Traps

Objectives

Students will build traps that stop a moving ball without the ball changing direction. First, they will test different items to determine which materials work best. Then, they will build traps to stop the ball, evaluate the results, improve their designs, and retest.

Teacher Note: This challenge is best used after students are familiar with the concepts introduced in the *Make it Move!* (*Effects of Unbalanced Forces*) lesson (page 45).

STEM Focus

Physical Science: Forces that do not sum to zero can cause changes in the object's speed or direction of motion. When objects collide, the contact forces transfer energy so as to change the objects' motions.

Engineering Design: Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

Science and Engineering Practices: Plan and carry out investigations; construct explanations; engage in argument from evidence.

Crosscutting Concepts: Energy and matter; cause and effect

Setup

Prepare to have a fairly large area of floor space available for these challenges. See page 65 for details on setting up ramps and appropriate materials for traps.

For Introduction and Mini Challenge

- Prepare the identical ramps for the Mini Challenge and the Main Challenge. Try to have one ramp per group of three to five students.
- Be prepared to share the assembly of one of the identical ramps during the Introduction.
- Gather a ruler, a heavy book or a block, and a golf ball for the demonstration.

For Main Challenge

- Arrange testing areas that have an established ramp set up for each group.

Materials

Mini Challenge

- *How to Build Ramps and Traps* (page 65)
- building materials (See page 65 for suggestions.)

Main Challenge

- *Traps—Materials Testing* (page 71)
- *Trap Testing* (pages 72–73)
- *Reflections—Traps* (page 74)
- golf balls,* one per group
- prepared ramps (See Setup and page 65.)

*If you do not have access to golf balls, you can use any fairly heavy balls, such as racquetballs, rubber bouncy balls, or large marbles.

Time Frame

The Introduction and Mini Challenge can be completed in one class session of about 40 minutes.

The Main Challenge can be completed in about 45–60 minutes.

Follow up with the Writing Reflection as time allows.

Vocabulary

balanced
contact
deflect
force
gravity
motion
trial
unbalanced

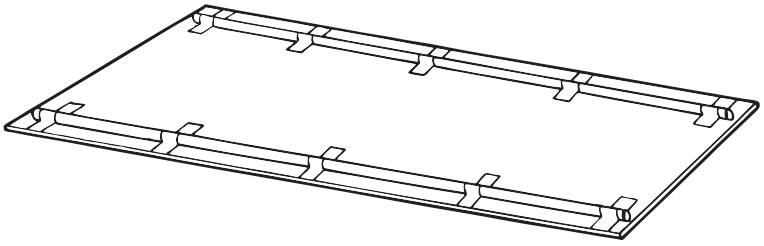
How to Build Ramps and Traps

Ramp Setup

Students will be sending golf balls down ramps in these challenges. All materials should be as identical as possible for each group.

Suggested Materials

* cardboard
* cardboard tubes or pool noodles (sliced in half lengthwise) will work if using marbles instead of golf balls
* items of uniform height such as textbooks, building blocks, step stools, yoga blocks, etc.
* large straws
* plastic gutters
* rulers
* wood planks



Procedure

1. Use any material that is long (approximately 2 feet to 3 feet) and flat to create a ramp. You will need an identical ramp for each group.
2. Tape large straws to the sides of the ramps in order to keep the balls from rolling off. If using cardboard, bend the sides up or tape straws on the sides for rails.
3. Provide items of uniform height to support the ramps.
4. Each ramp must be the same height. Decide ahead of time how tall it should be—try for approximately 12 inches high.

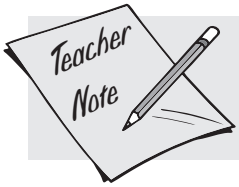
Trap Building

Students will build "traps" according to the *Challenge Constraints* in order to stop the golf balls' movement. Traps will be placed one foot past the ends of the ramps.

1. Use materials that you have on hand for this challenge.
2. Be sure to provide both hard and soft materials.

Suggested Building Materials

* aluminum foil
* blocks of wood
* bubble wrap
* cardboard
* cardstock
* cotton batting
* different types of fabric
* fake fur
* flooring samples
* index cards
* paper plates
* rug samples



Do not provide objects that the ball could roll into, such as cups or small boxes. That would be too easy. If students build cup-like traps on their own, that is fine—and ingenious!

