BALLOON ROCKETS

INSTRUCTIONS

Overview:

Students build a balloon rocket that moves along a string. Students compare how the volume of air in the balloon affects the distance the balloon travels. With the data collected, students graph the results and use Newton's third law of motion to describe the action and reaction forces that caused the balloon to move.

Objectives:

The student will:

- use Newon's third law of motion to explain the motion of a balloon rocket;
- draw a diagram showing the action and reaction forces that caused the motion of the balloon; and
- collect and graph data.

Targeted Alaska Grade Level Expectations:

Science

[10-11] SA1.1 The student demonstrates an understanding of the processes of science by asking questions, predicting, observing, describing, measuring, classifying, making generalizations, analyzing data, developing models, inferring, and communicating.

[10] SB4.1 The student demonstrates an understanding of motions, forces, their characteristics, relationships, and effects by recognizing that when one thing exerts a force on another, an equal amount of force is exerted back on it.

[11] SB4.1 The student demonstrates an understanding of motions, forces, their characteristics, relationships, and effects by conducting an experiment to demonstrate that when one thing exerts a force on another, an equal amount of force is exerted back on it (L).

Whole Picture:

Newton's third law of motion states that whenever an object exerts a force on a second object, the second object exerts an equal and opposite force on the first object. It is often simplified to say that for every action there is always an equal and opposite reaction. Anyone who has fired a gun will recognize the action and reaction forces that take place when a shot is fired. The bullet goes in one direction, and the person who fired the gun can feel the recoil of the rifle moving in the opposite direction. When a rocket is launched, the burning fuel causes the rocket to move in a direction opposite from the thrust coming from the engines. In this activity the thrust for the balloon is caused by air being propelled out the neck of the balloon. Students investigate how different volumes of air affect the motion of the balloon.

Materials:

- Skateboards, roller blades, scooter carts (from gym), or ice skates to be used on ice (two or two pairs)
- Balloon (9" round or cylindrical types) (one per group)
- Fishing line (one 5 meter length per group)
- Drinking straw (non flexing) (one per group)
- Tape (one per group)
- String (one per group)
- Ruler (one per group)
- TEACHER INFORMATION SHEET: "Balloon Rockets"
- STUDENT LAB: "Balloon Rockets"

Activity Preparation:

1. Ask students to bring in skateboards (two), or roller blades (two pairs) to use for the demonstration. Alternatively, the gym may have scooter carts that could also be used.

Activity Procedure:

1. Ask two students to face one another while each student is standing on a skateboard (or with roller blades on, scooter carts, etc.). This should be done on a hard surface and not on carpet.
2 Ask the class what will happen if the students on skateboards try to push away from each other. Have the students put their hands together and (gently) push away from each other. Use Newton's third law to explain what they observed. Ask the class if they think it is possible for just one student to push the other student away. Why or why not?

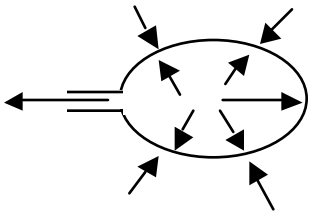
   NOTE: Newton's third law states that for every action force there is an equal and opposite reaction force. If the students weighed about the same, and the friction of each skateboard is the same, then each student should have moved an equal distance in opposite directions.

3. Repeat the demonstration with two students who weigh different amounts, or with the teacher and a student. Ask students what will happen when they push away. Do the demonstration and ask a student to explain why the results were different. Ask if the forces were different when the weights were different. Ask students how they could have one person on the skateboard move away without the other person moving.
4. Put the skateboards aside and inflate a balloon. Ask students what is going to happen when you let go of the balloon. Ask a student to draw a diagram of the forces acting on the balloon that will cause it to fly around the room. Ask students what factor(s) affect how far the balloon will travel. Ask students how they could determine if the volume of air in the balloon affects how far the balloon will travel.
5. Divide students into groups. Hand out STUDENT LAB: "Balloon Rockets" and explain the procedure. Before students begin testing the balloons, have them decide how they will hold the fishing line level and taut. The fishing line will be used for four trials, so both ends should not be tied off. Two students could each hold one end of the line, or one end could be tied off, leaving the other end to be free to thread through the straw multiple times.

