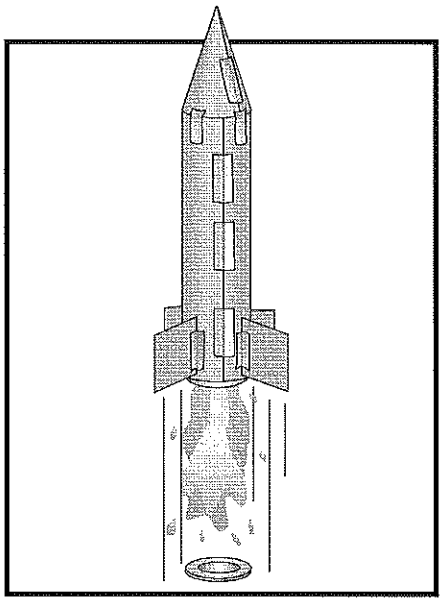


Educator Information

3-2-1 POP!

Objective:
To demonstrate how rocket liftoff is an application of Newton's Laws of Motion.

Description:
Students construct a rocket powered by the pressure generated from an effervescing antacid tablet reacting with water.

Science Standards:

Physical Science - Position and motion of objects
Science and Technology - Abilities of technological design - Understanding about science and technology

Process Skills:

Observing
Communicating
Making Models
Inferring

Management:
For best results, students should work in pairs. It will take approximately 40 to 45 minutes to complete the activity. Make samples of rockets in various stages of completion available for students to study. This will help some students visualize the construction steps.

A single sheet of paper is sufficient to make a rocket. Be sure to tell the students to plan how they are going to use the paper. Let the students decide whether to cut the paper the short or long direction to make the body tube of the rocket. This will lead to rockets of different lengths for flight comparison.

The most common mistakes in constructing the rocket are: forgetting to tape the film canister to the rocket body, failing to mount the canister with the lid end down, and not extending the canister far enough from the paper tube to make snapping the lid easy. Some students may have difficulty in forming the cone. To make a cone, cut out a pie shape from a circle and curl it into a cone. See the pattern on the next page. Cones can be any size.

Materials and Tools:

- Heavy paper (60-110 index stock or construction paper)
- Plastic 35 mm film canister*
- Student sheets
- Cellophane tape
- Scissors
- Effervescing antacid tablet
- Paper towels
- Water
- Eye protection

* The film canister must have an internal-sealing lid. See management section for more details.

Film canisters are available from camera shops and stores where photographic processing takes place. These businesses recycle the canisters and are often willing to donate them for educational use. Be sure to obtain canisters with the internal sealing lid. These are usually translucent canisters. Canisters with the external lid (lid that wraps around the canister rim) will not work. These are usually opaque canisters.

Background Information:
This activity is a simple but exciting demonstration of Newton's Laws of Motion. The rocket lifts off because it is acted upon by an unbalanced force (First Law). This is the force produced when the lid blows off by the gas formed in the canister. The rocket travels upward with a force that is equal and opposite to the downward force propelling the water, gas, and lid (Third Law). The amount of force is directly proportional to the mass of water and gas expelled from the canister and how fast it accelerates (Second Law). For a more complete discussion of Newton's Laws of Motion, see pages 13-17 in this guide.

