Rubber Band Cannon

Introduction

What determines how far a cannonball will fly? How does the launch angle of a cannon affect its range? Explore some of the variables that influence projectile motion using a Rubber Band Cannon.

Concepts

- Projectile motion
- Scientific method
- Variables

Background

Several factors affect how far a projectile will travel. The two most important variables are the launch angle and the magnitude of the initial force that sets the object into motion. In order to determine how a single variable affects a projectile's horizontal distance, experiments need to be designed to test each variable independently. This is done by making observations under controlled conditions where only one variable at a time is changed. Controlled experiments make it possible to separate or isolate the factors that are responsible for a given observation in a complex series of events. In this activity, students examine how launch angle affects the horizontal distance traveled by a rubber band.

Materials

Box, cardboard, empty	Rubber band
Pencil	Scissors
Protractor cutout, paper	Tape measure
Ruler, clear plastic, hole at end, 12″	Tape, transparent

Safety Precautions

Wear safety glasses or goggles during this experiment. Do not aim the Rubber Band Cannon at anyone. Cannon firing should be conducted in an open area such as a gymnasium, or outside.

Procedure

1. Cut out the paper protractor from page 4.
2. Using transparent tape, secure the paper protractor to the cardboard box so that the 0° line is about 2.5 cm from the bottom of the box (see Figure 1). *Note:* A shoe box is ideal for this activity.
3. Using a sharp pencil, poke a hole through the paper protractor and into the box at the point where the 90° and 0° lines intersect. Push the pencil about halfway into the box (see Figure 2).
4. Locate the hole on the end of a ruler. Slip the hole on the end of the ruler onto the pencil (see Figure 3). This completed setup will now be referred to as the "Rubber Band Cannon."

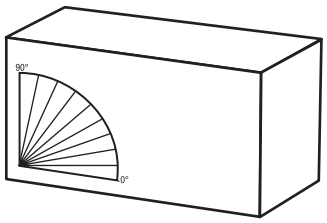

Figure 1.

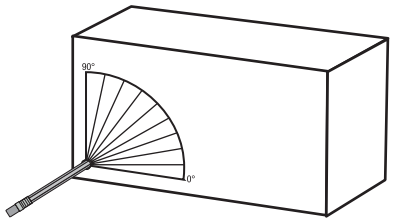

Figure 2.

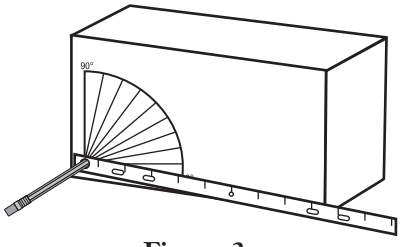

Figure 3.

Publication No. 10873
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5. Lift up the free end of the ruler so that its center is over the 10° mark on the protractor. Secure the ruler at this angle with a piece of transparent tape (see Figure 4).
6. Place the Rubber Band Cannon on the floor and hold it in place with your hand. Use your free hand (or help from a partner) to place a rubber band on the end of the ruler. Pull the rubber band back to the 12-cm mark on the ruler. Do this by pinching the rubber band between the thumb and index finger as shown in Figure 5.
7. Making sure the area in front of the Rubber Band Cannon is clear, quickly release the rubber band to launch it from the cannon. One lab partner should fire the cannon while the other becomes the spotter. The spotter should watch where the rubber band first hits the ground.
8. Use a tape measure to determine the horizontal distance traveled by the rubber band. Measure from the front end of the ruler to the front end of the rubber band. Repeat steps 6 and 7 for three more trials (a total of four trials).
9. Repeat steps 5–8 for launch angles of 30°, 45°, 60°, and 80°. Be sure to consistently pull the rubber band back to the 12-cm mark on the ruler. To change the angle, first remove the tape securing the ruler in place. Position the ruler so its center is at the new launch angle, and then re-secure the ruler with tape.
10. Analyze the data to determine which launch angle resulted in the greatest horizontal distance traveled by the rubber band.

