Spoon Drop Strength Test

MATERIALS

For the activity (per pair or team)

- 1 container with a wide round opening (e.g., 1-lb. coffee can, 32-oz. yogurt, or 18-oz. oatmeal container, or other canister)
- 1 sheet or square of each of the following materials large enough to cover the container opening (about 8" x 8"):

  newspaper, plastic wrap, aluminum foil, photocopier or printer paper, wax paper, freezer paper*
- 1 roll masking tape
- 1–2 thick rubber bands large enough to fit around the container opening
- 1 yard or meter stick
- 1 metal spoon (teaspoon or tablespoon)
- activity sheet

For the group

- 1 tennis ball
- 1 piece of string, 18 inches
- 1 balloon, over-inflated
- 1 wire coat hanger
- 1 piece of chalk
- video clip available at pbs.org/nova/education/makingstuff
- video display equipment

Note: *Freezer paper (a white paper wrap with a plastic coating on one side) is available in most grocery stores.

Time: Prep: 15 minutes; Activity: 45 minutes

Activity Description

Kids drop a spoon to break some common materials to test their toughness—how much energy they can absorb before breaking.

Learning Goal

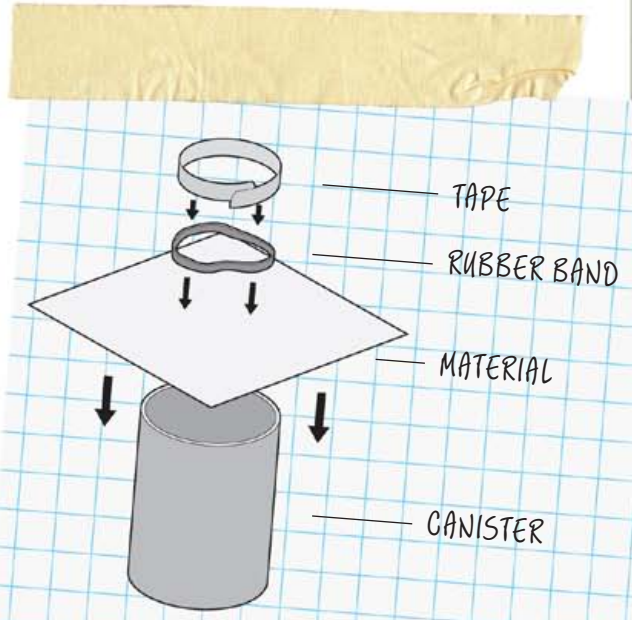
To learn about the physical properties of some everyday materials and how materials scientists test the properties of materials to determine how safe they are, how best to use them, and how to design better ones.

Introduction

All materials have certain physical properties, which determine how best to use them. For example, concrete is rigid and doesn't compress much, making it ideal for buildings and sidewalks, but a poor choice for sneakers, which need to be soft and flexible. To determine the best use for a material, scientists test it for different types of strength, including toughness. Toughness is how much energy a material can absorb before breaking. In this activity, kids explore the properties of some everyday materials and test them to see which is toughest by dropping a spoon from different heights. The greater the height, the more gravitational potential energy the spoon has when dropped. And the more kinetic energy it has when it hits the material.

Advance Preparation

- Gather the materials.
- Cut squares of the materials.
- Set out the tennis ball, string, inflated balloon, wire coat hanger, and piece of chalk for the demonstration in step 1 of the procedure.
- Prepare to demonstrate the spoon drop activity in step 2 of the procedure. Secure a square of newspaper over the opening of one of the containers with a rubber band and then place a long piece of tape, over the rubber band, around the container.



Procedure

1. Introduce the topic.

Ask: *What does it mean to be strong?* (Answers will vary.) Explain that there are many different types of strength and materials can be strong in different ways. Some types of strength are:

- **compression strength**—how much a material can be compressed or squeezed (Squeeze the tennis ball.)
- **tensile strength**—how much a material can be pulled apart (Pull the string taut and, if you can, break it.)
- **toughness**—how much energy a material can absorb before breaking (Press the over-inflated balloon against a table or wall and break it.)