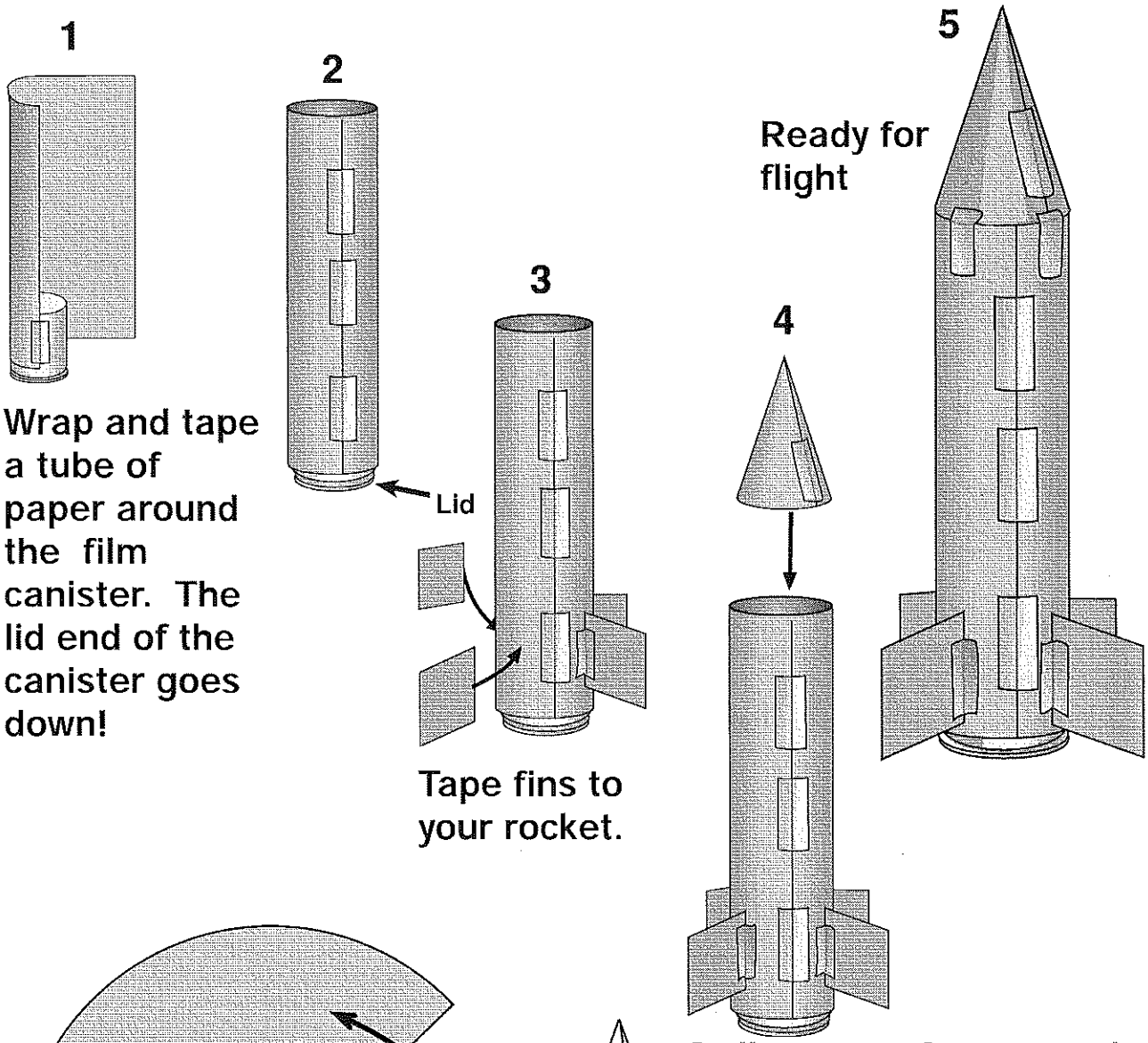
Procedure:
Refer to the Student Sheet.

Discussion:
- How does the amount of water placed in the cylinder affect how high the rocket will fly?
- How does the temperature of the water affect how high the rocket will fly?
- How does the amount of the tablet used affect how high the rocket will fly?
- How does the length or empty weight of the rocket affect how high the rocket will fly?
- How would it be possible to create a two-stage rocket?

Assessment:
Ask students to explain how Newton's Laws of Motion apply to this rocket. Compare the rockets for skill in construction. Rockets that use excessive paper and tape are likely to be less efficient fliers because they carry additional weight.

