SPEED IT UP

Student Section

Student Name ______________________

Lesson Objective

In this lesson, you will simulate how different propellant systems affect the velocity, or speed of a rocket by measuring the height the rocket is launched.

During this lesson, you will

- gather data by measuring the height an object is launched.
- use data to describe the results of the different simulated propellant combinations.
- develop a conclusion based upon the results of this experiment.
- compare individual results to class results to look for patterns.

Problem

How can I determine if different propellants will make a rocket travel faster?

Observation

The space shuttle uses a chemical propulsion system based upon both liquid and solid propellants. It combines the features of a rocket, aircraft, and glider and was designed to carry astronauts, satellites, and other cargo into Earth's orbit. Traveling at approximately 29,000 km/h (18,000 miles per hour), the shuttle orbits Earth every 90 minutes.

By using current technology and a spacecraft powered by chemical rocket engines, a one-way trip to Mars could take between 6 to 9 months. The trip back to Earth would be another 6 to 9 months.

We need to find faster ways to travel to Mars and beyond. NASA is studying alternative propulsion systems. The new propulsion systems will need to be more efficient by providing a faster trip in order for humans to travel to distant planets like Mars. Shorter flight times lessen an astronaut's exposure time in reduced gravity and will also reduce the amount of exposure to space radiation.

A nuclear thermal propulsion system could cut down the time needed to travel to Mars and other places in our solar system. Nuclear fuel lasts longer and allows a spacecraft to travel faster by providing a more efficient and light weight system. A nuclear thermal propulsion system could potentially be over 100 times more powerful than chemical systems of comparable weight.

NASA is studying a plasma-based propulsion system called project VASIMR (Variable-Specific-Impulse Magnetoplasma Rocket). Franklin R. Chang-Diaz, PhD, the first Hispanic astronaut, is studying this system. According to NASA, a VASMIR flight to Mars could take a little over 3 months, compared to 6 to 9 months using current rocket engines.

In this activity you will simulate how different propellant systems affect the velocity, or speed, of a rocket by measuring the height the rocket is launched.

Use the first column of this KWL chart to organize your observations about propulsion.

Brainstorm with your group what you want to know about propulsion, then list in the second column of this KWL chart.

KNOW	WANT TO KNOW	LEARNED

Hypothesis

Based on your observations, answer the “problem question” with your best guess. (How can I determine if different propellants will make a rocket travel faster?) Your hypothesis should be written as a statement.

My hypothesis: ____

Materials

Per group

- 1 small water bottle, or water in a plastic cup
- vinegar in a plastic cup
- 1 small box of baking soda
- 1 milliliter (¼ teaspoon) measuring spoon
- 6-10 small sheets of single ply facial tissue cut into quarters or single ply toilet paper squares
- 1 aluminum roasting pan, baking tin, or box lid with high sides
- 1 metric measuring tape or meter stick
- paper towels

Per student

- 2 clear film canisters with inner sealing lids.
- 1/4 of an effervescent antacid tablet crushed into pieces
- 1 pair of safety glasses

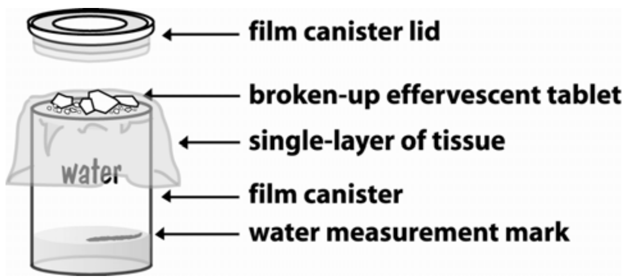
Safety

Review your classroom and lab safety rules. Put on safety glasses when instructed.

