Launch Weights with Rubber Bands

Purpose
To compare the distances traveled by launched objects having the same size and shape but different weights.

Process Skills
Predict, observe, measure, collect data, interpret data, communicate, identify and control variables, draw conclusions

Background
Objects can be at rest or in motion. To **move** an object, or to stop an object from moving, a **force** must be used. It takes less force to move lighter objects, whereas it takes more force to move heavier objects. When the same amount of force is applied to similar objects that have different **weights** (masses), the objects will travel different distances. In this activity, students will use rubber bands that are placed around their feet to launch canisters away from their bodies. By standardizing the launch mechanism, students will be able to compare the distances traveled by canisters of different weights.

Time – 45–60 minutes

Grouping – Whole class and small groups

Materials
- ❑ tape measure or meter stick
- ❑ masking tape
- ❑ permanent marker

(per group)
- ❑ Data Sheet
- ❑ 1 35 mm film canister or other small container with lid
- ❑ 1 extra-long rubber band or several smaller ones
- ❑ 30 pennies
- ❑ 1 zippered baggie

Procedure
<u>Preparation</u>

1. Collect film canisters ahead of time. Most photo developing labs will save canisters and donate them for a school project if you make a request in advance. Film canisters with lids that fit inside the open end will work best. If canisters are not available, consider similar small containers, such as: plastic baby-food jars with lids, empty yogurt containers with lids, plastic eggs (seasonal), small plastic food-storage containers with lids, or breath-mint tins.
2. Use a permanent marker to draw a line around the midsection of each film canister. This mark will help students be consistent in launching each canister from its center.

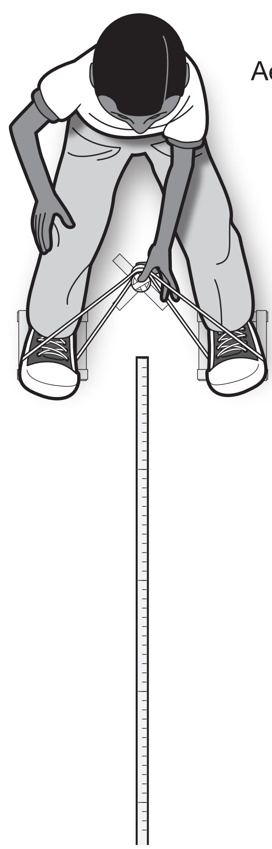

Figure A

3. Use a 25-foot tape measure to prepare a launch area on the classroom floor, in a hallway, or in another location with a spacious, smooth floor. Attach a 25-foot length of masking tape to the floor in a straight line, and ask student volunteers to help you mark each centimeter and meter (or inch and foot) with small and larger dash marks. Using masking tape will eliminate the risk of using a sharp-edged, retractable tape measure with young students.

If you prefer that groups not have to take turns launching their canisters, set up more than one launch area. Be sure to leave adequate space between them for safety reasons.

4. It is important that each launch be made from the same starting point and in the same direction so that each group uses an approximately equal amount of force in each trial. The only significant variable should be the weight of the canister being launched. Use more masking tape to mark precisely where each launch should take place:

- Use masking tape to mark two small squares, one on either side of the zero mark of the launch line. The near sides of the squares should be 30 cm (12 in.) apart. Students who serve as "launchers" will sit on the ground with their legs spread slightly in front of themselves and will place their heels in these boxes.
- From the midpoint between the squares, measure 15 cm (6 in.) in the opposite direction of the launch. Mark this spot with masking tape in the shape of an *X*. This will be the launching spot and will standardize how far back students should pull the rubber band.

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5. Obtain extra-long rubber bands from an office-supply store. When relaxed, these rubber bands are about 18 cm (7 in.) long, and they safely stretch to at least 60 cm (2 ft.). Alternatively, you can link a set of three normal-sized rubber bands together for each group. Provide enough rubber bands for each group.

6. Consider assigning roles for each student within a cooperative group, which may include group leader, launcher, measurer, canister assembler, and penny counter. Keep the number of students in each group small (3–4 students per group). Some students may have more than one role.

Discuss How Objects Move

Ask students how things move. Discuss a variety of objects and encourage students to suggest ways each object can move. Introduce the word *force* and explain that things move because of a force being used on them. A force is a push or a pull in any direction. Model a force in action by slowly pushing and then pulling a nearby object, such as a chair. Invite volunteers to carefully demonstrate pushing and pulling other common objects.

