Physical Properties of a Package

CONTENT AREA

- **Science**
  measurement, physical properties

OBJECTIVES

Students will…

- test the physical properties of packaging materials
- determine appropriateness of packaging materials for commonly purchased items

MATERIALS

For each student

- Station Instructions
- Properties of a Package data tables

For the stations

- 2 triple beam balances or digital scales
- 5 beakers
- tape
- glue
- food coloring (blue or green)
- 2 spoons
- paper towels
- 2 micrometers
- assorted gram weights (1, 5, 10, 20, 50, 100 and 1000 grams)
- paper packaging materials (candy wrappers, brown and/or white paper bag, tissue paper, lightweight cardboard boxes, such as cereal or cracker boxes; shoe boxes, pieces of appliance boxes)
- plastic packaging materials (polystyrene foam cup, clear wrap, such as Saran® brand wrap; plastic bottles, yogurt containers, bread wrappers)
- metal packaging materials (aluminum foil, aluminum cans, tin cans)
- composite packaging materials (coated milk cartons from the cafeteria or home, coffee bags, pet food or snack wrappers, juice boxes, foil/plastic drink pouches)

Safety Caution:

Do not use glass– there is the possibility of breaking or splintering.

TIME

Three periods
45 minutes each

In designing a package for a product, one must take into account the physical properties of various materials. Some products can be packaged in lightweight, flexible containers, while fragile items require heavier and usually more rigid packaging. Liquid products need containers that don't leak or easily spill. With food, one must also ensure that what's inside the package remains fresh and edible until consumed. And all packages must withstand the trip from producer to warehouse to store to consumer.

This activity asks students to collect and test a variety of packaging materials. As students rotate through a series of stations set up in the classroom, they perform various tests for mass, permeability, and "writability." The more tests that students perform, the better understanding they will have of the fact that packaging is scientifically designed for the product it houses.

The end result should be that students begin to realize just how complex packaging decisions can be. They should also become aware of the importance of designing packages with source reduction in mind, and that today's designers work hard to be as efficient as possible.

PREPARATION

1. Ask students to bring in samples of packaging materials that they have at home, so you don't have to collect them all yourself. (To ensure that you have all types represented, you might want to use the list on the previous page and ask for specific items.)

   Although the tests being performed are fairly rudimentary, they should give students a sense of the various aspects of a package. Because of this, all 24 pieces of each type of packaging material need not be identical, but similar– i.e., cereal boxes, yogurt containers, foils, juice boxes. Set aside a few containers, cans and wrappers for stations 3 and 4.

2. Set up three stations in your classroom – each large enough to allow groups of four to six students to work comfortably. At each station, place an Instruction Sheet and materials as described below.

STATION 1

Mass, Volume & Density

Materials

Two triple beam balances or digital scales; ruler; micrometer; enough pieces of test materials so that four students at a time can determine the mass of the various packaging materials.

Instruction card

For each packaging material, calculate mass and record your findings. To determine the mass, weigh items on the triple beam balance or digital scale. To determine volume, refer to Activity 1 and remind the class of the equation:

Volume = Length x width x height

(Students may need to use the micrometer to measure width, which in many cases is the same as thickness.)

Density is the amount of mass per unit of volume. Once students have determined mass and volume, they can calculate density using the following equation:

Density (D) = mass (m) ÷ volume (v)

STATION 2

Leakage

Materials

Five empty beakers; small bucket or pan; 1 beaker filled with water colored with several drops of food coloring; packaging materials similar to those at stations 1 and 2, but in the form of pouches, cups, cans or other small containers. (For flat, flexible materials, create pouches of the packaging material. Use tape or glue if necessary. For plastic foam and cardboard, use cups. For more rigid materials, use containers made of that material–for example aluminum cans, yogurt containers, juice boxes.)

Instruction card

1. Pour 25 ml of colored water into each pouch or container while it is over a pan, bucket or sink.
2. Continue to hold the pouch or container over a beaker for three or four minutes.
3. Observe the various packaging materials. Does the material allow the colored water to leak? If so how much? Note your observations.
4. Empty the colored water into the bucket or pan.

STATION 3

Special Features

Materials

Coffee bags, cheese wrappers, juice boxes, plastic bags, chip bags, soda cans, vegetable cans, milk cartons, dish detergent bottles or boxes

Instruction card

Observe and record the following features:

1. *Layers.* Is there more than one layer of material? If so, are the layers of the same material?
2. *Recycle numbers.* Look on the bottom of plastic containers. Often there is a number within a triangle. What are the numbers? What do they mean?

3. *"Scrunchability"* (compaction). Try to scrunch or compact the material. How easily does it compact? Does it stay that way?

4. *Protective features.* Note any features that protect the product from tampering, spoilage or damage.

5. *Flexibility.* Try to bend or fold the material. How flexible is it? Can the material withstand repeated folding and bending?

6. *Writability.* Use a Sharpie felt pen to determine how easy it is to write on the material.

PROCEDURE

1. Introduce the lesson by asking students "How do we define matter?" (Anything that takes up space and has mass.) What are the physical properties used to identify matter? (Color, composition, elasticity, density, mass, volume) Explain to students that they will determine and test various characteristics of packaging materials.

2. Give each student or group a copy of the data table.

3. Familiarize students with the various stations and the tests they will be performing.

4. Divide the class into 5 or 6 groups and have each group work at a table, with the members taking turns testing the various items at the table and recording the results. As students rotate through the various stations, they conduct different tests of the packaging materials. It should take 15 minutes at each station for students to conduct the test and record the data on their data table.

