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**CHAPTER 13** **SKILLS LAB**

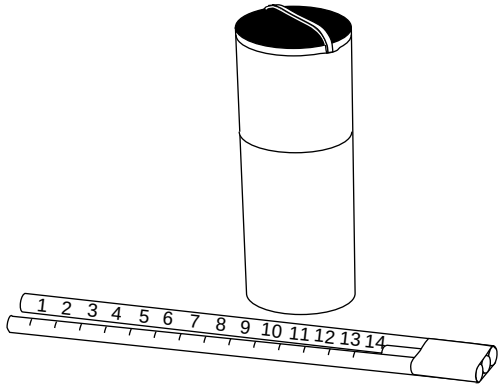
***Controlling Variables***

# Soaring Straws

In this lab, you will use the skill of controlling variables. You will investigate the relationship between the height reached by a rocket and the amount of stretch in a rubber band.

## ◆ Problem

How does the gravitational potential energy of a straw rocket depend on the elastic potential energy of the rubber band launcher?




## ◆ Materials

| | | |
|---|---|---|
| scissors | rubber band | 3 plastic straws |
| marker | metric ruler | meter stick |
| balance | masking tape | empty toilet paper tube |

## ◆ Procedure

*Review the safety guidelines in Appendix A.*

**1.** Construct the rocket and launcher following the instructions below. Use a balance to find the mass of the rocket in grams. Record the mass.

**Making a Rocket and Launcher**

**A.** Cut a rubber band and tape it across the open end of a hollow cylinder, such as a toilet paper tube. The rubber band should be taut, but only stretched a tiny amount. This is the launcher.

**B.** Cut about 3 cm off a plastic straw.

**C.** Lay 2 full-length straws side by side on a flat surface with the 3-cm piece of straw between them. Arrange the straws so that their ends are even.

**D.** Tape the straws together side by side.

**E.** Starting from the untaped end, make marks every centimeter on one of the long straws. This is the rocket.

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## SKILLS LAB *(continued)*

2. Hold the launcher in one hand with your fingers over the ends of the rubber band. Load the launcher by placing the straw rocket on the rubber band and pulling down from the other end as shown in the photograph. Let go and launch the rocket straight up. **CAUTION:** *Be sure to aim the straw rocket into the air, not at classmates.*
3. Have your partner hold a meter stick, or tape it to the wall, so that its zero end is even with the top of the rocket launcher. Measure the height, in meters, to which the rocket rises. If the rocket goes higher than a single meter stick, use two meter sticks.
4. Be sure to record your data in the data table.
5. You can measure the amount of stretch of the rubber band by noting where the markings on the rocket line up with the bottom of the launching cylinder. Launch the rocket using three different amounts of stretch. Record your measurements.
6. For each amount of stretch, find the average height to which the rocket rises. Record the height in your data table.
7. Find the gravitational potential energy for each amount of stretch.

   Gravitational potential energy = Mass × Gravitational acceleration × Height

   Since you have measured the mass in grams, the unit of energy is the millijoule (mJ), which is one thousandth of a joule. Record the results in your data table.

### ◆ Data Table

| Amount of Stretch (cm) | Height (Trial 1) (m) | Height (Trial 2) (m) | Height (Trial 3) (m) | Average Height (m) | Gravitational Potential Energy (mJ) |
|---|---|---|---|---|---|
| | | | | | |
| | | | | | |
| | | | | | |

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**SKILLS LAB** *(continued)*

## ◆ Analyze and Conclude

*Write your answers on the back of this sheet or on a separate sheet of paper.*

1. Which variable in your data table is the manipulated variable? The responding variable? How do you know?
2. Graph your results. Show gravitational potential energy on the vertical axis and amount of stretch on the horizontal axis.
3. What measurement is related to the elastic potential energy in this experiment?
4. Look at the shape of the graph. What conclusions can you reach about the relationship between the gravitational potential energy of the rocket and the elastic potential energy of the rubber band?
5. How do you think the amount of energy before the rocket was released compares to the amount of energy after the rocket was released? Account for any losses.
6. **Think About It** Besides the amount of stretch, what other variables might affect the height to which the straw rocket rises? Have you been able to control these variables in your experiment? Explain why or why not.

## ◆ More to Explore

Use your launcher to investigate launches at angles other than straight up. Instead of manipulating the amount of stretch, hold that variable constant and manipulate the angle of launch. Measure both the heights and distances of the rocket. **CAUTION:** *Be careful not to aim the rocket near any of your classmates.*