

Table of Contents

Introduction

Challenges vs. Lessons	3
Standards and Assessments	4
Meeting the Challenges	5
Budgets	8
Challenge Overview	11
STEM Vocabulary for Every Challenge	13
Engineering Design Process	14
Scientific Inquiry	15

Challenges

Animal Life Cycles (<i>Reproduction</i>)	16
Animal Adaptations (<i>Organism Survival</i>)	24
Oil-Spill Cleanup (<i>Environmental Change</i>)	35
Make It Move! (<i>Effects of Unbalanced Forces</i>)	45
Crash Testing (<i>Testing Variables</i>)	54
Traps (<i>Change in Motion</i>)	64
Shelters (<i>Force and Motion</i>)	75
Towers—Stack Attack (<i>Center of Gravity</i>)	86
Magnet Maze Game (<i>Magnetic Forces</i>)	95
Bottle Flipping (<i>Controlling Variables</i>)	102

Next Generation Science Standards Correlation	111
--	------------

Shelters

Objective

Students will design and build models of shelters that can stand and keep occupants safe in high winds.

STEM Focus

Earth and Space Science: A variety of natural hazards result from natural processes. Humans cannot eliminate natural hazards, but they can take steps to reduce their impact.

Physical Science: Each force acts on one particular object and has both strength and direction. Forces that do not sum to zero can cause changes in the object's speed or direction of motion.

Engineering Design: Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost. Make a claim about the merit of a design solution that reduces the impacts of a weather-related hazard.

Science and Engineering Practices: Ask questions and define problems; construct explanations.

Crosscutting Concepts: Cause and effect: stability and change

Setup

For Main Challenge

- ▶ You will need at least two building materials in each of the following categories:

Supports for structure: straws, skewers, craft sticks, uncooked spaghetti

Connectors: pushpins, string, toothpicks, rubber bands, pipe cleaners **Note:** No tape or glue!

Something to make walls: fabric, paper, foil, cut-up trash bags (12" × 18" pieces)

- ▶ Set up the testing area by plugging in the fan and placing the fan on a table. Use tape to mark out an area about 3 feet in front of the fan where students will take turns placing their complete shelters for testing.

Materials

Introduction and Mini Challenge

- *The Three Little Pigs* (pages 81–82)
- *Shelter Examples* (page 83)
- small paper cup, one per pair
- straws, 1 per student

Main Challenge

- *Shelters* (page 84)
- *Reflections—Shelters* (page 85)
- 20" × 30" (approx.) corrugated cardboard or foam core boards, one per group
- electric fan (multi-speed if possible)
- markers
- materials for building (See Setup.)
- scissors
- small paper cups, two per group

Time Frame

The Introduction and Mini Challenge can be completed in one class session of about 20 minutes.

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

Follow up with the Writing Reflection as time allows.