Launch Weights with Rubber Bands

1. Prepare three film canisters, labeled *0, 15,* and *30,* and place the corresponding number of pennies in each one. Shake each canister so that students can hear that two of the canisters have pennies inside. Explain that one canister has no pennies inside, one has 15 pennies, and one has 30 pennies. Pass the film canisters around. Ask students which one is heavier (the one with 30 pennies) and why (it has the most pennies inside).
2. Explain the activity. Then invite students to make predictions about which film canister will move the greatest distance from its starting point if launched the same way with the same rubber band. Ask students to explain why they made their prediction. Record students' predictions and reasons on the board, and have students reflect on them after the activity.
3. Place students into groups and assign roles. Use the data sheet to model recording a prediction. Give a data sheet to the recorder in each group. Have each student write the group's prediction in the appropriate place.
4. Bring the class to the reserved location with a spacious, smooth floor. Make sure that students bring their data sheet and pencil. Have the class sit around one of the pre-measured and marked launching areas. Explain safety rules, such as:
   - Film canisters may only be launched along the ground, not through the air.
   - Film canisters may only be launched by pulling the rubber band back to the *X.*
   - Film canisters may only be launched if no one is in the launch target area.
   - Film canisters may only be launched when the teacher says "Go."
5. Model the activity (see Figure A). Place one long rubber band (or a chain of three smaller rubber bands) around both feet of a student volunteer. Coach the student to sit with his or her legs spread and heels placed in the masking-tape squares. He or she should be facing the long, straight piece of tape on the ground. Show students a film canister, noting the line around its midsection. Explain that the rubber band must be lined up at the line drawn on the film canister. The launcher should use his or her fingers to hold the top and bottom of the canister, keeping it upright, and then release all fingers at the same time in order to launch it.

   Have the student volunteer pull the film canister (and the rubber band) toward his or her body until the canister is resting in contact with the ground on the launch pad, which is marked with an *X.* Ask the volunteer to quickly open his or her fingers when you say "Go!" Once the film canister has been launched, demonstrate how to read the measured line of tape to determine the distance that the canister traveled. Then show students where they should enter the measurement on their data sheet, including the proper units for measuring length.

   TIP: Students may all want to try the launch themselves. One option is to have each student complete his or her own data sheet. Alternatively, let all students from each group attempt the launch and ask them to record their own data in a science journal or notebook. Then help students calculate their group's average distance—or simply have each group estimate how far its canister traveled overall—during each trial. If the group shares one data sheet, it should record a single measurement for each trial.

6. Give each group a film canister, a large rubber band, and a baggie containing 30 pennies. Provide masking tape in a central area. Have students start by putting all 30 pennies into their film canister and taping it closed (see Figure B). Once all groups are ready and film canisters are pulled back to their launch pads, call out "Go!" and monitor the launches. Remind students not to move the canister until they have measured the distance and recorded the result on their data sheet.

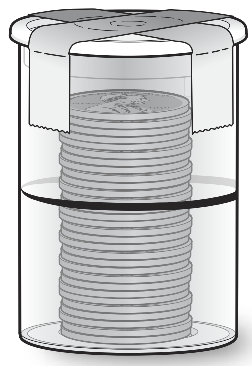


Figure B

Assist students as needed with measuring the farthest point that the canister reached. If the launched canister did not travel in a straight line and wind up near the measuring tape on the ground, have the launcher try again. (Alternatively, an adult helper might help measure the distance in any direction by using a tape measure.)

7. Instruct each group to take the tape off the lid and to remove 15 of the pennies, leaving 15 in the canister (see Figure C). Students should place the removed pennies in a zippered baggie, and they should reseal the film canister with the same amount of tape used earlier. Once all groups are ready and film canisters are pulled back to their launch pads, call out "Go!" and monitor the launches. Again, assist students as needed with measuring and recording data.

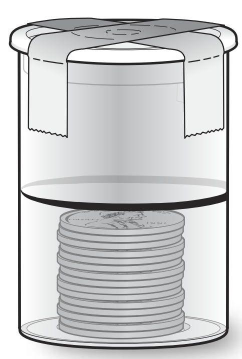


Figure C

8. Instruct each group to take the tape off the lid and to pour the remaining 15 pennies into their zippered baggie, leaving the canister empty (see Figure D). Students should reseal the film canister with the same amount of tape used earlier. Once all groups are ready and film canisters are pulled back to their launch pads, call out "Go!" and monitor the launches. Once again, assist students as needed with measuring and recording data. [**Note:** The empty film canisters may go farther than the line of tape on the ground can measure. If so, provide assistance as needed so students can measure the total distance.]

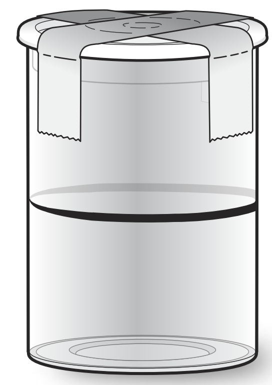


Figure D

9. Record group results on the board or on butcher paper. Help students compare their results with their group's predictions.

10. Have students record and draw what they learned on their data sheet.

Discussion Questions

Use these questions to guide a discussion about the experiment. Encourage students to use the words *move*, *heavy*, *light*, *force*, *push*, *pull*, *weight*, and *distance* in their responses.

1. What made the film canisters move?

When you stretch out a rubber band and then release it, it quickly returns to its original position. When students let go of the canisters, the force of the rubber band returning to its original position pushed the film canisters forward.