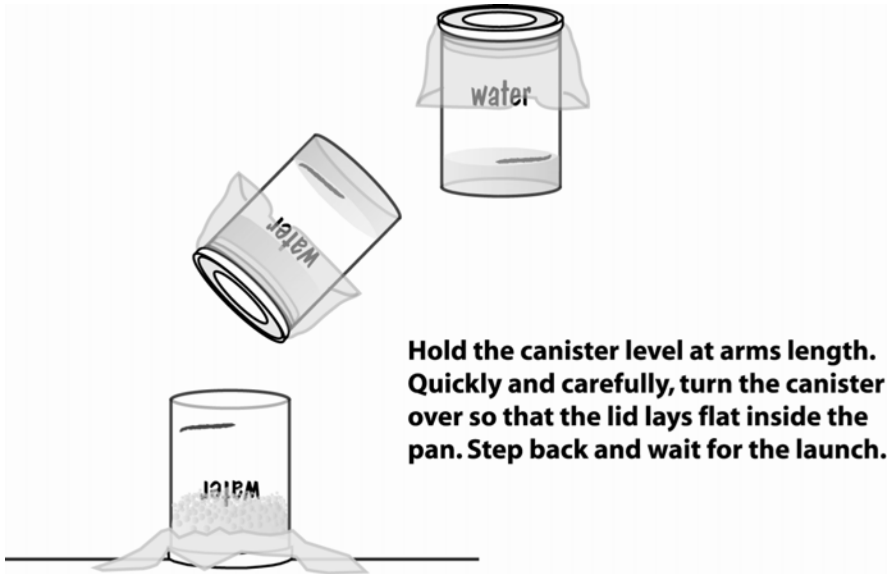
Test Procedure

1. Put on your safety glasses.
2. Your group will be assigned a section along a wall where you will be launching the rockets. Each group will need at least 2 meters (6-7 feet) of working space along the wall so that you do not interfere with the other groups working beside your section.
3. Measure the height of the top of the desks in centimeters. Record the measurement on the How High Did It Go Data Sheet. You and your partner will launch your rockets from the desk top.

4. Your first rocket launch will have a propulsion system of water and effervescent tablets. Predict how high your first rocket launch will go using the first propellant combination. Record the predicted height for Launch One on the How High Did It Go Data Sheet. Discuss your predictions with your group.
5. Before launching your first rocket, make sure to read and understand Steps 6-12 below.
6. Your first rocket propulsion system will be of water and effervescent tablets. Open your film canister. Carefully and slowly, pour water into the film canister up to the marked line.
7. The film canister should stay on the desk top. Place one tissue (single ply) square loosely on top of the canister opening.
8. Hold the tissue around the top of the canister. Carefully place the broken pieces of a ¼ of an effervescent tablet into the center of the tissue. (Your zipper seal bag should already contain a ¼ of an effervescent tablet.) Make sure the tissue does not fall into the water. (See diagram.)

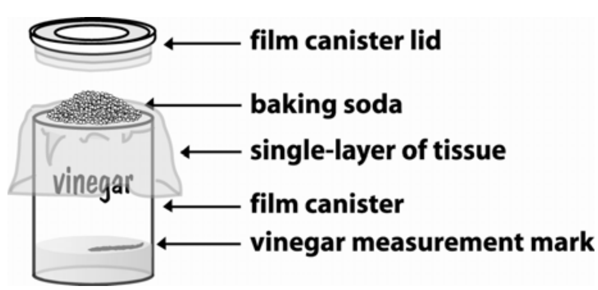


9. KEEP THE CANISTER LEVEL and on the desk top. Without letting the tissue fall into the canister, close the lid on the tissue so that the tissue and effervescent tablet pieces are suspended above the water. Make sure the lid snaps on and closes tightly – if it does not close properly, call you teacher for help. The simulated rocket is now loaded with propellants.
10. One student will launch the rocket. The other will step back at least 3 meters (about 10 feet away) in order to see the height that the rocket travels along the measured tape on the wall. Make sure that the student measuring the maximum height the rocket travels always stands in the same place for each launch.
11. To launch the rocket, follow these steps:
    - Place the aluminum pan on the desk top. This will catch any liquid that will come from the launch.
    - Keeping the rocket level, hold the canister (with the lid up) above the aluminum pan, at arms length from the body, keeping the rocket away from your face and away from other students.
    - Quickly and carefully, turn the canister over so the lid lays flat inside the aluminum pan. Steady the rocket and then let go of the canister. The rocket will take several seconds to launch, so work quickly but do not rush.
    - Step back and wait for the launch.



