

## Stomp Rocket Investigation

**Target Grade: 4th**

**Teacher Prep Time:** 30 minutes

**Lesson Time:** 2 hours

### **Learning Goals:**

- Students will explore the flow of energy in the Stomp Rocket System
- Students will explore the attributes of cause and effect in rocket design

### **NGSS:**

- 4-PS3-4. Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.
- Disciplinary Core Ideas
  - PS3.A: Definitions of Energy
    - Energy can be moved from place to place by moving objects or through sound, light, or electric currents
  - PS3.B: Conservation of Energy and Energy Transfer
    - Energy is present whenever there are moving objects, sound, light, or heat.
  - PS3.C: Relationship Between Energy and Forces
    - When objects collide, the contact forces transfer energy so as to change the objects' motion
  - ETS1.A: Defining Engineering Problems
    - Possible solutions to a problem are limited by available materials and resources (constraints). The success of a desired solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account.\*
- Cross Cutting Concepts
  - Energy and Matter
    - Energy can be transferred in various ways and between objects.
- Science and Engineering Practice
  - 6. Constructing explanations (science) and designing solutions (engineering)

### **Where this lesson fits in:**

- This lesson provides students an opportunity to deepen their understanding of energy. In previous lessons, students learned what energy is and that energy isn't created or destroyed, but energy can be transferred from one form to another. They have also learned about potential and kinetic energy.
- This lesson will build upon the knowledge that energy can be transferred from the Sun to food to humans to a stomp rocket.
- In addition, students are challenged to apply engineering skills to improve upon their stomp rocket design.

**Materials Needed:**

Per Individual: Pencil, *Stomp Rocket* and *Effect of Variables on Rocket Flight Distance* worksheets (2 copies)

Per Group of 3-4 students

*Building a Stomp Rocket Directions*

One 2 liter plastic bottle (soda)

\*One PVC pipe about 24" if using 11" paper or 12" (longer than a length of paper)

2 feet of ½" inner diameter flexible vinyl tubing to attach the soda bottle to the PVC pipe (needs to fit into each)

(\*20 feet for 10 groups of 3 students)

One 3"x5" index card for fins

Measuring Tape (50 ft.)

Clipboard, (optional)

2 scissors

\*PVC pipe, duct tape, and tubing can be purchased at Home Depot

Per Class:

*Energy Vocabulary and Concepts* poster

One package (~200 sheets) 20 lbs. copying paper (8 ½" x 11")

Duct Tape (3 rolls )to attach the three items together (Groups can share rolls)

Transparent tape (5-6 rolls) (Groups can share)

**Teacher Prep:**

- Prepare *Energy Vocabulary and Concepts* poster
- Cut Flexible Vinyl Tubing into 2 feet sections as needed
- Premark rocket path distance (ft.) in chalk or stretch measuring tape over expected distance.

**Beginning Thoughts:**

- Tell students that we are continuing our study of energy today and will be exploring energy as it relates to paper rockets.
- Ask students to pair/share what they have learned so far about energy.
- Have students share out their ideas,
- Display and review *Energy Vocabulary and Concepts* Poster
- Show first 45 seconds of Video Clip, *I Didn't Know That: How Rockets Work*
  - <http://video.nationalgeographic.com/video/i-didnt-know-that/idkt-how-rockets-work?source=related>
- Ask students to pair/share why they think the man on the roller skates didn't move.
- Explain that today they will be experimenting with designing, testing, and observing the flight of a paper rocket.

**Lab: Part 1**

- Explain that this part of the investigation will focus on the effect of the Rocket Nosecone Shape on the Rocket Flight Distance. Each group will build and test a rocket with three different nosecone designs. Each group will start with a Flat nosecone design as the only variable. After testing this design, they will be able to come up with their own nosecone shapes to investigate.
- Explain the materials available and demonstrate how to build the bottle launcher and rocket with a **Flat** nosecone shape following the *Building a Stomp Rocket Directions*.
- Explain how they will be launching and evaluating their rocket. (One student will stomp on the plastic bottle, one student will hold the PVC pipe at ~ 45 degree angle, and one student will measure and record the distance the rocket traveled before hitting the ground. (Safety Note:

Instruct students to stand **behind** launching to avoid rocket hitting students' eyes Care should be taken to show students how to use metal Measuring Tape as edges can be sharp).

- Complete the worksheet, *The Effect of Variable on Rocket Flight Distance* through the prediction section before conducting trials for the flat Nosecone design.
- Allow time for the students to build their rockets, test the flat nosecone design, and record results. (Students should use their math skills or a calculator to calculate the *Average Distance* traveled for this design).
- Gather students together to discuss how energy relates to the Flat Nosecone Rocket.
- Ask students to discuss the following questions in their groups. Review answers.
  - Why *doesn't* the rocket appear to be moving prior to the "stomp"? (ESR: The forces acting upon the rocket are all equal.
  - What types of energy does the Stomp Rocket possess after the "stomp"? (ESR: motion, sound, gravitational energy)
  - Where did the energy come from when the rocket blasted off? (ESR: energy can be transferred from humans to a stomp rocket. It is transformed or changed from chemical energy to motion energy when we metabolize protein and carbohydrates. *Conservation of Energy* states that energy cannot be created or destroyed, it is transferred from one form to another.
  - Draw a picture of the Stomp Rocket System. What objects had the energy? Label the types of energy: chemical, motion, and gravity.

