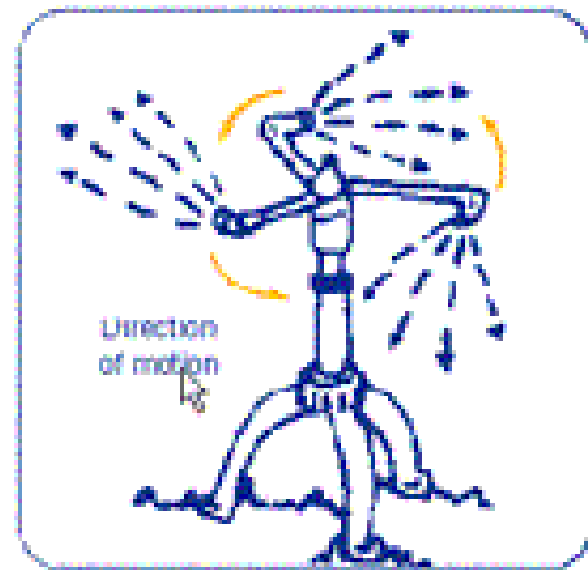


The **FORCE** that **INITIATES** (starts) the reaction can thus be named the **ACTION** force, and the force that **RESPONDS** to the initial action can thus be called the **REACTION** force.

Newton's 3rd Law...

Example 2:

What makes a sprinkler head turn?

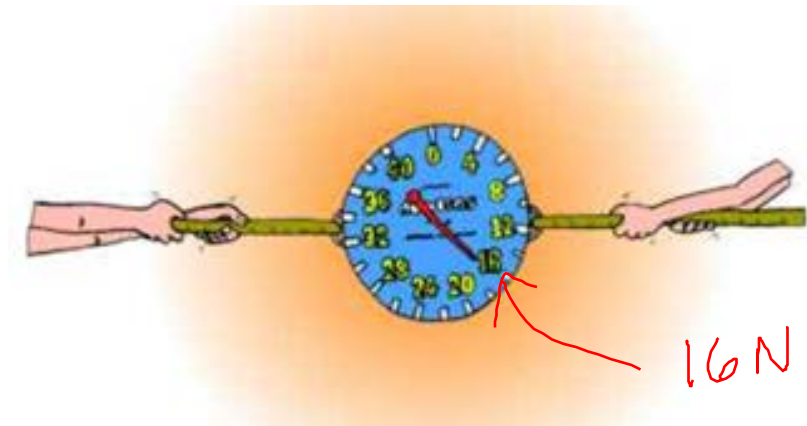


- To make the water move out of the nozzle, the **NOZZLE EXERTS A FORCE ON THE WATER**
→ **ACTION FORCE**
- The **WATER PUSHES BACK ON THE NOZZLE IN THE OPPOSITE DIRECTION**, making the nozzle spin in the opposite direction
→ **REACTION FORCE**

Newton's 3rd Law...

Example 3:

Two students of DIFFERENT MASSES pull on two pieces of rope that are connected by a spring scale to measure force. What does the scale read?



How do we know that the force exerted by the small student is exactly the same as the force exerted by the heavier student?

Balanced → no motion

Remember the relationship between force and acceleration.

UNBALANCED FORCES CAUSE ACCELERATION.

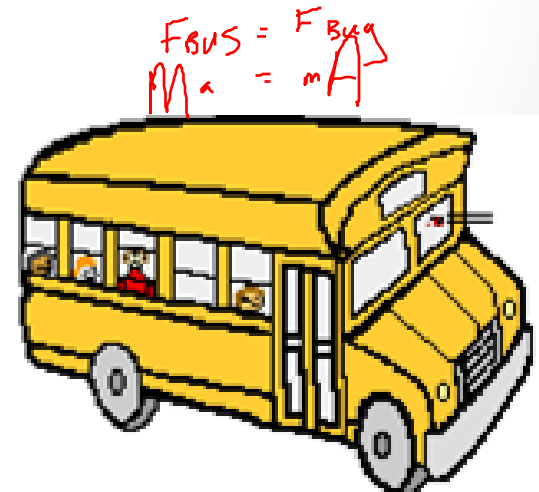
Newton's 3rd Law...

Try these ones...

1. Anna Litical watched a bug hit the windsheild of her school bus, obviously a case of Newton's 3rd law (the bug hit the windsheild, and the windsheild hit the bug). Which of the two forces is greater: the force on the bug, or the force on the windsheild?

Neither - the forces are the same!

The bug's acceleration changes quickly because its mass is so small



Newton's 3rd Law...

Try these ones...