Traps

Introduction

1. Review with students these basic concepts related to forces:

   ➜ A **force** is a push or a pull that acts on an object.

   ➜ When the forces acting on an object are **balanced**, the object doesn't move. For instance, a book on a table doesn't move because gravity is pushing down, and the resistance of the table is pushing up, and the forces are equal.

   ➜ When the forces acting on an object are **unbalanced**, the object moves or changes.

✏ Write the words *force*, *balanced*, and *unbalanced* and their definitions on the board.

2. Write this question on the board or chart paper: "What can happen to an object when unbalanced forces act on it?" Ask students to read it with you and to share their ideas. (*They will most likely say that it moves.*)

✏ Write *starts moving* under the question on the board.

3. Ask if there are other things that can happen. If students have difficulty, ask them to describe what happens when they are riding in a car or a bus, and the driver steps on the gas or the brake, or turns the steering wheel.

4. With students, add to the list of the changes that can happen when an unbalanced force acts on an object.

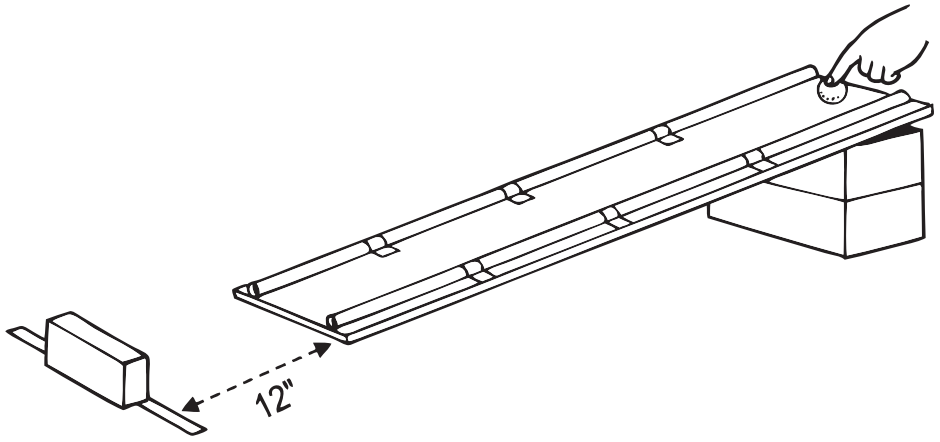
What can happen to an object when unbalanced forces act on it?	
It starts moving.	It changes direction.
It slows down.	It stops moving.
It speeds up.	

Traps

Ramp Demonstration

1. Demonstrate for students how to set up a ramp by using the materials you have selected.

2. Use a ruler and tape to mark a line exactly one foot in front of the bottom of the ramp. Place a block of wood, a book, or another fairly heavy object on the line so that the ball will roll into it.



3. Ask students to predict what will happen when you set the golf ball in motion down the ramp. Encourage students to explain their thinking.

4. Hold a golf ball at the top of the ramp by pressing down on it with one finger. Explain to students that you will not push the ball—just let it go on its own. Carefully lift your finger off the ball to send it down the ramp and into the obstacle. Let it roll to wherever it stops.

5. Ask students to describe what happened and the forces that were involved. Have them discuss their ideas with partners via think-pair-share, turn and talk, or another strategy, and then share ideas.

6. Ask students specific questions:

   —What happened when the ball ran into the obstacle?

   —Why do they think that happened? What forces acted on the ball?

7. Refer students to the list that you made earlier of changes that can happen when unbalanced forces act on an object.

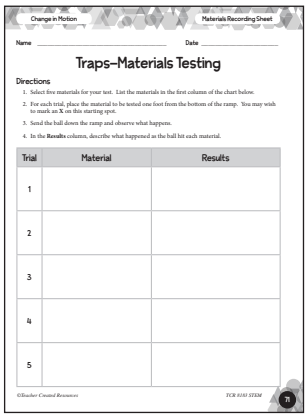
Explain the Science

Explain to students that the force of **gravity** gives the ball energy. When the ball makes contact (hits) the block, some of its energy is transferred into the block, which changes the direction that the ball is moving. Gravity draws the ball down and makes the ball roll. When the ball hits the block, the force deflects the ball, making it change direction.