Ask: *Why is it important for car body materials to be strong?* (To make a car safer in a crash.) *Do seatbelts need to be strong?* (Yes, they have to be strong to hold people in their seats.) *Are seatbelts strong in the same way that the outside of a car is?* (No. Cars bodies are designed to crumple, or deform, to absorb energy from the crash and keep the people inside as safe as possible. They are tough. Seatbelts are designed to resist pulling, stay tight, and not break. They have high tensile strength.)

To design the best material for the job, scientists test materials to see which have the best type of strength and other properties that suit the task. They ask:

- How much deformation, or strain, can a material withstand? (To deform means to bend, stretch, or change shape.)
- How does it deform? (A material that deforms slowly before breaking is **ductile**. A material that deforms quickly before breaking is **brittle**.)

A ductile material can bend or stretch a lot before breaking, like a piece of rubber or a wire coat hanger. (Bend the wire coat hanger back and forth, breaking it if possible.) In order for a material to be tough, it must also be somewhat ductile.

A brittle material doesn't bend or stretch much before breaking, like a coffee mug dropped on the floor or a piece of chalk. (Break the piece of chalk in two.)

2. Demonstrate the spoon drop test.

Explain that you will be doing your own toughness test to see how much energy a material can absorb before breaking. Ask a volunteer to come up and help you. Have him or her hold the measuring stick next to the can. Explain that you're going to test the strength of the newspaper by dropping the spoon on it. The higher the drop height, the more energy the spoon will have.

Drop the spoon from 5 inches above the can. The newspaper should not break. Ask kids what they observed. Continue the test, increasing the drop height until the newspaper tears. Ask the kids what they observed. (The newspaper tore easily.) *What can you conclude from this?* (Newspaper can't absorb much energy and is not very tough.)

3. Facilitate the activity.

Pass out the activity sheets and follow the steps. Kids will explore the materials, predict which ones will be the easiest and hardest to break, and rank them. (Final results may vary, but the order from easiest to hardest is roughly: newspaper=1, wax paper=2, aluminum foil=3, plastic wrap=4, photocopier/printer paper=5, freezer paper=6.)

4. Analyze the results.

When all the pairs have finished testing, discuss how the kids' predictions compare with their results.

- *Which materials were dented or stretched before breaking?* (plastic wrap, aluminum foil, and freezer paper—these materials are ductile and stretch out before breaking)
- *Which material was the easiest to break?* (newspaper or wax paper)
- *Which was the toughest—able to absorb the most energy before breaking?* (freezer paper) *Why?* (The freezer paper is the toughest to break because it is a composite—two materials, plastic and paper, put together.) Explain that when you put two materials together, you can take advantage of the best properties of both.

5. Conclude the activity.

Explain that materials scientists are always looking for ways to make stronger materials.

- *Why is knowing the strength of a material important?* (To determine the best way to use it and how safe it is.)
- *What could you use the strongest material for? What about the weakest?* (Accept all answers.)
- *What other types of tests might materials scientists do on different materials?* (Compression strength tests—squeezing or crushing a material until it breaks; Tensile strength tests—pulling a material apart until it breaks; Deformation tests—stretching or bending a material until it will not return to its previous shape)
- *What are some other ways you can make a material stronger?* (Add layers, change the shape, or change the structure, for example, by folding, weaving, or bending, like corrugated cardboard.)

If time permits, have kids try the variations above or the "Extend the test" step on the activity sheet. Conclude by showing the clip from NOVA *Making Stuff: Stronger,* available at pbs.org/nova/education/makingstuff, in which host David Pogue participates in a demolition derby to explore the toughness of steel car bodies.

MAKING STUFF

Spoon Drop Strength Test

NOVA PBS

MATERIALS

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  newspaper, plastic wrap, aluminum foil, photocopier or printer paper, wax paper, freezer paper*
- 1 roll masking tape
- 1–2 thick rubber bands large enough to fit around the container opening
- 1 yard or meter stick
- 1 metal spoon (teaspoon or tablespoon)

*Freezer paper (a white paper wrap with a plastic coating on one side) is available in most grocery stores.

