Rocket Power

Arizona Science Standard:

Science Strand 5: Physical Science: Concept 2: Motion and Forces: Understand the relationship between force and motion. Performance Objective 4: Describe forces as interactions between bodies (Newton's 3rd Law of Motion) using words or pictures. Explain why a rocket must work harder to move up as opposed to across.

Arizona Math Standard: Measurement and Data (MD)
Describe and compare measurable attributes.

Next Generation Standards:
Cross Cutting Standards:

- Cause and Effect
- Energy and Motion
- System and systems models

Learning Goal:

The construction and testing of basic balloon rockets develops students' understanding of Newton's third law of motion: for every actions there is and equal and opposite reaction. A rocket pushes lots of gas in one direction, causing the rocket to move in the opposite direction. Many types of engineers are needed to design rockets and spacecraft.

Students investigate how balloon rocket propulsion is affected by the angle the balloon rocket is launched. They will construct a model of a rocket. Students test an air filled balloon propelled across a strung line at a flat or horizontal position, then at a raised or inclined position. The expulsion of air forces the motion of the balloon rocket. Students measure the balloon's propulsion distance traveled at both string positions.

Instructional Objectives:

1. Students will be able to build and test a balloon rocket at a horizontal position and at an inclined position.
2. Students will compare the distance traveled at a level and inclined position..
3. Students will identify and describe the action and reaction forces.

Investigative Key Questions:

How can air move a balloon? How is the balloon's motion affected by the position of the line?

Time:

This investigation will take 1 day that can be broken into 2 sessions: conducting the investigation and recording the results of the investigation.

Vocabulary/Definitions

Combustion: The process of burning.

Engineer: A person who applies his/her understanding of science and math to creating things for the benefit of humanity and our world.

Gas: Tiny particles with enough energy to remain isolated and free floating (as opposed to liquids and solids in which particles group together).

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Newton's third law of motion: For every action there is an equal and opposite reaction. (This is why rockets work!)

Pressure: The exertion of force upon a surface by an object, fluid, gas (etc.), in contact with it. Force per area. Measured in units of pounds per square inch (psi) or Newton's per square meter (N/m^2) or Pascal's (Pa). Pressure results from collisions of gas molecules with a surface

Rocket: A vehicle that moves by ejecting fuel.

Thrust: The forward-directed force on a rocket in reaction to the ejection of fuel.

Materials to build the Balloon Rocket:

Each group of 4 students needs:

- 1 balloon (long shape works best)
- 1 plastic drinking straw (cut in half)
- Masking tape
- Measuring tape (or a yard- or meter-stick) non standard measuring tool of choice
- Rocket Flight Recording worksheet, one per person

For the entire class to share:

- Scissors
- Several pieces of fishing line (or fine, smooth string), cut into 30-foot (9-meter) lengths
- Duck tape or push pins

Before the Investigation:

Set up the rocket course lines for students. Create a clear space in the classroom--move desks, chairs and tables. Tie (or attach using duct tape) each piece of 30 ft. (9 meters) fishing line or string to a classroom wall (or chair leg) about one yard (1 meter) above the floor. Space apart the lines evenly, about a 3 feet (1 meter) apart.

Procedure:

Part One

1. Divide the class into groups of 4 students each. Assign one team member to gather supplies or pass out supplies and Rocket Flight Recording worksheet.
2. Have students cut the straw in half. Use one of the cut straws and share the other with another teams.
3. Each team takes turns using the course.
4. One student from each team inflates the balloon. Twist the open end of the balloon to close it temporarily. DO NOT TIE OFF THE END WITH A KNOT.
5. Another teammate tapes the straw to the balloon so that it is in the center of the balloon. One end faces the balloon top and the other end facing the balloon opening (nozzle).
6. Next, one student threads the string at the unattached end of the course through the straw so that the twisted end of the balloon faces toward the end of the line that is attached to the wall.
7. One team member holds the unattached end of the line so that it is taut and level. The other team member makes sure the balloon hangs below the line.

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8. With the class counting aloud down from 10, have students release the twisted ends of the balloons at zero.
9. Give the students a minute to determine how far their rocket flew by measuring how far it went on the fishing line.
10. Record the distance traveled on the worksheets.
11. Have the teams take turns using the course until each team has launched their rocket three times, and recorded the distances traveled on their worksheets.

Part Two

1. Detach the lines from the wall or a chair. Raise the line higher, so that each line is between 6 and 10 feet (2 or 3 meters) above the floor (as high as you can reach).
2. Have the student hold the unattached line at the starting end near the ground so the balloons must travel up equal inclines
3. Next, with the lines positioned at an incline and taut, have each group launch their rocket three more times and record the length the balloon rocket traveled up the incline on their worksheets..
4. Have students finish their rocket trials and complete their worksheets.
5. Conclusion: Conclude by holding a class discussion, comparing results. See if students understand Newton's third law of motion. Talk about test results in both horizontal and incline conditions and how the expelled air created thrust.
    a. Does the shape of the balloon affect how far (or fast) the rocket travels?
    b. Does the length of the straw affect how far (or fast) the rocket travels?
    c. Does the type of string affect how far (or fast) the rocket travels?
    d. Does the angle of the string affect how far (or fast) the rocket travels?

    e. What do you notice? What do you wonder?
6. Discuss what types of engineers are needed to design a rocket.

Assessment:

Pre-Activity Assessment:

Question/Answer: Ask the students and discuss as a class:

- How does a rocket fly? (Answer: It expels exhaust in one direction and moves in the other.)
- Is it harder for a rocket to fly straight up or horizontally? (Answer: It is harder to fly up because it must overcome gravity.)
- Who designs rockets? (Answer: Engineers.)
- Which types of engineer? (Answer: Aerospace, mechanical, electrical, computer, materials, chemical, software, systems; it takes many types of engineers, working together, to design a rocket or spacecraft.)

Activity Embedded Assessment:

Worksheet: Students complete the activity using the Rocket Flight RecordingWorksheet. Review their answers to gauge their mastery of the subject.

Post-Activity Assessment

Drawing: Have students design and draw their own space rockets. Have them use arrows to label the action and reaction of Newton's third law of motion.

Engineering Redesign: Ask students how they might improve the design of their balloon rocket. Then have them sketch or test their ideas.

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Differentiation: How can you make this work in your classroom?

- For lower grades, conduct the activity as a teacher demonstration.
- For upper grades, have students experiment with different balloon shapes (rockets) as well as the opening size (straw diameter). Ask students to come up with different prototypes and work through the engineering design process to see which combination of factors produce the best balloon rocket. Design process steps: brainstorm many different design ideas; select the best design; draw, create and test your design; review your design; improve your design based on what you learned.
- For more advanced students, have them calculate (and graph) the average rocket distance traveled for their horizontal and incline data collected. Have them hypothesize what other factors contribute to the different distances achieved. Calculate rate using the distance and time. Graph the rate for each run.
- Measure with standard or metric measurements
- Run competitions among the groups. Whose rocket went the farthest? The fastest? The slowest?

Questions to promote engineering process:

- How can you differentiate the activity to make work for you grade level?
- What else can we do to change the speed, move faster, slower?
- What happens when we change the material of the line it runs on? How does the type of string affect the rate of motion?
- What happens when we change the size or shape of the balloon? Or the straw?
- What happens when we limit the amount of breaths to blow up balloon?