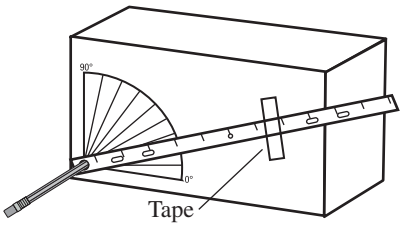

Figure 4.

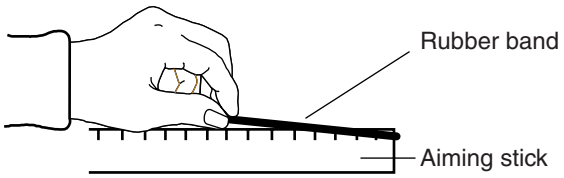

Figure 5.

Disposal

The materials may be saved for future use.

NGSS Alignment

This laboratory activity relates to the following Next Generation Science Standards (2013):

Disciplinary Core Ideas: Middle School
- MS-PS2 Motion and Stability: Forces and Interactions
  - PS2.A: Forces and Motion
  - PS2.B: Types of Interactions
- MS-PS3 Energy
  - PS3.A: Definitions of Energy
  - PS3.B: Conservation of Energy and Energy Transfer
  - PS3.C: Relationship Between Energy and Forces

Disciplinary Core Ideas: High School
- HS-PS2 Motion and Stability: Forces and Interactions
  - PS2.A: Forces and Motion
- HS-PS3 Energy
  - PS3.A: Definitions of Energy
  - PS3.B: Conservation of Energy and Energy Transfer
  - PS3.C: Relationship Between Energy and Forces

Science and Engineering Practices
- Asking questions and defining problem
- Planning and carrying out investigations
- Analyzing and interpreting data

Crosscutting Concepts
- Patterns
- Cause and effect
- Energy and matter

Tips

- This activity may also be used to show how the force applied to stretch the rubber band can have an effect on the horizontal distance traveled. The students can test this by keeping the launch angle constant while altering the stretch distance of the rubber band.
- For further concept development, try the Flinn Scientific *Rubber Band Cannon Student Laboratory Kit* (Catalog No. AP6624). This kit includes reproducible student handouts, valuable Teacher Notes, rubber bands, and enough Rubber

Band Cannons for eight groups of students. All materials are reusable.

- The distances traveled by the rubber bands typically have a wide range. They are significantly affected by air resistance and air currents. Additional trials can be performed for each experiment. High and low values can be ignored when calculating the average values. Several practice launches should also be performed until students are comfortable with a launch technique.
- In this activity students will fire rubber band projectiles over several meters. Be sure that all safety precautions are followed during the activity. Safety glasses or goggles must be worn at all times by everyone.

Sample Data Table

Launch Angle	Stretch Distance	Launch Distance				
		Trial 1	Trial 2	Trial 3	Trial 4	Average
10°	12 cm	*126 cm*	*128 cm*	*138 cm*	*152 cm*	*136 cm*
30°	12 cm	*268 cm*	*280 cm*	*280 cm*	*279 cm*	*277 cm*
45°	12 cm	*288 cm*	*289 cm*	*278 cm*	*283 cm*	*286 cm*
60°	12 cm	*217 cm*	*183 cm*	*194 cm*	*238 cm*	*208 cm*
80°	12 cm	*86 cm*	*140 cm*	*110 cm*	*89 cm*	*106 cm*

Materials for the *Rubber Band Cannon* are available from Flinn Scientific, Inc.

Catalog No.	Description
AP6624	Rubber Band Cannon—Student Laboratory Kit
AP4685	Ruler, Transparent, 120
AP1818	Rubber Bands, Medium, 750/pkg.

Consult your *Flinn Scientific Catalog/Reference Manual* for current prices.

Protractor Master