

# Newton's Third Law

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# Two Rules for Newton's 3rd

1. Every Action force has a Reaction Force. Period. Always.
2. Action and Reaction forces ALWAYS act on different objects.

# One Rule for Free Body Diagrams

1. All forces on the diagram for object A must act on object A.

# Interacting Systems

- Our Free Body Diagrams so far have primarily looked at isolated systems
- Since Action/Reaction pairs occur on different Free Body Diagrams, we need to consider how different systems interact with each other
- If we are considering the dynamics of a nail being nailed into a wall by a hammer, we probably don't care that the wall must exert a force on the earth.
- Forces from objects whose dynamics aren't being considered are called external forces.

# Example:

A crate is in the back of a truck. The truck accelerates forward, but the crate does not slip.

Draw the Free Body Diagram for the truck.

Draw the Free Body Diagram for the crate.

Indicate which forces are action/reaction pairs.

## Quick Quiz:

A crate is in the back of a truck. The truck accelerates forward, and the crate does slip...but there still is some kinetic friction acting between the bed of the truck and the crate. In which direction does the kinetic friction act?

- A) Forward
- B) Backward

# Newton's Third Law

A precocious child is given a wagon for her birthday. She refuses to use it. She says, "Newton's Third Law says that no matter how hard I pull, the wagon will exert an equal but opposite force on me. So I will never be able to get it to move forward!"

Is she right?

Does Newton's third law work for wagons?

## Quick Quiz:

A large wrestler and a small wrestler try to push each other backwards out of the ring. At first they are motionless as they push; then the large wrestler moves the other one backwards. Compare the *forces they exert on each other*. Which statement is correct?

- a) The forces are always equal.
- b) The larger wrestler always exerts a larger force.
- c) When they are motionless, the forces are equal. They start to move when the force on the small wrestler is larger than the force on the larger wrestler.

# What do pulleys do?

- In this course, a pulley has no mass and no friction
- The rope that goes around these magic pulleys also has no mass, and doesn't stretch
- A physics student can use these magic pulleys to change the direction of a force without changing that force's magnitude

# Worked Example

Three blocks are connected by strings on a level table. The masses of the blocks are 1 kg, 2 kg and 3 kg, respectively. The coefficient of kinetic friction between block 2 and the table is 0.1. What is the magnitude of tension  $T_1$  when the blocks are in motion?