Answers:

STUDENT LAB: "Balloon Rockets"

Analysis of Data:

1. Answers may vary. The balloon should have moved a greater distance with a greater volume of air due to the increase of force and the increase in the amount of air being expelled.
2. 
3. The balloon is similar to a real rocket because both move in the direction opposite the thrust.
4. When Dana jumped from the boat she applied an action force on the boat causing it to move backwards. The reaction force from the boat acting on her was not enough to allow her to land on the dock. The result is that Dana would land in the water and the boat would move away from the dock.
5. Since the fan is attached to the boat, the action and reaction forces will be equal and opposite so there will be no movement. If Pat wanted the boat to move, it would be better to turn the fan around to face the water, to use the boat like an airboat.

NAME: _____

BALLOON ROCKETS

Testable Question:

Does the volume of air in a balloon affect the distance the balloon will travel?

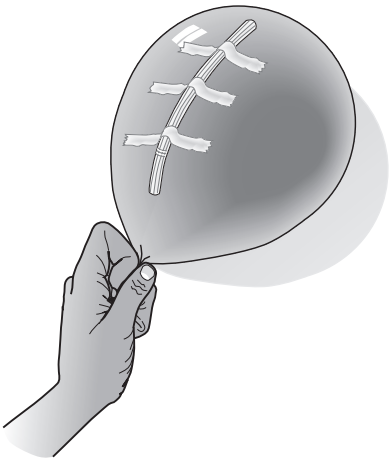
Investigation:

Materials:

- Balloon
- Fishing line (5-meter length)
- Drinking straw (non flexing)
- Tape
- String
- Ruler

Procedure:

1. Gather materials and decide how to set up the fishing line to test the balloons. Be sure the fishing line is level during all the trials.
2. Run one end of the fishing line through a straw and set it aside.
3. Blow up the balloon to the full amount, but do not tie it off. Measure the circumference of the balloon by wrapping string around it at the widest point. Record the circumference in the data table. Measure the length of the string with a ruler and record the length on the data table.
4. While still holding the balloon, have a lab partner tape the straw onto the balloon. It should be attached so the neck of the balloon is parallel to the floor when the line is stretched out.
5. Make sure the line is level and taut, then release the balloon to let the air escape.
6. Measure the distance the balloon traveled down the string and record the distance on the data table.
7. Repeat steps 2–6 for the different volumes of air.

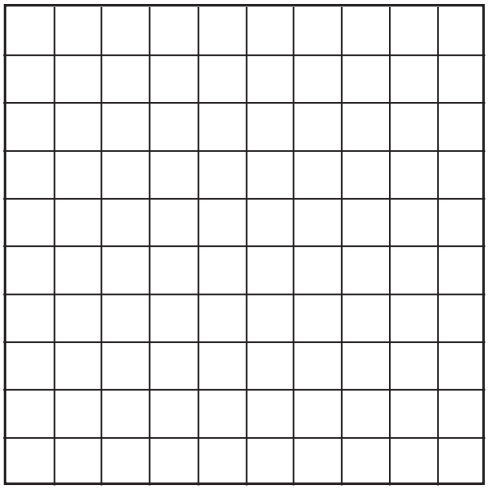


Data:

1. Calculate the radius of the balloon using the formula radius = .5 x (circumference / π). Remember $\pi = 3.14$.
2. Calculate the approximate volume of the balloon using the formula $V = 4/3\ \pi\ r3$. The balloon is not a perfect sphere so this value is only an approximation.

Amount of Air	Circumference (cm)	Radius (cm)	Approximate Volume of Balloon (cm^3)	Distance Traveled (cm)
Full				
¾ full				
½ full				
¼ full				

3. Make a graph comparing the distance the balloon traveled to the volume of air in the ballon.



Analysis of Data:

1. Describe how the volume of air in the balloon affected the distance teh balloon traveled._____

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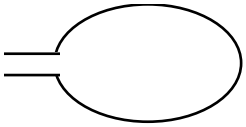
2. Below is a diagram of the balloon rocket. Use arrows to show the action and reaction forces that caused the balloon to travel along the fishing line.



Conclusion:

3. Describe how the balloon rocket is similar to a "real" rocket. _____

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Further Questions:

4. Dana rows her small boat up to a dock. She is in a hurry and decides to jump from the boat to the dock. Using the terms action force and reaction force to describe what happens to the boat and to her when she jumps from the boat.

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5. Pat has come up with an ingenious plan to install a battery-powered fan on the back of his boat facing the sail. On days that there is no wind, Pat plans to turn on the fan to push against the sail. Will this work to let Pat sail across the lake on days there is no wind? Use Newton's third law of motion to explain why this will or will not work.