Name ______________________________

Newton's Third Law

Newton's 3rd Law states: "for every action there is an equal and opposite reaction."

What is Newton's 1st law?

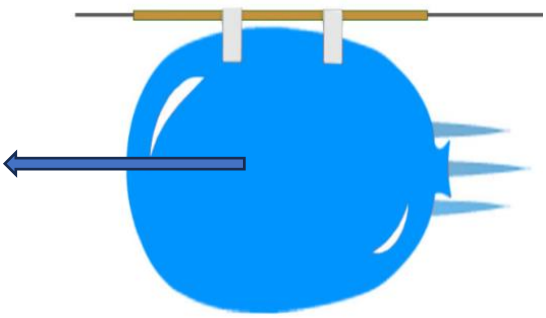
What is Newton's 2nd law?

Experiment 1: Rocket Balloon

We know from Newton's first law that a force is pushing on the front of the balloon. This force results from the molecules of air pushing on the inside of the *front* of the balloon. **Based on the example of the accelerating car, discuss what must the balloon be doing to the molecules of air?**

If the forward arrow on the balloon is the "reaction force" in Newton's third law, then where would we draw the "action force"?

Draw the action force onto the diagram below. (If the length of the force arrow tells us how "strong" the force is, or its magnitude, then how long would the action force arrow be? Be sure to show this on the diagram.)



Experiment 2: Rocket Balloon with Added Mass

Write out a hypothesis describing what will happen to the balloon as more and more mass is *removed*:

Hypothesis:

IF…mass is removed from the balloon

THEN… ____

BECAUSE… ____

Experiment 3: Massive Rocket Balloon

Is the balloon going to move rapidly or slowly along the wire?

Discuss as a group and write your answer below with an explanation:

____

Review:

- ✓ What is Newton's 3rd law?
- ✓ If the reaction force arrow is 3 cm long (representing the "power" of the force), then how long must the action force be?
- ✓ Removing mass from the balloon and observing the result is an example of which of Newton's laws?
- ✓ The *sluggishness* of the big, 90 cm balloon, is a good example of which of Newton's laws?

Newton's Third Law

Teacher Notes

***Newton's 3rd Law states:* "for every action there is an equal and opposite reaction."**

What is Newton's 1st Law? "An object at rest remains at rest and an object in motion continues in motion unless an outside force acts upon it."

What is Newton's 2nd Law? "Acceleration and force are proportional, and there is an opposite proportional relationship between acceleration and mass."

Demonstration: Pull back car

Teach

The "pull-back" car can be bought at K-Mart or Walmart. These kinds of cars have some kind of elastic device in the car that sort of "winds them up." You will also need a long, flat piece of carboard and some markers for the carboard to sit upon.

First, "wind up" the car, hold the wheels and then place it on the table. Now let the wheels go. It will accelerate away. Explain to them that as the wheels turned, they applied a backwards force that pushed on the table. Newton's third law tells us that there must also be an opposite and equal reaction. Thus the table pushed back on the wheels propelling the car forward. Now ask the students if they *saw* the table move backwards? Of course, they did not. And this is because the mass of the table is much greater than that of the car.

Now you are going to prove that indeed two forces of equal strength (magnitude) are at work when the car accelerates away. Place the markers down on the table and place the carboard over the markers as in the video. "Wind up" the car, hold the wheels and place on the carboard. Now let the car go. As the car accelerates away, its wheels push on the carboard, causing a backwards force. That is why the carboard goes backward. But, the carboard also pushes on the wheels causing it to move forward. Now ask the students if they observed two forces at work. Draw the car and the forces on the board (see video). You have confirmed Newton's third law.

Experiment 1: Rocket Balloon

Teach

Set up a wire using fishing line about 20 feet apart. Thread wire through a straw and attach the blown-up balloon to the straw (as in video) using tape. Attach a peg to the end of the balloon.

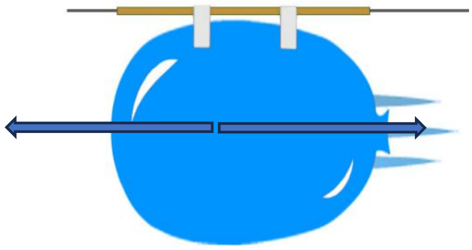
Group discussion about Newton's third law and balloon rockets

We know from Newton's first law that a force is pushing on the front of the balloon. This force results from the molecules of air pushing on the inside of the *front* of the balloon. Based on the example of the accelerating car, what must the balloon be doing to the molecules of air? Well, the balloon must also be pushing back on the molecules! Hence their ejection from the balloon!

From the lab on force, we learned that the molecules are pushing on the inside of the *front* of the balloon. We call this "pressure." But, according to Newton's third law, if the molecules are pushing on the balloon, then the balloon must push on the molecules. That means the balloon is "pushing back" on the molecules and forcing them out of the only available opening—the back of the balloon. In Newton's third law one of the forces is called the "action force" (the backwards force) and the other is called the "reaction force" (the forward force).

For effect, you can fill the balloon with a small amount of powder, like baking soda. Towards the end of the balloon's run, the powder will be pushed out of the back of the balloon. This helps illustrate what is happing with the air (see video). Make sure to do this outside!

If the forward arrow on the balloon is the "**reaction force**" in Newton's third law, then where would we draw the "**action force**"? Draw the action force onto the diagram below. And if the length of the force arrow tells us how "strong" (magnitude) the force is, then how long would the action force arrow be? Be sure to show this on the diagram.



Experiment 2: Rocket Balloon with Added Mass

Setup balloon rocket as before, only this time add weight to the balloon by sticking several objects like popsicle sticks, paper clips etc. to the balloon using sticky tape. Progressively remove these weights at the beginning of each run. Perhaps do three runs. This exercise is meant to be an overview of Newton's three laws, specifically reinforcing Newton's first and second laws.

Write out a hypothesis describing what will happen to the balloon as more and more mass is *removed*:

Hypothesis:

- **IF…**mass is removed from the balloon,
- **THEN…**its acceleration will be greater
- **BECAUSE…**as mass decreases, acceleration increases.

Experiment 3: Massive Rocket Balloon

This experiment is more for fun. You can buy very large 90 cm balloons! Blow one up and let it run along the wire. The students like this because the balloon is so big!

Is the balloon going to move rapidly or slowly along the wire?

Discuss as a group and write your answer below with an explanation:

The balloon will move sluggishly because it has more mass and more air (added mass). (Although this is true, you will find that the students will think the balloon is going to skip along the wire because of its size! Wrong!)

Teach

This is more an example of Newton's first law. Because the balloon has more mass, and it is also filled with a lot of air (so more mass again), it will possess a greater amount of inertia and so resists moving (changing its speed). It is also an example of Newton's second law because as you increase the mass you will get a proportional decrease in acceleration.

Review:

- ✓ What is Newton's 3rd law?
- ✓ If the reaction force arrow is 3 cm long (representing the "power" of the force), then how long must the action force be? 3cm
- ✓ Removing mass from the balloon and observing the result is an example of which of Newton's laws? Newton's second law.
- ✓ The *sluggishness* of the big, 90 cm balloon, is a good example of which of Newton's laws? Newton's first law.