2. For years, space travel was believed to be impossible because there was nothing which rockets could push off of in space in order to provide the propulsion necessary to accelerate. This inability of a rocket to provide propulsion is because
- a) Space is void of air so the rockets have nothing to push off of.
 - b) Gravity is absent in space.
 - c) Space is void of air and so there is no air resistance in space.
 - d) Nonsense! Rockets do accelerate in space and have been able to do so for a long time.

Rocket pushes gas out
gas pushes rocket forward



Newton's 3rd Law...

Try these ones...

3. Many people are familiar with the fact that a rifle recoils (kicks) when fired. This recoil is the result of action-reaction force pairs. A gunpowder explosion creates hot gases which expand outward allowing the rifle to push forward on the bullet. Consistent with Newton's third law of motion, the bullet pushes backwards upon the rifle. The **acceleration** of the recoiling rifle is ...
- a. greater than the acceleration of the bullet.
 - b. smaller than the acceleration of the bullet.
 - c. the same size as the acceleration of the bullet.

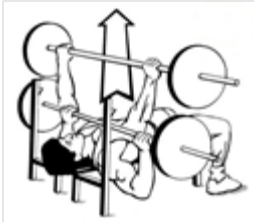


Newton's 3rd Law...

Try these ones...

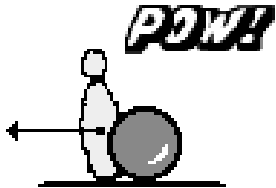
4. In the following scenarios the action force is stated. Determine the reaction force :

a. A weightlifter pushes the bar upwards:



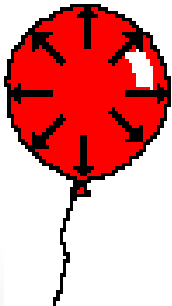
Reaction Force: *Bar pushes down*

b. A bowling ball pushes the pin leftwards:



Reaction Force: *Pin pushes ball right*

a. Air in the balloon pushes outwards:

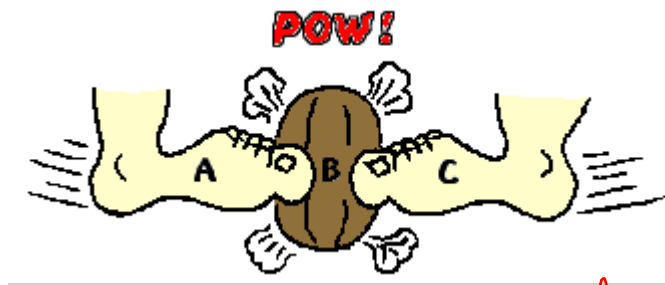


Reaction Force: *Balloon pushes inward*

Newton's 3rd Law...

Try these ones...

5. Consider the interaction depicted below between foot A, ball B, and foot C. The three objects interact simultaneously (at the same time). Identify the two pairs of action-reaction forces. Use the notation "foot A", "foot C", and "ball B" in your statements.



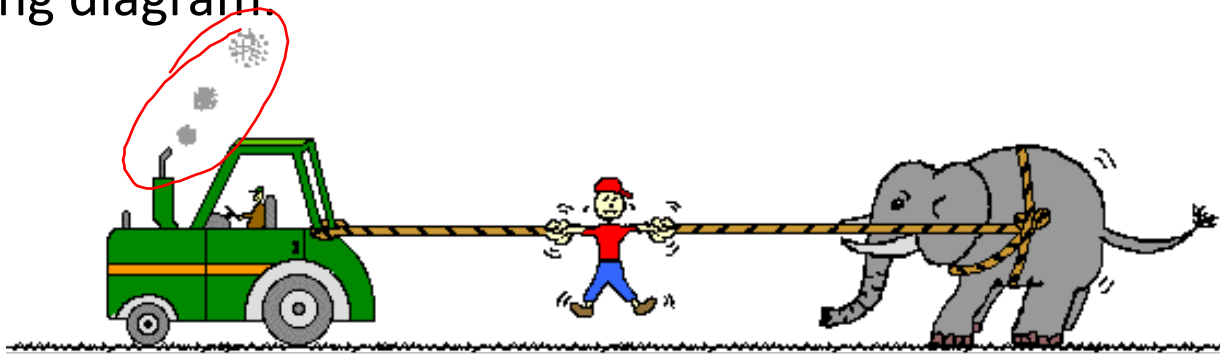
foot a pushes ball right
ball pushes foot a left

foot c pushes ball left
ball pushes c right

Newton's 3rd Law...

Try these ones...

6. Identify at least 5 pairs of action-reaction force pairs in the following diagram.



- ① kid & tractor
- ② tractor & ground
- ③ elephant & kid
- ④ elephant & ground
- ⑤ kid & rope
- ⑥ tractor & elephant
- ⑦ pipe & smoke