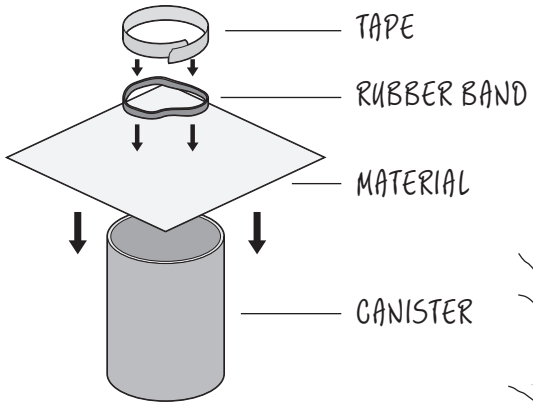
Materials scientists look at the different properties of materials, including strength and toughness, to determine the best way to use them. Toughness is how much energy a material can absorb before it breaks. **Test some everyday materials to see which is toughest by dropping a spoon from different heights until the materials break.**

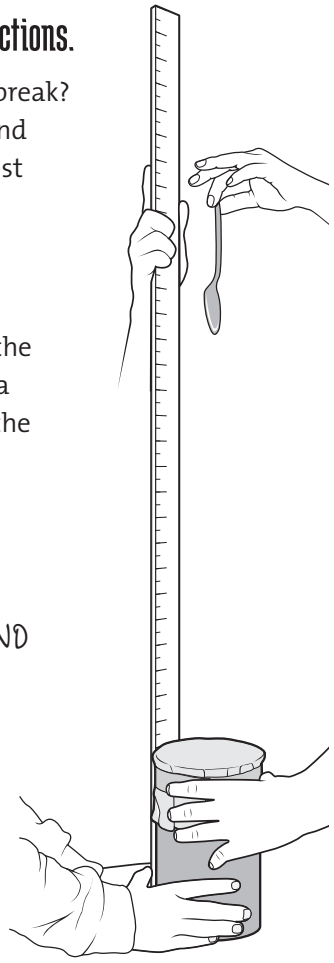
1. Examine the materials and make predictions.

Which material will be the easiest to break? The hardest? Make your predictions and rank the materials in order from easiest to hardest in the table.

2. Set up the test.

Select a material to test. Place it over the top of the canister and secure it with a rubber band. Put a strip of tape, over the rubber band, around the container.





3. Do the test and record observations.

Hold the covered container next to the yard or meter stick. Hold the spoon by the handle, with *the bottom of the spoon* 5 inches (12.7 cm) above the top of the container. Drop it straight down onto the material. What happens to the material when the spoon hits it? (e.g., Does it dent or tear?) Write your observations in the table.

If the material does not break, place the *bottom of the spoon* 10 inches (25.4 cm) above the canister and drop it again. Record your observations. Keep increasing the drop height by 5 inches (12.7 cm) until the material breaks. Record any new observations and write the final drop height in the table. (Don't forget to subtract the height of the container to get the exact distance that the spoon fell.)

4. Repeat the test for each material.

Remove the broken material and do the same test with a different material.

5. Analyze your results.

Remember, the higher the drop height, the more energy the spoon had when it hit.

- Which material was the easiest to break?
- Which was the toughest—able to absorb the most energy before breaking?
- Which materials were dented or stretched before breaking?
- How did your predictions compare with the results?

6. Think like a materials scientist.

Materials scientists are always looking for ways to make stronger materials.

- Why is knowing the strength of a material important?
- Based on the results of your test, what are some ways you could use the strongest material? the weakest?
- What other types of tests might materials scientists do on different materials?

7. Extend the test.

- What are some ways that you could make a material stronger? Design and build a stronger material and test it.
- It took several spoon drops to break most of the materials, which may have deformed (dented or stretched) the material. Predict if a new piece of the same material would break if you dropped the spoon from the final drop height. Test your prediction.

Material	**Prediction** Rank materials in order from weakest to strongest (1-6).	**Final Drop Height** (inches or centimeters)	**Observations** (What happened to the material when the spoon hit it?)	**Results** Rank materials in order from weakest to strongest (1-6).
aluminum foil				
freezer wrap				
newspaper				
photocopier/ printer paper				
plastic wrap				
wax paper				

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