Extensions:
- Hold an altitude contest to see which rockets fly the highest. Launch the rockets near a wall in a room with a high ceiling. Tape a tape measure to the wall. Stand back and observe how high the rockets travel upward along the wall. Let all students take turns measuring rocket altitudes
- What geometric shapes are present in a rocket?
- Use the discussion questions to design experiments with the rockets. Graph your results.

3-2-1 POP!


1
2
3
4
5
Ready for flight
Lid
Wrap and tape a tube of paper around the film canister. The lid end of the canister goes down!
Tape fins to your rocket.
Roll a cone of paper and tape it to the rocket's upper end.
Cone Pattern
Overlap this edge to form cone
Cones can be any size!
Tape

ROCKETEER NAMES

_____

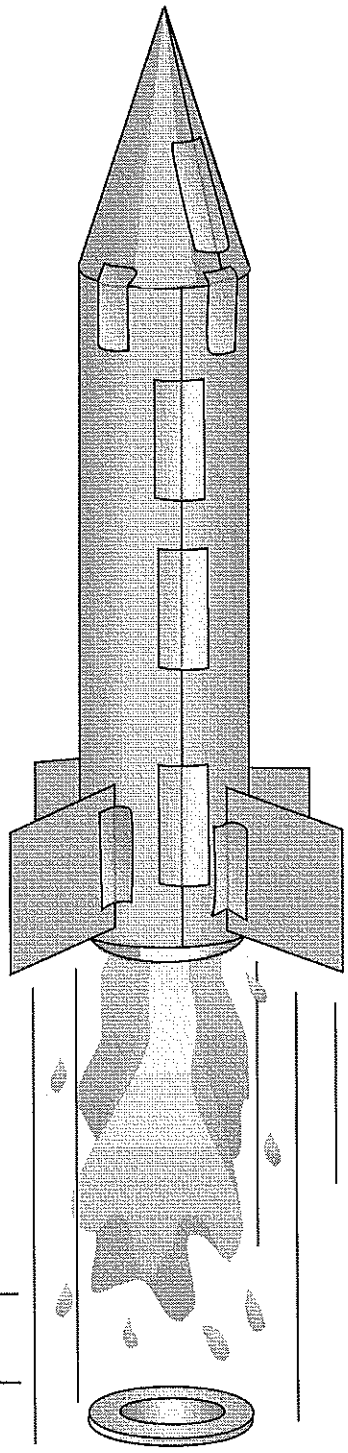
_____

COUNTDOWN:

1. Put on your eye protection.
2. Turn the rocket upside down and fill the canister one-third full of water.

<u>Work quickly on the next steps!</u>

3. Drop in 1/2 tablet.
4. Snap lid on tight.
5. Stand rocket on launch platform.
6. Stand back.



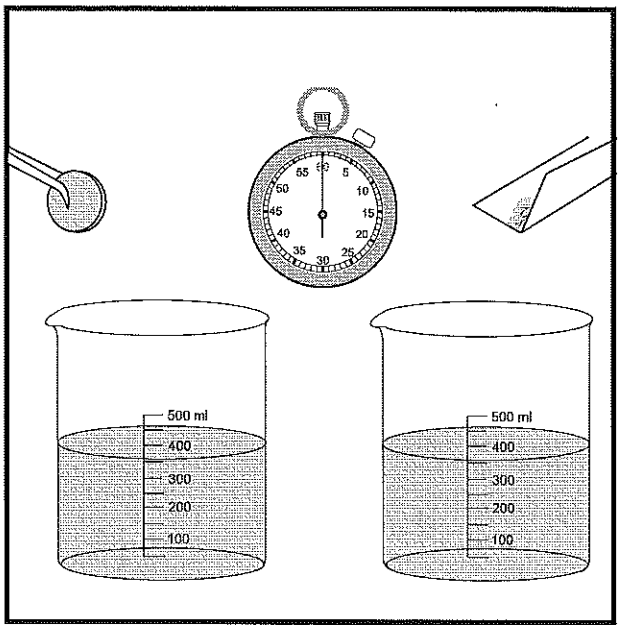
LIFTOFF!

