Balloon Rockets **Primary Audience: 2nd-4th Grades**

Description: Participants will create a rocket (balloon) to demonstrate Newton's 3rd Law and then see what they can do to make their balloons go farther.

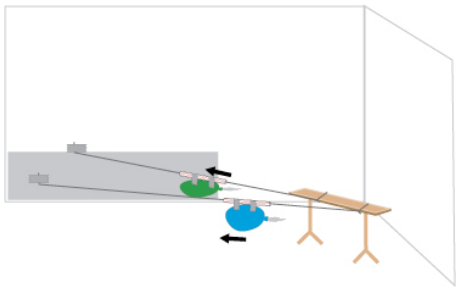
Keywords: Newton, friction, force, balloon, rocket

Concepts:

- A rocket is propelled by gas escaping from a container.
- Newton's 1st Law – An object in motion tends to stay in motion and an object at rest tends to stay at rest until acted upon by an unbalanced force.
- Newton's 3rd Law – Every action is accompanied by an equal and opposite reaction.

Materials:

- For Demonstration
  - Skateboard
  - Large Balloon
  - Pin
- Per Room:
  - Multiple Strings of Equal Length Strung Between Supports, Each with a Piece of Straw Suspended on the String
  - Tape Dispensers
- Per Group:
  - Large Long Balloons (Several per Group)
  - Balloon Pumps
  - Fluorescent Mason Line
  - Straws
  - Tape
  - Clothespins



Instructions:
SET UP:

1. Attach the mason line to the top of the carpet wall with duct tape.
2. Thread the mason line through the two straws. Tie the other end to the balance beam. Place the signs at either end of the balance beam.
3. Another line that can be attached so that it is horizontal to provide another place for experimentation.
4. This is an activity best suited for at least 2 people.

PROCEDURES:
Over 300 years ago a famous scientist named Sir Isaac Newton worked out a set of rules that explain why things move the way they do. These rules still apply today, even to the most modern machinery.

One of these laws stated that for every action, there is an equal and opposite reaction. I'll bet that some of you can think of actions that have noticeable reactions. What about the last time you got angry and slammed the door to your room? Did a nearby adult have an immediate reaction? Well, Newton wasn't talking about those types of actions/reactions, but right now we are going to see what types he was talking about.

Ask for a volunteer from the audience. Have the participant stand on the skateboard close to a wall. What will happen if the volunteer pushes against the wall (the action)? The volunteer and the skateboard will move away from the wall (the reaction).

What sort of a reaction do you get when you put a pin into an inflated balloon? What happens to the air inside the balloon when you do that? (Demonstrate it!) (The air rushes out.) Right now we are going to experiment to see what happens when we control that air as it is escaping.

Have lines set up around the room for participants to use with their balloons. Have some lines horizontal to floor, some at angles to the floor. Try various materials (string, fishing line, yarn) to compare how fast the balloon rockets move in relation to friction.

Balloons can also be raced from each end of the line to see which reaches the middle first, or from the middle to see which reaches the ends first.

Have participants form lines behind supports (two, four or more lines, depending on how

many volunteers are available). You can have half the participants on each end so that two participants race down to one end of the lines, then another two participants race back.

Pass out a balloon to each participant. Demonstrate safe balloon blowing techniques: Hold on to the balloons as they are blowing them up; do not over inflate.

Tell them they are going to race their balloons to the end of the strings, two participants at a time.

They are to figure out what they have to do to make their balloons move quickly along the string.

Have participants blow their balloons up, but not tie them. Participants should just hold on tightly to the balloon opening.

When the participants are ready to race balloons, tape the balloons onto the straws. Give a signal for the race to start. Have participants release the balloons and watch them go!

After completion, participants then remove their balloons from the straws.

When the races are over, have participants sit down. Ask the participants what causes the balloons to race down the string? (The air rushing out of the balloon) In this case, the action was the air rushing out of the opening, and the reaction was the balloon rushing down the string. Why did the balloons stay on the straws? Friction!

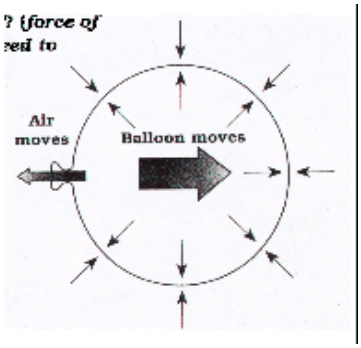
You can also set this up at several stations so participants can try placing their balloons at various angles to the string. What happens if you place the balloon at right angles to the string? What happens if you place two balloons on a straw with both ends opened, one balloon facing forward, and one facing backward? Let the students come up with their own experiments. Did you see action/reaction taking place even when you didn't get the reaction you desired?

Possible Interactive Questions:

- How should we attach this balloon to the straw to make it go up the string?
- Which way do you think the balloons should face? What will happen to the air inside the balloon? How is this like a tank of fuel on a rocket or space shuttle?
- How far will your balloon go if you fill it half way?
- What happens if you put some weight on one side of the balloon (this can be some extra tape)? Will it go farther? Why or why not?
- How could you make the balloon go further along the line/ string?
- What if we attach two balloons to the straw? What if the two balloons face different ways?

What's Going On?
For every action (in this instance, the air being squeezed out of the opening in the balloon) there is a reaction (in this instance, the balloon being pushed backwards along the string).

Before the balloon is released, the air trapped inside pushes out equally in all directions. All the forces are in balance. The elastic balloon material pushes inward equally in all directions, thus the forces cancel one another, and no movement occurs.



Once the neck of the balloon is opened, the trapped air is able to escape through the neck of the balloon, and the forces no longer balance in all directions. As the balloon pushes air through its neck, the air pushes back against the balloon in the opposite direction (remember Newton's Third Law of Motion), and the balloon moves forward. The forces at work on the balloon are similar to the forces that cause a rocket to accelerate or change direction in space.

Further Exploration:

1. Attempt this experiment with additional weights. Will the balloons travel as far? Why not? How can you make the balloon travel the same distance without adjusting the payload?

Relevant Ohio Science Content Standards:

- Physical Sciences 3-5: Describe the forces that directly affect objects and their motion.
    - 3.4: Predict the changes when an object experiences a force (e.g., a push or pull, weight and friction).
- Physical Sciences 6-8: In simple cases, describe the motion of objects and conceptually describe the effects of forces on an object.
    - 8.3: Explain that an unbalanced force acting on an object changes that object's speed and/or direction.
- Physical Sciences 9-10: Explain the movement of objects by applying Newton's three laws of motion.
    - 9.22: Demonstrate that any object does not accelerate (remains at rest or maintains a constant speed and direction of motion) unless an unbalanced (net) force acts on it.
    - 9.23: Explain the change in motion (acceleration) of an object. Demonstrate that the acceleration is proportional to the net force acting on the object and inversely proportional to the mass of the object. (F net=ma. Note that weight is the gravitational force on a mass.)

- 9.24: Demonstrate that whenever one object exerts a force on another, an equal amount of force is exerted back on the first object.