Traps

Mini Challenge

Tell students that their challenge today is to build something that will stop, or "trap," the ball without the ball changing direction.


Change in Motion — Materials Recording Sheet

Name _____ Date _____

Traps–Materials Testing

Directions

1. Select five materials for your test. List the materials in the first column of the chart below.
2. For each trial, place the material to be tested one foot from the bottom of the ramp. You may wish to mark an X on this starting spot.
3. Send the ball down the ramp and observe what happens.
4. In the **Results** column, describe what happened as the ball hit each material.

Trial	Material	Results
1		
2		
3		
4		
5		

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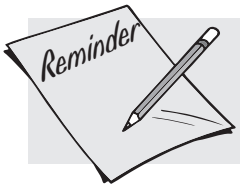
Part 1

1. Establish groups of three to five student builders for each trap. Distribute a copy of *Traps—Materials Testing* to each group.
2. Tell students they will need to test different materials to build their traps.
   ➜ They are looking for materials that will slow the ball down and stop it without the ball bouncing off and changing direction.
3. Go over the *Traps—Materials Testing* sheet with students and make sure that they understand the procedure.



Remind student testers to keep all the variables the same except for the material they are testing. That means that they will need to release the ball in the same way from the same point each time.

4. Show students the materials that they may select for testing. Allow a few minutes for students to handle and inspect the materials.
5. Ask each group to choose five materials to test.

✏ Have students list the material choices on their testing sheets.

Part 2

1. Have students gather their chosen materials. Give them time to conduct their tests.

✏ Have students record their data on their testing sheets.

2. Circulate during work time to observe and ask questions for formative evaluation, such as:

   —Why did you select these particular materials?

   —How are you ensuring that your test is the same each time?

3. Have each group share their results with the class.
4. Discuss any differences in results using the same materials, and try to identify differences in how students conducted the test that may have contributed to these discrepancies.
5. Give each group a few minutes to discuss their data as well as the data from other groups. They should be thinking about what materials they will use for their traps in the Main Challenge and how they will use them. Prompt them to think about how they could combine materials.

Traps

Main Challenge

Define the Problem & Plan

1. Tell students that they will now build "traps" designed to stop the ball without it changing direction.
2. Present the constraints for this challenge.

✏ Write them on the board or make individual copies for each group.

Challenge Constraints

- You may not alter the ramp.
- Build a trap that stops the ball without the ball bouncing off and changing directions.
- The trap must be placed exactly one foot from the bottom of the ramp.
- Choose only from the materials provided. You do not have to use all of the materials.

3. Give a copy of *Trap Testing* to each group or student.
4. Have students gather building materials. Allow groups time to handle the materials, discuss, brainstorm, and plan their traps.

✏ Have students sketch the plan for *Trial 1* on their *Trap Testing* sheets.

Build • Test • Improve

1. Review the *Engineering Design Process* (page 14) with students. Remind them that they can test, improve, and retest as much as they like in the time available. Let them know how much time they will have.
2. Circulate as students build and test their traps to observe and question for formative evaluation. For example:

   —What materials have you chosen for your trap?

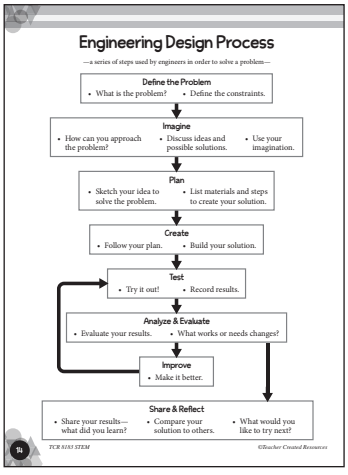
   —How will you combine them?

   —What happened the first time you tested your trap?

   —How can you improve it?

3. Give students some warning as they reach the end of the testing time so that they can wrap up.

✏ Remind students to continue documenting each **trial**, or test, on their recording sheets.