Vocabulary

balanced	shelter
force	unbalanced
gravity	wind
resist	



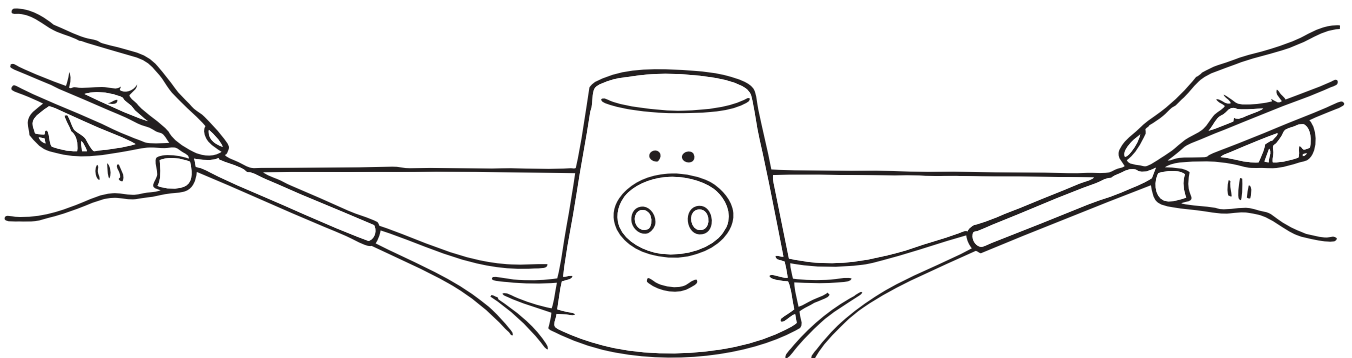
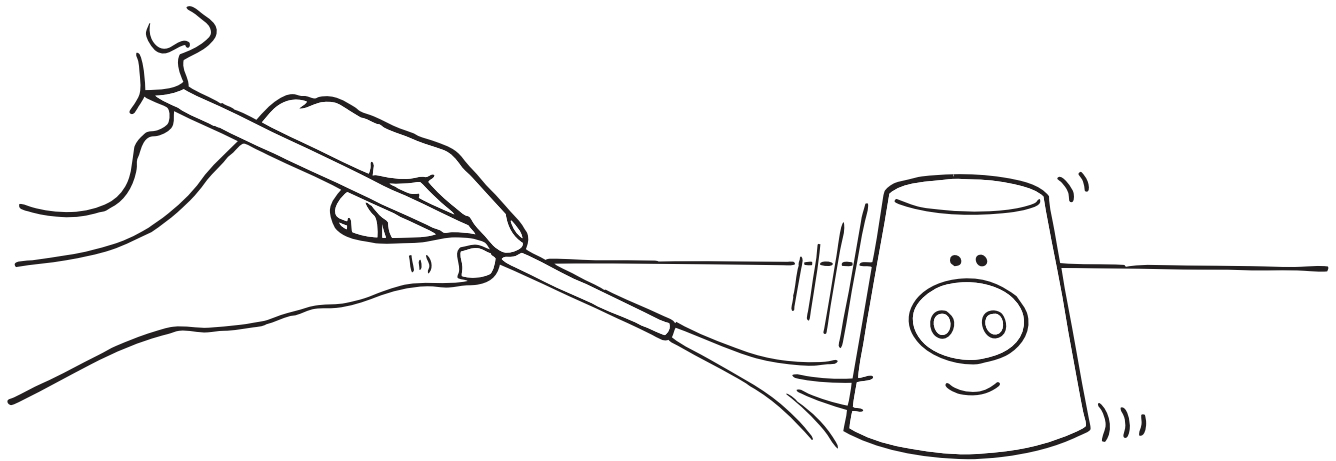
Part of the challenge is that no tape or glue is allowed. Most students will use the pushpins to anchor the structure to the foam core. If you want to make it more of a challenge, take away the pushpins.

Shelters

Mini Challenge (cont.)

Part 2

1. Have students pair up, and give each pair a small paper cup and two straws.
2. Explain that the cup will be their “pig” for this activity. The cup should be placed upside down. Allow a minute or so for them to draw a face on the pig if they like.
3. Have students place their pig between them on a desk or table. Ask:
 - Are there forces working on the pig? (*Most will probably say “no” because the pig is not moving.*)
4. Have one student blow through the straw towards the pig so that the pig moves. Ask:
 - What force was making the pig move? (*The push of the air when you blow.*)
5. Give the second student a chance to blow on the pig. Ask students to describe what they see.
 - What is happening with the forces on the pig? (*The pig moves when we blow on it, or The force of the air makes the pig move.*)




Shelters







Main Challenge

Define the Problem

1. Tell students that they will be building a shelter for two “pigs” (small paper cups) that will protect them from the huffing and puffing of the “wolf” (electric fan).
2. Share the constraints for the challenge with students.

 Write them on the board, post them, or make copies of them for each group.

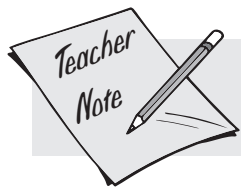
Challenge Constraints

-  The pigs must fit completely inside the shelter.
-  The pigs must be able to enter and exit the shelter (needs a door).
-  The pigs must not be restrained in any way.
-  Use only the materials provided. You do not have to use all of the materials.
-  During testing, two students may use two fingers to hold the base of their shelter to the table.
-  **Super Challenge Constraint** (optional): The shelter must not be attached to its base.