What three ways can you improve your rocket?

1. _____

2. _____

3. _____



Educator Information

Antacid Tablet Race

Objective:
To investigate methods of increasing the power of rocket fuels by manipulating surface area and temperature.

Description:
Students compare the reaction rates of effervescent antacid tablets under different conditions.

Science Standards:

Science as Inquiry
Physical Science - Properties of objects and materials
Science and Technology - Abilities of technological design

Science Process Skills:

Observing
Communicating
Measuring
Collecting Data
Inferring
Predicting
Interpreting Data
Making Graphs
Hypothesizing
Controlling Variables
Investigating

Mathematics Standards:

Mathematics as Communication
Mathematical Connections
Estimation
Measurement
Statistics and Probability

Management:

This activity should be done in groups of two or three students. The specific brand of effervescent antacid tablets used for the experiment is not important, but different brands should not be mixed during the experiments. Give student groups only two tablets at a time. Make sure they know how to fill in the stopwatch graphs on the student pages. Although there is little eye hazard involved with the experiment, it is valuable for students to get in the habit of wearing eye protection for experiments involving chemicals.

Background Information:

This activity enables students to discover methods of increasing the rate that rocket propellants release energy. When rocket propellants burn faster, the mass of exhaust gases expelled increases as well as how fast those gases accelerate out of the rocket nozzle. Newton's Second Law of Motion

Materials and Tools:

- Effervescent Antacid tablets (four per group)
- Two beakers (or glass or plastic jars)
- Tweezers or forceps
- Scrap paper
- Watch or clock with second hand
- Thermometer
- Eye protection
- Water (warm and cold)

states that the force or action of a rocket engine is directly proportional to the mass expelled times its acceleration. Consequently, increasing the efficiency of rocket fuels increases the performance of the rocket.

Students will discover two methods for increasing the efficiency of rocket fuels by using antacid tablets. The first experiment measures the relationship between the surface area of a tablet and its reaction rate in water. Students will learn that increasing the surface area of a tablet by crushing it into a powder, increases its reaction rate with the water. This is a similar situation to the way a rocket's thrust becomes greater by increasing the burning surface of its propellants.

Expanding the burning surface increases its burning rate. In solid rockets, a hollow core extending the length of the propellant permits more propellant to burn at a time. This increases the amount of gas (mass) and acceleration of the gas as it leaves the rocket engine. Liquid propellants spray into the combustion chamber of a liquid propellant rocket to maximize their surface area. Smaller droplets react more quickly than do large ones, increasing the acceleration of the escaping gases. (See page 20 for more information.)

The second experiment measures the reaction rate of tablets in different water temperatures. Tablets in warm water react much more quickly than tablets in cold water. In liquid propellant rocket engines, super cold fuel, such as liquid hydrogen, is preheated before being combined with liquid oxygen. This increases the reaction rate and thereby increases the rocket's thrust. More information about this process appears on page 20.

Assessment:
Conduct a class discussion where students explain how this experiment relates to the way rocket fuel burns. Collect and review completed student pages.

Extensions:
- Try a similar activity relating to the surface area of rocket fuels using small pieces of hard candy. Take two pieces of candy and crush one. Then, give the whole candy piece to one student and the crushed candy to another student to dissolve in their mouths. Which candy will dissolve first?

