

**Overview:**

During this lesson students will build a spoon catapult to launch washers of different masses, then collect data and graph the results. The distance a washer travels depends on its mass, just as the distance material that is ejected from a volcano travels depends on its mass. More massive material ejected during a certain volcanic eruption is found close to the eruption site, while less massive material is found a greater distance from the source.

**Objectives:**

The student will:

- understand the relationship between the mass of an object and the distance it will travel from a source of energy;
- understand that more massive material ejected from a volcano is found close to the eruption site and less massive material is found a greater distance from the source; and
- collect and graph data.

**National Standards:****Science as Inquiry**

[5-8] Understanding of scientific concepts; Abilities necessary to do scientific inquiry

**Physical Science**

[5-8] Motions & forces

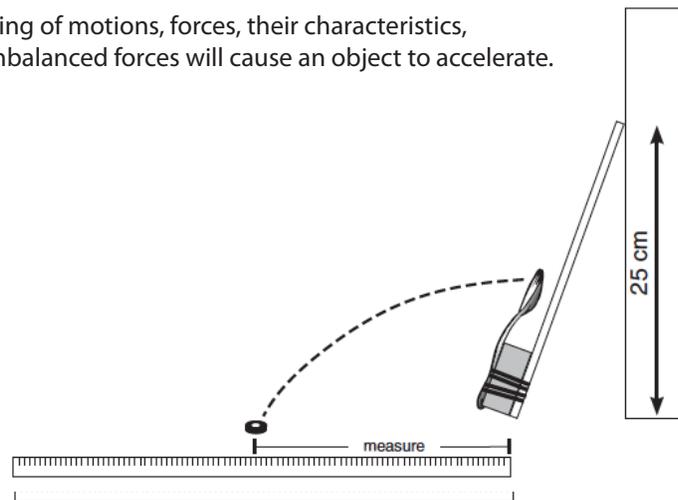
**Targeted Alaska Grade Level Expectations:****Science**

[5-8] 1.1 The student demonstrates an understanding of the processes of science by asking questions, predicting, observing, describing, measuring, classifying, making generalizations, inferring, and communicating

[7] SB4.1 The student demonstrates an understanding of motions, forces, their characteristics, relationships, and effects by illustrating that unbalanced forces will cause an object to accelerate.

**Materials:**

- Rubber bands
- Plastic spoons
- 1/4" washers
- 2"x 2"x 3" blocks
- Tape
- 30 cm ruler
- Meter stick
- Goggles
- STUDENT WORKSHEET: "Tephra Catapult"

**Activity Procedure:**

1. Distribute STUDENT WORKSHEET: "Tephra Catapult" to each student. Divide the class into lab groups of four students each. Distribute supplies to each group. Explain that groups will perform an experiment to determine how mass affects the distance tephra travels from a volcanic vent. Ask students to read the Background Information and complete their hypothesis.
2. Explain that each group will build a spoon catapult by wrapping rubber bands around a ruler, block of wood and plastic spoon. Use the diagram on the Procedure section of the Student Worksheet to demonstrate this for students.
3. Ask each group to create two objects to catapult. Make the first object by taping together four washers, and

the second object by taping together two washers. Explain that the first object has greater mass than the second.

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**NOTE:** Tephra is solid material that has been shot into the air or underwater by an explosive volcano. The four types of tephra are identified by size. Ash is the smallest tephra. It is so light it can be carried in the wind around the world. Ash falls from the sky and is deposited in layers on the ground. Cinder is medium-sized tephra. It is heavier than ash and usually falls a short distance from the volcano's vent. Bombs are thrown into the air as liquid during an eruption. They cool into solid forms while flying through the air. They are large streamlined forms that are sometimes as large as a football and are usually found close to the volcano's vent. Blocks, the largest solid tephra, are exploded fragments of rock that fall close to the volcano's vent. Blocks can be as large as a car.

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4. Find an area for groups to launch the washers. To ensure the catapult works well, prop the catapult up approximately 25 cm high against a wall or stack of books. Find an area that will let the washers shoot out 1 meter.
5. Ask students to shoot the different masses of washers 10 times (starting with the larger mass), record the distance, then find the average distance each mass traveled. Emphasize the importance of accurately recording the data, launching the washers with the same amount of force and at the same angle each time. Later students will graph the results
6. After students complete the lab, discuss conclusions and further questions.

## Extension Idea:

1. Relate this lesson to Newton's second law of motion:

$$\text{Mass} \times \text{Acceleration} = \text{Force.}$$

## Answers:

### STUDENT WORKSHEET: "Tephra Catapult"

#### Data:

Chart answers will vary depending on student experiment.

#### Analysis:

1. Graph will vary
2. Large mass

#### Conclusion:

If a large mass and a small mass are launched with the same force, then the small mass will travel farther  
Other answers will vary.

#### Further Questions:

1. C. Heavy blocks
2. Answers will vary
3. Answers will vary

**NAME:** \_\_\_\_\_  
**TEPHRA CATAPULT**

**STUDENT WORKSHEET**  
**(page 1 of 2)**

**Testable Question:**

How does the mass of tephra affect the distance it travels?

**Background Information:**

Tephra is solid material that has been shot into the air or underwater by an explosive volcano. The four types of tephra are identified by size. Ash is the smallest tephra. Ash falls from the sky and is deposited in layers on the ground. Cinder is medium-sized tephra. It is heavier than ash. Bombs are thrown into the air as liquid during an eruption. They cool into solid forms while flying through the air. They are streamlined forms that are sometimes as large as a football. Blocks, the largest solid tephra, are exploded fragments of rock. Blocks can be as large as a car. The distance a washer travels depends on its mass, just as the distance material that is ejected from a volcano travels depends on its mass.