5. Be available to answer any questions or assist with testing.

QUESTIONS

When all students/groups have completed the tests, conduct a class discussion on appropriate product packaging based on their findings.

a. You might begin the discussion by presenting a really ridiculous idea: Why don't we buy pickles in cardboard boxes? Or computers in aluminum foil? Or candy bars in tissue paper?

b. What are the packaging factors that make products available whenever we want them in stores? Why is packaging needed?

c. What factors contribute to selecting appropriate materials for certain products? Besides the ones tested, what other physical properties might packages need to have? (Strength, impact resistance, weather resistance, hardness, etc.)

d. What other types of tests might be done before a package can be placed on a store shelf?

e. How does the definition of "appropriateness" change when looking at the various physical properties from a source reduction or waste standpoint? Is a material that is "appropriate" for packaging necessarily "appropriate" in environmental terms?

f. Describe the physical properties of the "perfect" packaging material.

EXTENSIONS

1. Place a piece of the same kind of cheese in several types of clear wrap. (One of these must be Saran® Wrap.) Design a way to test the type of package that keeps cheese from getting moldy. Test different amounts of the same packaging material and see if it makes a difference in the protection of the product.

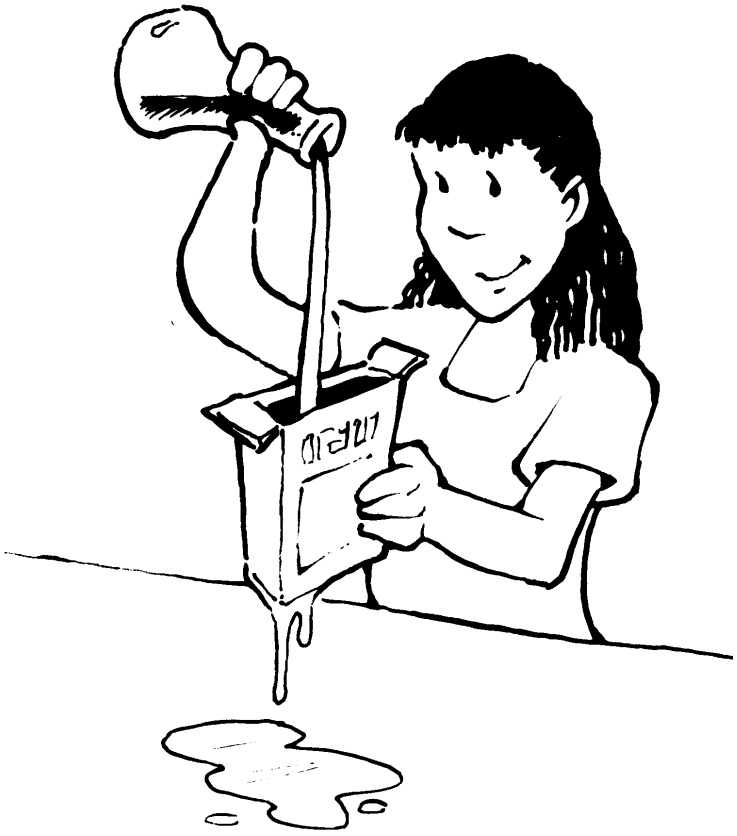
2. Go to the library and research the history of packaging and how materials have changed.

What Else Does Packaging Do?

Many products are packaged in a way that makes them easy to use. For example,

- *Squeezable bottles get ketchup flowing faster, then keep it from overflowing.*
- *Airtight packaging ensures that medical items, such as bandages and surgical instruments, stay sterile until used.*
- *Paper milk cartons have tops that make them easy to open, close and pour. Plastic milk containers have handles that make them easy to hold and carry.*
- *Spice containers have closures or lids that make it simple to pour or measure the right amount of flavoring.*
- *Cereal boxes have reclosable tops that keep contents fresh.*
- *Bottles with pop-up tops permit shampooing without removing the cap.*

Packages also provide important information about their contents. Food packages contain preparation instructions as well as nutritional, dietary and ingredient data. Packages of all types include safety and storage information.



Station Instructions

Station 1: Mass, Volume & Density

1. For each packaging material, calculate mass and record your findings. To determine the mass, weigh items on the triple beam balance or digital scale.
2. Calculate the volume of each material, using the formula we used in Activity 1:

   Volume = Length x width x height. You might need to use the micrometer to measure width, or thickness.
3. Density is the amount of mass per unit of volume. Calculate the density of each of the materials.

Station 2: Leakage

1. Pour 25 ml of colored water into each pouch or container. (Do this over a sink, pan or bucket.)
2. Once filled, hold the pouch or container over a beaker for three to four minutes.
3. Observe the various packaging materials. Does the material allow the colored water to leak? If so, how much? Note your observations.
4. Empty the colored water into the bucket or pan.

Station 3: Special Features

Observe and record the following features:

1. *Layers.* Is there more than one layer of material? If so, are the layers of the same material?
2. *Recycle numbers.* Look on the bottom of plastic containers. Often there is a number within a triangle. What is the number?
3. *"Scrunchability"* (compaction). Try to scrunch or compact the material. How easily does it compact? Does it stay that way?
4. *Protective features.* Note any features that protect the product from tampering, spoilage or damage.
5. *Flexibility.* Try to bend or fold the material. How flexible is it? Can the material withstand repeated folding and bending?
6. *Writability.* Use a Sharpie felt pen to determine how easy it is to write on the material.

Properties of a Package Data Tables

Station 1: Mass, Volume & Density

Material	Density	=	Mass	÷	Volume
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					
10.					

Station 2: Leakage

Material	Yes / How Much	No
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		
10.		

Properties of a Package Data Tables

Station 3: Special Features

Material	Layers	Recycle#	Scrunchability
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			

Station 3: Special Features, continued

Material	Protective features	Flexibility	Writability
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			