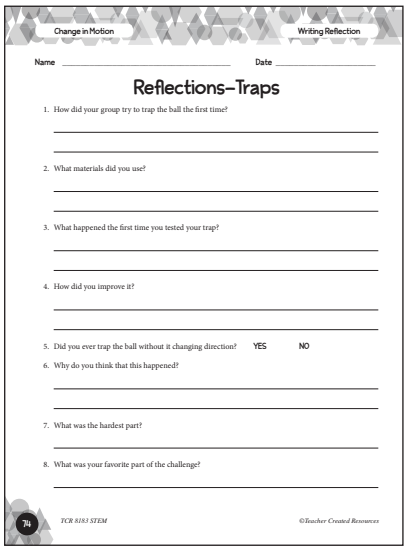
Traps

Main Challenge *(cont.)*

Analyze & Evaluate

1. Ask each group to share the results from their tests. They should provide the following information:
   - ➜ How they built their traps.
   - ➜ How their traps worked.
   - ➜ How they improved their traps.
2. Ask groups to discuss their opinions and interpretation of the results, and then ask the rest of the class for its observations.

   —Did they find any patterns in the results?
3. Encourage students to cite evidence in their answers, such as, "The traps that worked best slowed the ball down before trying to stop it," or "The softer materials were better at slowing and catching the ball."


Change in Motion — Writing Reflection

Name _____ Date _____

Reflections–Traps

1. How did your group try to trap the ball the first time?
2. What materials did you use?
3. What happened the first time you tested your trap?
4. How did you improve it?
5. Did you ever trap the ball without it changing direction? YES NO
6. Why do you think that this happened?
7. What was the hardest part?
8. What was your favorite part of the challenge?

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Writing Reflection

✏ Have each student complete the *Reflections—Traps* writing reflection individually.

Extensions

- Raise the ramps higher and have students predict what will happen when students try the test again. Have students make changes to their traps to handle the ball moving faster and share their findings.
- Try the test again with balls that are heavier, and have students predict what will happen when they try the test again. Have students make changes to their traps to handle the heavier ball and have them share their findings.
- Have students build things to make balls change direction in specified ways.

Name _____ Date _____

Traps—Materials Testing

Directions

1. Select five materials for your test. List the materials in the first column of the table below.
2. For each trial, place the material to be tested one foot from the bottom of the ramp. You may wish to mark an **X** on this starting spot.
3. Send the ball down the ramp and observe what happens.
4. In the **Results** column, describe what happened as the ball hit each material.

Trial	Material	Results
1		
2		
3		
4		
5		

Name _____ Date _____

Trap Testing

Directions

1. Plan a trap that will stop the ball without the ball bouncing off and changing direction.
2. Sketch your first plan in the box for Trial 1.
3. Run the trial, and record your results.
4. Improve your trap, and run more trials, sketching each trap and recording each trial below.

Trial 1

- ❑ Sketch your trap and label the materials. ➜
- ❑ Run your trial.
- ❑ On your sketch, draw a line showing where the ball went.

Did the ball stop without changing direction?

YES NO

If not, what can you change to improve it?

_____

_____

Trial 2

- ❑ Sketch your trap and label the materials. ➜
- ❑ Run your trial.
- ❑ On your sketch, draw a line showing where the ball went.

Did the ball stop without changing direction?

YES NO

If not, what can you change to improve it?

_____

_____

Name _____ Date _____

Trap Testing *(cont.)*

Trial 3

- ❑ Sketch your trap and label the materials. ➜
- ❑ Run your trial.
- ❑ On your sketch, draw a line showing where the ball went.

Did the ball stop without changing direction?

YES NO

If not, what can you change to improve it?

_____

_____

Trial 4

- ❑ Sketch your trap and label the materials. ➜
- ❑ Run your trial.
- ❑ On your sketch, draw a line showing where the ball went.

Did the ball stop without changing direction?

YES NO

If not, what can you change to improve it?

_____

_____

If you have time to run more trials, record them on the back of this paper.

Which trial was your most successful?

_____

What is your evidence?

_____

Name _____ Date _____

Reflections—Traps

1. How did your group try to trap the ball the first time?

_____

_____

2. What materials did you use?

_____

_____

3. What happened the first time you tested your trap?

_____

_____

4. How did you improve it?

_____

_____

5. Did you ever trap the ball without it changing direction? YES NO

6. Why do you think that this happened?

_____

_____

7. What was the hardest part?

_____

8. What was your favorite part of the challenge?

_____