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Balloon Rockets

Guided Inquiry Kit

Introduction

Experiment with Newton's third law of motion and launch a balloon rocket across the classroom.

Concepts

- Newton's third law of motion
- Bernoulli's principle
- Rocket engine thrust
- Friction

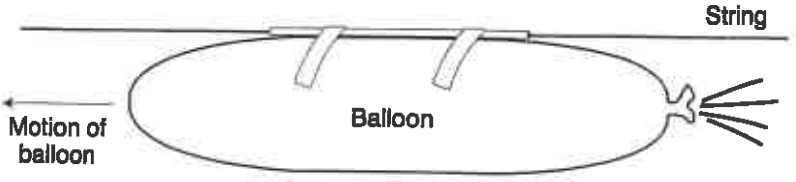

Figure 1.

Background

Newton's third law of motion states that for every action force there is an equal and opposite reaction force. Rockets clearly show Newton's third law in action. When a rocket burns fuel, hot gases are forced out the bottom of the rocket at high speed. The fast-moving gas particles are pushed by the rocket chamber in one direction and the gas particles, in turn, push on the rocket in the opposite direction. A common misconception about rocket thrust is that when the fast-moving gas particles exit a rocket engine, the gas particles push against the air outside the rocket and this causes the rocket to shoot upward. However, if this were the case, then rockets would never work in outer space because there are no air molecules in space for the fast-moving gases to push against. Instead, the fast-moving particles are forced out the rocket engine by the body of the engine.

When the fuel burns, a great amount of heat is created and the pressure inside the rocket combustion chamber increases. At the same time, the walls of the combustion chamber push back on the fast-moving gas particles. Rockets are composed of strong, solid materials with a small opening at the bottom. This opening is the only region on the engine where the pressure can be released. Since gas particles move from high to low pressure, the gas shoots out the bottom of the rocket. This creates a net force that thrusts the rocket in the opposite direction of the ejected gases (see Figure 2).

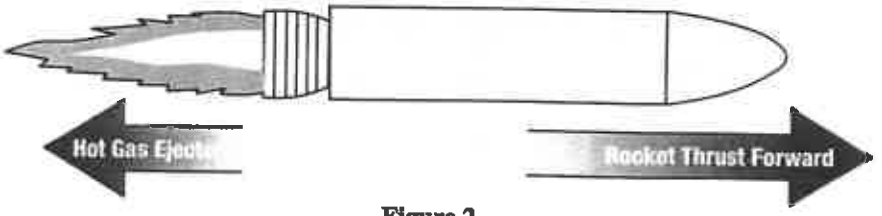

Figure 2.

An enormous amount of fast-moving gas particles need to be generated in order to lift a rocket into orbit. A small thrust channel increases the speed of the hot gases as they exit from the larger combustion chamber. Gases always accelerate toward lower pressure, so the high-pressure gas moves faster and faster as it rushes out of the nozzle. The constricted flow path increases the speed of the gas particles. This increase in particle speed in a chamber as the diameter decreases is an example of *Bernoulli's principle* (see Figure 3). The small-diameter chamber increases the speed of the exiting particles and therefore increases the net force that blasts off the rocket.

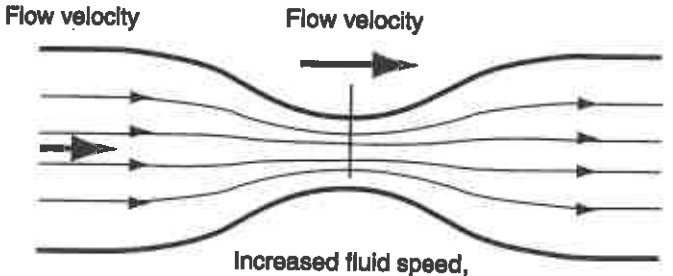

Figure 3.

Teacher's Notes *continued*

14. If the rocket did not travel all the way across the room, make necessary modifications and repeat steps 5–13. It is best to remove the original balloon and tape from the straw piece, and then use new tape.
15. Repeat step 14 until the balloon rocket reaches its goal of traveling across the classroom on the fishing line.

Sample Data Table *(Student data will vary.)*

Launch No.	Results of Launch	Possible Solutions If Problems Were Encountered
1	Balloon traveled about a quarter of the way down the fishing line. Balloon cork-screwed and twisted as it went down the line.	Make sure the straw and balloon point directly down the line. Twisting was caused by crooked straw. Place the straw closer to the nozzle end of the balloon.
2	Balloon traveled half-way down the line before it got hung-up. Air was still pushed out the balloon but the balloon stopped moving.	Inflate balloon more. The deflated balloon got hung-up on the fishing line. Move the fishing line towards the nozzle end a few centimeters more.
3	Balloon traveled half-way down the line before it stopped. Balloon got hung-up again and twisted.	Pull the fishing line tighter and double check the straw and balloon alignment.
4	Balloon traveled three-quarters of the way down the line before running out of air. Track was smooth and even. The balloon just ran out of air.	Inflate the balloon more. Make sure fishing line is taut. Place straw half-way between the center of the balloon and the nozzle end. Make sure the straw and balloon are aligned.
5	Balloon traveled all the way across the room with a little air to spare. Total length of classroom is about 38 feet.	
6		
7		