Antacid Tablet Race

Experiment 1

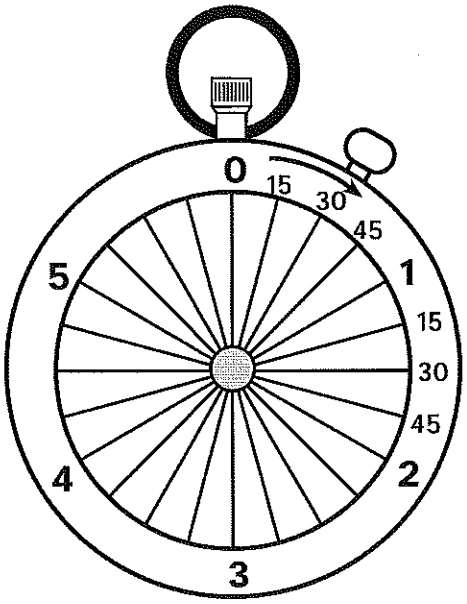
Team Members: _____

_____

_____

Jar 1 Results

Your Prediction: _____ seconds



1. Fill both jars half full with water that is at the same temperature.

2. Put on your eye protection.

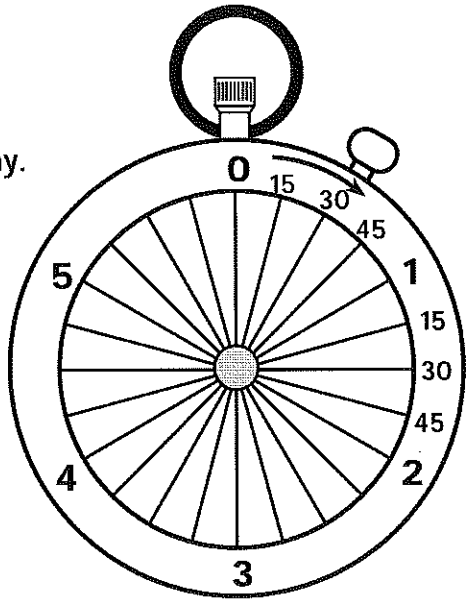
3. Predict how long it will take for the tablet to dissolve in the water. Drop a tablet in the first jar. Shade in the stopwatch face for the actual number of minutes and seconds it took to complete the reaction. The stopwatch can measure six minutes.

4. Wrap another tablet in paper and place it on a table top. Crush the tablet with the wood block.

5. Predict how long it will take for the crushed tablet to dissolve. Drop the powder in the other jar. Shade in the clock face for the number of minutes and seconds it took to complete the reaction.

Jar 2 Results

Your Prediction: _____ seconds



Describe what happened in the experiment and why.

_____

_____

_____

_____

Experiment 2

1. Empty the jars from the first experiment. Put warm water in one jar and cold in the other.

2. Measure the temperature of the first jar. Predict how long it will take for a tablet to dissolve. Drop a tablet in the jar. Shade in the clock face for the actual number of minutes and seconds it took to complete the reaction.

3. Measure the temperature of the second jar. Predict how long it will take for a tablet to dissolve in the water. Drop a tablet in the jar. Shade in the clock face for the actual number of minutes and seconds it took to complete the reaction.

Describe what happened in the experiment and why.

_____

_____

_____

_____

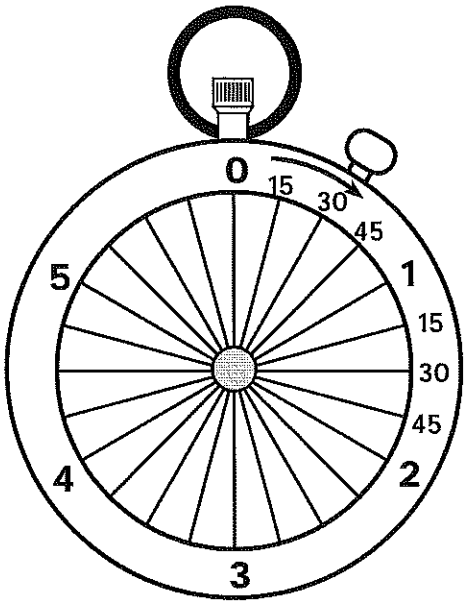
How can you apply the results from these experiments to improve rocket performance?

_____

_____

Jar 1 Results

Temperature: _____ °C
Your Prediction: _____ Seconds



Jar 2 Results

Temperature: _____ °C
Your Prediction: _____ Seconds