3. Show students the fan setup for testing their shelters. Hold a sheet of paper in front of the fan as you demonstrate all of the speed settings.

Safety Note: Make it clear that you (or another adult) are the only one allowed to touch the fan.

4. As a class, decide on the criteria for success, e.g., *At the lowest fan speed, the house stands, and the pigs are safe inside for 10 seconds, or The pigs stay upright inside the shelter for 30 seconds.*
5. Let students know that, if their shelter passes the test on the lowest fan setting, they can elect to try faster fan speeds.
6. Let students look at and handle the building materials. Let students know that no tape or glue will be used in this challenge!
7. Review the *Engineering Design Process* (page 14) with students. Let them know that they can test and revise their designs as many times as they like in the time available.



If you plan to challenge students by pricing materials and giving them a budget, add the budget to the constraints. (See pages 8–10.)

Name _____

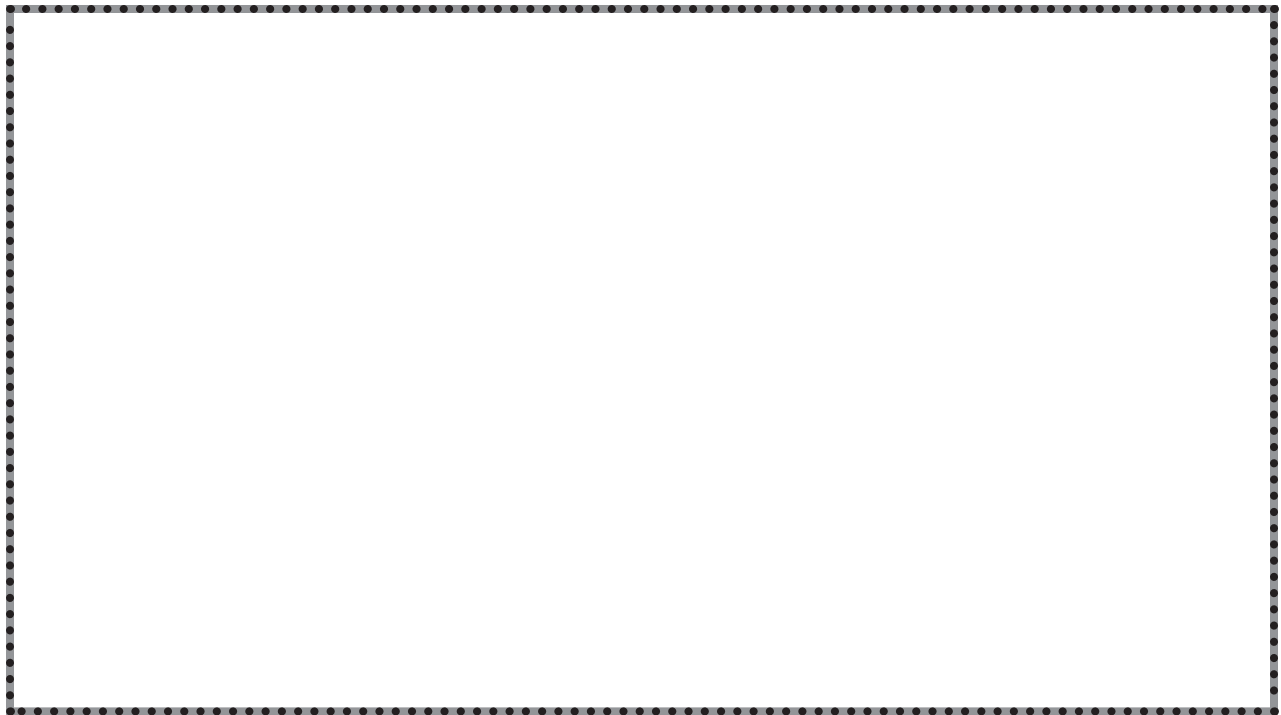
Date _____

Shelters

1. What basic shape will you use for your structure?

2. List the materials that you will use to build your structure.

3. Draw a diagram of your structure.



4. On your diagram, draw an arrow to show the direction of the force from the fan.

5. How will your shelter resist the force of the wind? _____
