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Resources continued

QuickView

Students experiment with different water volumes to test the effects on apogee.

Standards Addressed

NSTA 5-8
Students develop abilities necessary to do scientific inquiry.

- Students identify questions that can be measured through scientific inquiry.
- Students use appropriate tools and techniques to gather, analyze, and interpret data.
- Students think critically and logically to make the relationships between evidence and explanations.
- Students recognize and analyze alternative explanations and predictions.
- Students communicate scientific procedures and explanations.
- Students use mathematics in all aspects of scientific inquiry.

Students develop understandings about scientific inquiry.

- Students understand different kinds of questions suggest different kinds of scientific investigations and some investigations involve observing and describing objects, organisms, or events; some involve collecting and analyzing specimens; some involve experiments; some involve discovery of new objects; and some involve making models.
- Students understand mathematics is important in all aspects of scientific inquiry.

Students develop abilities for technological design.

- Students evaluate completed technological designs or products.

NCTM 6-8
Students select and use appropriate statistical methods to analyze data.

- Students develop and evaluate inferences and predictions that are based on data.

Students recognize and apply mathematics in contexts outside of mathematics.

ITEA 6-9
Students develop the abilities to assess the impact of products and systems.

- Students learn to design and use instruments to gather data.

Time Required

45-90 minutes (will vary with class size)

After completion of the rocket, one to two class periods for experimentation and write-up are required for this lesson.

Content Areas

Primary: Science
Secondary: Math

Vocabulary

- apogee
- altimeter
- hypothesis
- conclusion
- variable
- control
- outlier
- thrust

Materials

- Completed bottle rocket
- Water
- Launcher
- 250-milliliter graduated cylinder or measuring cup
- Pencil
- "Fuel Volumes I Data Sheet"
- Altimeter
- "Lab Report Template" (optional)

Note:

The air pressure is held constant in this experiment. A graduated cylinder can be used to measure the amount of water for each test. If a graduated cylinder is not available, a measuring cup or other available measure could be used.

The "Fuel Volumes I Data Sheet" is provided for students to track experimental data. If time allows, students could create a more detailed lab report following the provided "Lab Report Template."

An altimeter is used to find the rocket's apogee. It may be necessary for students to practice with the altimeter several times before recording data.

Procedure

Before beginning, students should be given background information about the forces acting on the rocket, Newton's laws of motion, rocket fuel, and experimental controls and variables. Fuel pressure in this activity will be constant at 60 psi.

1 Write a hypothesis stating how you think changes in the volume of water in the rocket's fuel will affect the rocket's apogee.

Middle school students should understand hypotheses. However, you may wish to explain that a hypothesis is a prediction based on prior knowledge or experience.

2 Use the graduated cylinder to measure 100 ml of water.

The amount of air pressure and the rocket are controlled in the experiment. The variable is the amount of water.

3 Place the water in the rocket.

4 Attach the rocket to the launcher.

5 Pump up the launcher to 60 psi.

6 Launch the rocket.

7 Using an altimeter, find the apogee of the rocket's flight.

Apogee is the highest point of the rocket's flight. Students may need to practice with the altimeter several times before recording data.

8 Record the rocket's apogee.

Keep in mind that students must stand a specified distance from the launch site to use the altimeter. Students can be positioned at different distances; however, the reading from the altimeter will then need to be converted to get an accurate height. If space limitations require that students stand closer to the launchpad than the distance recommended on the altimeter, you will need to go over calculating apogee from this distance.

9 Repeat Steps 2-8 using 125 ml, 150 ml, and 175 ml of water; do two tests for each water volume. Complete the data sheet.

10 Analyze the data generated from your tests and write a conclusion explaining how different fuel pressures affected the rocket's apogee.

Conclusions should be supported by data. Discuss with students that extreme values in a data set are known as outliers. Any outliers should be explained in the conclusion.

QuickView

Experiment with different water volumes to test effects on apogee.

Materials

- Completed bottle rocket
- Water
- Launcher
- 250-milliliter graduated cylinder or measuring cup
- Pencil
- "Fuel Volumes I Data Sheet"
- Altimeter
- "Lab Report Template" (optional)

Procedure

1 Write a hypothesis stating how you think changes in the volume of water in the rocket's fuel will affect the rocket's apogee.

2 Use the graduated cylinder to measure 100 ml of water.

3 Place the water in the rocket.

4 Attach the rocket to the launcher.

5 Pump up the launcher to 60 psi.

6 Launch the rocket.

7 Using an altimeter, find the apogee of the rocket's flight.

8 Record the rocket's apogee.

9 Repeat Steps 2-8 using 125 ml, 150 ml, and 175 ml of water.

10 Analyze the data generated from your tests and write a conclusion explaining how different fuel pressures affected the rocket's apogee.

Fuel Volumes I Data Sheet

Record your hypothesis in the space provided below.

Hypothesis _____

Test Number	Amount of Water (ml)	Amount of Pressure (psi)	Rocket's Apogee
1	100	60	
2	100	60	
3	125	60	
4	125	60	
5	150	60	
6	150	60	
7	175	60	
8	175	60	

Record the data from each test using the fuel pressures listed. Complete any additional testing you think might improve your understanding of the effect of fuel pressures on apogee. *Never* place more than 100 psi of pressure in the rocket.

Record your conclusion in the space provided below.

Conclusion _____