- If your rocket does not launch in approximately 30 seconds, call your teacher over to the launch site for a quick check of the rocket.

12. Using the tape measure or other markers on the wall, collect and record data by measuring how high the rocket traveled on the How High Did It Go Data Sheet.
13. Calculate the actual distance your rocket traveled by subtracting the desk height from the height of the rocket launch and record on the How High Did It Go Data Sheet.
14. Use paper towels to clean the rocket and test area. Make sure to clean the inside of the canister and the lid. Dispose of the paper towels properly.
15. Repeat steps 3-14 for your partners' first rocket.
16. You will now run the test again, this time using a different propellant combination of baking soda and vinegar. Predict how high the second rocket will travel. Record your predicted height for Launch Two on the How High Did It Go Data Sheet. Discuss your prediction with your group.
17. Open your clean and dry film canister. Carefully and slowly, pour vinegar into the film canister up to the marked line.
18. The film canister should stay on the desk top. Place one tissue (single ply) square loosely on top of the canister opening.
19. Hold the tissue around the top of the canister and carefully place 1 milliliter (1/4 teaspoon) of the baking soda into the center of the tissue. The tissue will need to sink into the canister a little bit so that the baking soda will not fall off. Make sure the tissue does not fall into the vinegar. (See diagram.)



20. KEEP THE CANISTER LEVEL and on the desktop. Without letting the tissue fall into the canister, close the lid on the tissue so that the tissue and baking soda are suspended above the

vinegar. Make sure the lid snaps on and closes tightly. The simulated rocket is now loaded with propellants.

21. One student will launch the rocket. The other student will step back to the same spot as before (about 3 meters or 10 feet away) in order to see the height that the rocket travels along the measured tape on the wall.
22. To launch the rocket, follow these steps:
    - Place the aluminum pan on the desk top. This will catch any liquid that will come from the launch.
    - Keeping the rocket level, hold the canister (with the lid up) above the aluminum pan, at arms length from the body keeping the rocket away from your face and away from other students.
    - Quickly and carefully, turn the canister over so the lid lays flat and inside the aluminum pan. Steady the rocket and then let go of the canister. The rocket will take several seconds to launch, so work quickly but do not rush.
    - Step back and wait for the launch.
    - If your rocket does not launch in approximately 30 seconds, call your teacher over to the launch site for a quick check of the rocket.
23. Using the tape measure or other markers on the wall, collect and record data by measuring how high the second rocket traveled on the How High Did It Go Data Sheet.
24. Calculate the actual distance your rocket traveled by subtracting the desk height from the height of the rocket launch and record on the How High Did It Go Data Sheet.
25. Use paper towels to clean the rocket and test area. Make sure to clean the inside of the canister and the lid. Dispose of the paper towels properly.
26. Repeat steps 16-25 for your partners' rocket.
27. After taking all measurements, study the data and draw conclusions by answering the questions following the How High Did It Go Data Sheet.

Record Data

How High Did It Go Data Sheet

	Launch One (effervescent tablet and water)	**Launch Two** (baking soda and vinegar)
Predicted height of rocket travel (meters and centimeters)		
Desktop Height (m, cm)		
Launch Height (m, cm)		
Actual distance of rocket launch (*Difference between launch height and desk height*)		

Study Data

1. Describe the rocket launches by comparing and contrasting the two launches.

2. Which propellant combination made your rocket travel higher/faster? How do you know this?

3. Does this data support your hypothesis? Why or why not?

4. How do your results compare to your partner's results? With the class results?

5. Based on your findings, what would you suggest to NASA engineers designing new systems for rocket propulsion?

Conclusion

- Update the LEARNED column in your KWL chart.
- Restate your hypothesis and explain what happened during testing.