Newton’s Third Law of Motion

Law of Interaction or Action-Reaction Law

Balloon goes up

Air goes down

Every action has an equal and opposite reaction
Student Success Statement:

8.6C - investigate and describe applications of Newton’s law of inertia, law of force and acceleration, and law of action-reaction such as in vehicle restraints, sports activities, amusement park rides, and rocket launches

• Students will understand and investigate Newton’s third law through every day examples and an exploratory lab.
Why does this happen?
Newton’s Third Law of Motion states: *for every action, there is an EQUAL but OPPOSITE reaction.*
Action - Reaction

• Newton’s first two laws of motion explain how the motion of a SINGLE object changes.

• Newton’s third law describes: when one object exerts a force on ANOTHER (second) object.

• According to Newton’s third law of motion, forces always act in equal but opposite pairs.
Understanding the Law:

- If you have two objects, represented here by boxes.
• If an object exerts a force on another object,

• Then at other object is going to exert an equal and opposite force on the first object

• We call these “action-reaction pairs”
Action - Reaction

- The forces exerted by two objects on each other are often called an action-reaction force pair.
- Either force can be considered the action force or the reaction force, and these two forces are equal in strength (magnitude) and opposite in direction.
- Action and reaction force pairs don’t cancel because they act on different objects in the situation.
A simple example:

• Right now, gravity is pulling you *down* in your seat, but Newton’s Third Law says your seat is pushing *up* against you with *equal force*.

• This is why you are not moving. There is a *balanced force* acting on you—gravity pulling down, your seat pushing up.
Equal forces, but Opposite directions of movement

- A ball is thrown against a wall:

- The ball puts a force on the wall (action force), and the wall puts a force on the ball (reaction force) so the ball bounces off the wall with the same force.
Action - Reaction

• You constantly use action-reaction force pairs as you move.

• When you jump, you push down on the ground (action).

• The ground then pushes up on you. It is this upward force that pushes you into the air. The effect of the reaction force is hard to detect because the earth is so massive.
Equal forces, but **Opposite** directions of movement

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- The ball puts a force on the wall (action force), and the wall puts a force on the ball (reaction force) so the ball bounces off the wall with the same force.
Action-Reaction on a Rocket:

- Let’s look at a classic example of this law -

- Recall, for every action there is an **equal** and **opposite** reaction
Rocket Launch in Action-Reaction Pairs

- Video 1
- Video 2 (at 1.36 mark)
Rocket Launch -

- Rocket fuel burns from a chemical reaction (explosion) and makes gases

- **Action**: The downward push that happens when the gases push out and down.

- **Reaction**: As the ignited gases push down, the rocket has only one way to go – UP!

- The **two forces are equal in magnitude, but opposite in direction**
Summary – sketch and label!

• Action – gases push out from the thrusters (part of the engine) on the rocket
• Reaction – upward push or movement by the rocket (it goes up)
• The forces are EQUAL and OPPOSITE!
Action and Reaction Forces Don’t Cancel

• When a bird flies, its wings push in a downward and a backward direction (Action).
• This pushes air downward and backward.
• Reaction: the air pushes back on the bird in the opposite directions—upward and forward.
• The forces are acting on different objects, so they do not “cancel” each other.
Everyday Examples
Walking:

• When you walk forward, you push backward on the ground (action).

• Your shoe pushes Earth backward, and Earth pushes your shoe forward (reaction).
• Earth has so much mass compared to you that it does not move noticeably when you push it.

• If you step on something that has less mass than you do, like a skateboard, you can see it being pushed back.
Action – Reaction and Sports

Bowling example: Ball rolls down the lane and at the end what happens to the pin?
If the rolling bowling ball pushes pin leftwards, what movement does the pin have?

Pin pushes bowling ball rightward.

Recall what you know about balanced and unbalanced forces. There is a CHANGE IN MOTION!
Action – Reaction – Baseball:

• Consider the interaction between a baseball bat and a baseball.

• If the baseball forces the bat to the left (action force), the bat forces what to move in what direction?
Action – Reaction: Baseball

• The bat forces the ball (object) to the right (direction of movement is opposite).
• Again, forces are acting on different objects.
• Why does the ball going flying?
• The ball goes flying because it’s mass is less.
Action-Reaction in Running

- When is the action-reaction force pair happening in this example?
Action-Reaction in Volleyball

- When is the action-reaction force pair happening here?

Ball hits player’s hand – action         Reaction – hand hits ball – ball then moves in opposite direction
Action – Reaction and Vehicles

• **Stepping to land from boat:** The action force applied on the boat and the reaction force push you to land. The action force pushes the boat backward.
Action – Reaction and Amusement
Park Rides

• If two bumper cars traveling at the same speed and carrying the same amount of weight run into each other, they will bounce off and move an equal distance away from each other.

• So what is the action?

• And the reaction?
Check Your Understanding

• While driving down the road, an unfortunate bug strikes the windshield of a bus.
• The bug hits the windshield and the windshield hits the bug.
• Which of the two forces is greater:
  • the force on the bug or
  • the force on the bus?
Trick Question!

• Each force is the same size.
• For every action, there is an equal ...
• The fact that the bug splatters only means that with its smaller mass, it is less able to withstand the larger acceleration resulting from the interaction.
Video!

- https://www.youtube.com/watch?v=iV3NXFkdUyw
Help with balloon rocket sketch:

• Be sure to label “action force” and “reaction force”
Get ready to do the lab!

• Put up your notes in your binder
• Get your lab page and put your name on it.
Balloon Rocket Lab:  

Name: ___________________________  Class Period: _________  Due Date: _______

**Balloon Rocket Lab – Newton’s Third Law**

**TEKS:** 8.6C - investigate and describe applications of Newton’s law of action - reaction

**ATL Skill:** Research - Collect, record and verify data.

**Objective:** Students will investigate the law of action – reaction by building a balloon rocket.

**Requirements:** The balloon will travel over a measured distance in the shortest possible time. You must come up with a way for your balloon to travel from start to finish in the quickest way possible using only the pressure of air inside it to propel it forward.

**Materials:**
- Balloon
- String and meter stick
- Tape
- Stopwatch/phone
- Scissors
- Straw

\[
\text{Speed} = \frac{\text{distance}}{\text{time}}
\]
Lab Expectations:

• Be principled in your behavior and work only with your group, taking care to make sure you are in “your space”.

• Clean up when asked to do and put all supplies back away - room needs to be neat!

• In class – you MUST finish collecting data and record it.

• Outside of class (HW) are the analysis questions – due next class. Questions 3, 5 need to be in complete sentences.