**Hypothesis:**

During this experiment, you will build a catapult to launch washers of different masses. Complete the hypothesis below by answering this question: If a large mass and a small mass are launched with the same force, which mass will travel farther?

If a large mass and a small mass are launched with the same force, then:

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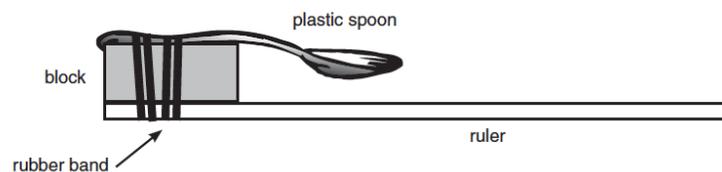
**Investigation:**

**Materials:**

- Rubber band
- Plastic spoon
- 1/4" washers
- 2"x2"x3" block
- Tape
- 30 cm ruler
- Meter stick
- Goggles

**Procedure:**

1. Use the diagram to construct a catapult using a 30 cm (12") ruler, wooden block, plastic spoon and rubber band.



2. Stack and tape two washers together. This will make an object with a small mass for catapulting. Tape four washers together in the same way. This will form the second object with a large mass for comparison.
3. Prop the catapult against a wall or stack of books as shown on the diagram. The ruler should be propped up so the top is about 25 cm from the floor. Clear a space at least one meter in front of the catapult for launching the washers.

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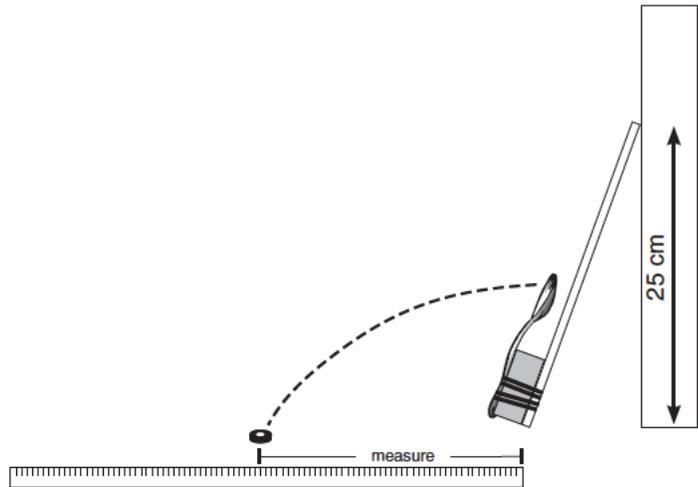
**Note:** It is important that the washers are launched at the same angle and with the same force each time.

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**Important:** Before launching the washers from the catapult be sure everyone is wearing safety goggles.

4. Place the larger mass (four washers taped together) in the spoon and carefully bend the spoon toward the ruler. Be sure no one is in front of the catapult, then release the spoon to launch the washers.
5. Record the distance the large mass travelled from the base of the catapult on the data table on the Student Worksheet: "Tephra Catapult." Repeat this 10 times and record the data for each launch.
6. Do the same experiment using the smaller mass (2 taped washers) recording the data in the table each time.
7. After launching the objects, find the average distance each traveled.
8. Make a bar graph of your data in the Analysis of Data 8. section of the Student Worksheet.



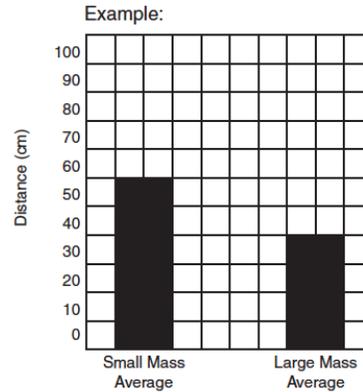
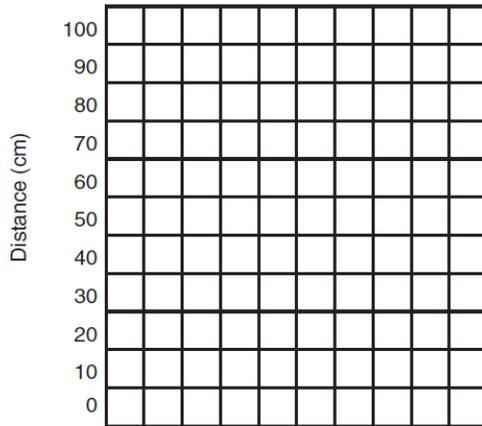
**Data:**

1. Record the distances the object with large mass traveled 10 times in the left side of the table, and the distances the object with small mass traveled 10 times on the right side of the table. Be sure to launch both objects at the same angle with the same amount of force.

	Distance large mass travels (cm)	Distance small mass travels (cm)
Trial 1		
Trial 2		
Trial 3		
Trial 4		
Trial 5		
Trial 6		
Trial 7		
Trial 8		
Trial 9		
Trial 10		
Average (Total Distance ÷ 10)		

**Analysis of Data:**

1. Make a bar graph of the average distance traveled for the large mass and small mass.



3. Circle which landed closest to the catapult:
  - A. large mass
  - B. small mass

**Conclusion:**

1. If a large mass and a small mass are launched with the same force, then:

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2. Was your hypothesis proved or disproved? Explain your answer.

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**Further Questions:**

1. In a volcanic explosion, what would you expect to fall closest to the eruption site?
  - A. lightweight ash
  - B. medium weight cinder
  - C. heavy blocks
2. What modifications could be made to maximize the distance the washers traveled?.

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3. What factors affect the distance that tephra travels from a volcanic vent?

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