2. Why did some of the film canisters move a greater distance than others?

The film canisters with no pennies inside should move farthest when launched. The film canisters that had the most pennies should move only a small distance by comparison. When equal amounts of force are used (such as the rubber band being drawn back the same distance each time), objects with less weight will travel farther. Students might consider how far they can throw a small rock versus a big one.

3. Why did some groups' film canisters of equal weight travel farther than those of other groups?

There will almost always be small differences in the results of experiments. In this activity, the canister's shape may have caused it to tumble differently each time it was launched. Explain to students that it was important to keep as many things (variables) the same during each test so that they were able to focus on the one thing that was different each time they tried the test again. In this case, the only thing that should have changed was the weight.

4. What might have happened during this experiment if the floor had been bumpier or rougher (for instance, if it had been covered with carpet instead of tile)?

The film canister would not have traveled as far in any of the trials if the floor had been bumpy or rough. The texture of the floor would have rubbed against the canister, slowing it down (friction). If the floor had been smoother than the one used, the canister would have traveled farther than it did because there would have been little or no texture to slow it down. However, unless launched into a very soft target that immediately stopped the object regardless of weight (such as water or mud), the film canisters with less weight will likely always travel a greater distance than those with more weight.

Conclusions

1. What makes objects move?

Force makes objects move. A force can be a push or a pull. The rubber bands pushed the film canisters forward.

2. Why did one of the canisters travel farther than the two others?

Empty film canisters do not weigh as much as film canisters filled with pennies. It would take more force to make the film canisters filled with pennies travel as far as the empty film canister traveled.

3. What would have happened if the rubber bands had been pulled farther?

Stretching the rubber band farther (within safe limits) would have propelled each canister farther than it traveled during this experiment. More force makes an object move a greater distance. However, there still would have been a difference in distance traveled between the empty and full film canisters.

4. What would have happened if you had tried launching heavier or lighter objects?

Objects that are heavier than the 30-penny canister would have traveled a shorter distance. Objects that are lighter than the empty canister would have traveled a greater distance. (Things that are too heavy, such as a person or a box of books, would not have moved at all because the force of the rubber band would not have been great enough. Objects that are too light, such as a sheet of paper, a feather, or a human hair, would not have traveled far at all. This is because the force of the air resistance that slows their motion would quickly exceed their momentum, due to their shape and/or their small mass.)

Extensions and Variations

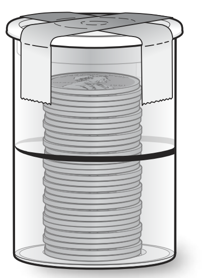
- Variation/Math: Have students help create a class graph showing the results of the experiment.
- Variation: Allow students to explore what happens when objects of the same weight but a different size or shape are launched. Do not let students launch sharp or fragile items.
- Variation: Allow students to explore how the distance the canister travels is affected by the rubber band being drawn back different distances. Only allow students to draw the rubber band back a safe distance, and always be sure the launch target area is clear before each launch.
- Writing: Have students write an acrostic poem using the word *movement*, *launch*, or *force*. Each letter should begin a word or phrase related to what students learned during the experiment.
- ELL/ESL: Create a word wall. Include content vocabulary such as *move*, *heavy*, *light*, *force*, *push*, *pull*, *weight* (or *mass*), *distance*, and *centimeter* (or *inch*). Also include relevant vocabulary from the lesson, such as *rubber band*, *film canister*, *zero*, *fifteen*, *thirty*, and *penny*. For more vocabulary resources, visit VocabularyAZ.com.
- Technology: Have students videotape and/or take pictures of their launches and create a multimedia presentation about how weight influences the distance that film canisters travel. Share the finished products with another class and with families.
- Home Connection: Challenge students to create their own rubber-band launcher at home (with adult supervision) and bring it to school to explain the results of any testing they conducted with it.
- Research: See Using the Internet in the Unit Guide for suggested websites to extend the learning.

Data Sheet: Students should record their predictions and results in the correct places on the page. Measurements should be reasonable and should include correct units. In the *What I learned* section, students should explain that light objects move a longer distance than heavy objects do, when launched with same amount of force. Ideally, students should use key vocabulary terms. They should also draw a diagram and add labels to support their statement. Encourage students to share their results and to summarize what they learned.

Names________________________________ Date____________

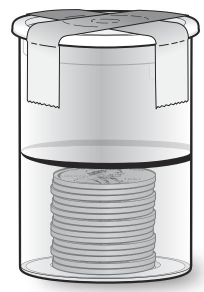
Prediction: The film canister with (circle one) **30 15 0** pennies will travel the greatest distance because:

30 pennies



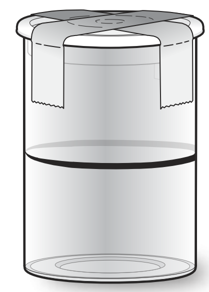
Distance: ____________

15 pennies



Distance: ____________

0 pennies



Distance: ____________

What I learned (write and draw):