### Lab: Part 2

- Ask students to share their observations about the rocket flight. What problems did they observe? What changes might they make to address these problems?
- Ask students if a change in the Rocket Nosecone Shape will have an effect on the Rocket Flight Distance?
- Challenge students to investigate 2 other Rocket Nosecone shapes they think will increase the flight distance of the rocket keeping all other parts of the system and launch process the same.
- Allow time for the groups to record their prediction, test their designs, and complete the worksheet, *The Effect of Variables on Rocket Flight Distance*.
- Gather groups together and have them share their results.
- Ask students how what they have learned might apply to current and future space rocket designs. Students should record how they acted like engineers today.

### Extension:

- Allow students to experiment with other modifications to increase rocket flight distance. They should come up with their own variable to test. Variables may include: Fin design or quantity, bottle volume, tubing length, rocket material, and launch angle.

# **ENERGY VOCABULARY AND CONCEPTS**

**ENERGY IS THE ABILITY TO DO WORK**

**POTENTIAL ENERGY IS STORED ENERGY**

**KINETIC ENERGY IS ENERGY OF MOTION**

**A COLLISION OCCURS WHEN TWO OBJECTS MEET**

**ENERGY ISN'T CREATED OR DESTROYED**

**MOVING OBJECTS CAN MOVE ENERGY FROM PLACE  
TO PLACE**

**ENERGY IS PRESENT WHENEVER THERE ARE MOVING  
OBJECTS, SOUND, LIGHT, OR HEAT.**

**WHEN OBJECTS COLLIDE, ENERGY CAN BE  
TRANSFERRED FROM ONE OBJECT TO ANOTHER,  
THEREBY CHANGING THEIR MOTION**



## Procedure for Building A Stomp Rocket

### 1. Gather materials

Launcher: One, 2 liter plastic bottle, vinyl tubing, duct tape (shared), one PVC pipe

Rocket: One piece typing paper, transparent tape roll (shared), scissors, index card

### 2. Build the launcher

- Put one end of the tubing into the neck of the bottle and create an airtight seal with the duct tape.
- Place the other end of the tubing just up against the PVC pipe, and make an airtight seal with the duct tape.

### 3. Build the rocket

- Place transparent tape along length of the paper.
- Roll the other edge of the paper the long way around the PVC pipe and secure the edge to the taped edge. The rocket should not be taped to the PVC pipe, and must **just** be able to slide up and down the pipe.
- Build a flat nosecone by flattening the tube at the top, and seal with transparent tape.
- Add 4 fins to the rocket by folding the index card in half and then cutting it along the fold. Then cut each half diagonally ending up with 4 equal pieces.
- Use transparent tape to secure both sides of each fin to the bottom of the rocket so they are equal distances apart from each other.

### 4. Launching the rocket

- Position rocket about halfway down the PVC pipe.
- Put the bottle on the ground
- One team member holds the PVC pipe with the rocket and positions it at a 45 degree angle.
- One team member will check launch angle
- One team member will retrieve the rocket after it has landed.
- One team member will stomp with both feet on the middle of the bottle to launch the rocket.
- One team member will be responsible for measuring the distance the rocket traveled.
- To re-inflate the bottle for another launch, hold the top of the PVC pipe with your hand and blow against your hand until the bottle is totally inflated.

# The Effect of Nosecone Shape on Rocket Flight Distance

By \_\_\_\_\_

We will be investigating 3 different nosecone shapes to determine how the shape affects the rocket flight distance. The first shape we will investigate is a Flat Nosecone.

Choose 2 different nosecone shapes your group will investigate and record below.

Nosecone Shape:

Shape 1. Flat Nosecone

Picture:



Shape 2. \_\_\_\_\_

Picture:

Shape 3. \_\_\_\_\_

Picture:

Controls: Variables that will not be changed

paper type \_\_\_\_\_ / typing \_\_\_\_\_

paper size \_\_\_\_\_ / 8 1/2 x 11 inches \_\_\_\_\_

\_\_\_\_\_ / \_\_\_\_\_

\_\_\_\_\_ / \_\_\_\_\_

\_\_\_\_\_ / \_\_\_\_\_

\_\_\_\_\_ / \_\_\_\_\_

Prediction: We predict the flight of the rocket will be longest on with the \_\_\_\_\_ nosecone shape because \_\_\_\_\_.

Results Data: Nosecone Shape and Rocket Flight Distance (ft.)

Nosecone Shape	SHAPE 1 FLAT	SHAPE 2 Trial 2	SHAPE 3 Trial 3
Test 1 Flight (ft.)			
Test 2 Flight (ft.)			
Test 3 Flight (ft.)			
Order test results from smallest to largest for each shape.			
Median Number (The number in the middle of the ordered numbers)			

Conclusion: (A claim supported by data)  
The results of the experiment shows \_\_\_\_\_

Claim

because \_\_\_\_\_

Data (measurement/observation)

Diagram of Recommended Design based upon Rocket Flight Distance:

Engineering Recommendation:

Based on the data I collected, or that has been reported collaboratively, as an engineer, I recommend

---

\_\_\_\_\_ because \_\_\_\_\_

---

Other changes I would investigate to improve the Rocket Flight Distance:



Stomp Rocket Worksheet  
By

---

Discuss these questions with your group and record your responses on the lines.

1. Why *doesn't* the rocket appear to be moving prior to the "stomp"?

---

2. What type of energy does the Stomp Rocket possess prior to the stomp?

---

3. Why type of energy does the Stomp Rocket possess after the "stomp"?

---

4. Where did the energy come from when the rocket blasted off?

---

5. Describe how the energy was transferred through the Stomp Rocket System.

---

---

---