Foam Peanuts

Learning Objectives: *Students learn about the impact of packing materials on the environment.*

GRADE LEVEL

K–8

SCIENCE TOPICS

Solutions and Mixtures
Chemical Reactions
Environmental Chemistry

PROCESS SKILLS

Describing/Defining
Classifying
Controlling Variables

GROUP SIZE

1–3

SNEAK PEAK inside …

ACTIVITY

Students observe changes when they add water and iodine to Styrofoam and biodegradable packing peanuts.

STUDENT SUPPLIES

see next page for more supplies

tincture of iodine
Styrofoam peanuts
biodegradable foam peanuts
popcorn
spoons and plastic cups, etc.…

ADVANCE PREPARATION

see next page for more details

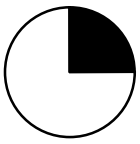
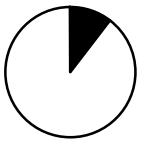
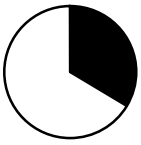
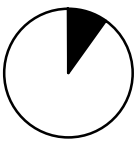
Make iodine and water solution
Pop the popcorn, etc.…

OPTIONAL EXTRAS

DEMONSTRATION
Dissolving Styrofoam in Acetone (p. D - 18)

EXTENSIONS
Iodine Starch Test (p. D - 22)
Compost in a Bottle (p. D - 23)

TIME REQUIRED

Advance Preparation	Set Up	Activity	Clean Up
			
15 minutes	**5 minutes**	**20 minutes**	**5 minutes**

SUPPLIES

Item	Amount Needed
tincture of iodine	1–2 teaspoons per class
Styrofoam packing peanuts	1–2 per group
biodegradable packing peanuts (e.g., Biofoam™)	1–2 per group
microwaveable popcorn (or other starch source, e.g., white bread or plain crackers)	1 package per class
pop-top squeeze bottles (e.g., water or sports drink) 16 oz. or larger	2 per group
water	1 cup per group
spoons (e.g., teaspoon measures)	1 per group
clear plastic cups	3 per group
wooden craft sticks	3 per group

For Extension or Demonstration supplies, see the corresponding section.

ADVANCE PREPARATION

Supplies Preparation

Popcorn:
- ❑ Pop the popcorn and let it cool.

Water:
- ❑ Fill pop-top squeeze bottles with water.
- ❑ Label the bottles "water."

Iodine Solution:
- ❑ Add 1 teaspoon of tincture of iodine to 2 cups of water.
- ❑ Fill pop-top squeeze bottles with about ¼ cup of iodine solution.
- ❑ Label the bottles "iodine solution."

CAUTION: Iodine is poisonous and may stain skin and clothing.

Notes and Hints
- ❑ In place of popcorn, bread or plain crackers will work. Popcorn, bread, and plain crackers give the most noticeable color change and are structurally the most similar to the biodegradable foam peanut.

SETUP

For each group
- ❑ iodine solution in pop-top squeeze bottle
- ❑ water in pop-top squeeze bottle
- ❑ 1–2 Styrofoam peanuts
- ❑ 1–2 biodegradable foam peanuts
- ❑ 1–2 pieces of popped popcorn
- ❑ 3 wooden craft sticks
- ❑ 3 clear plastic cups
- ❑ spoon

At a central location (or with the teacher)
- ❑ towels and sponges for clean up

INTRODUCING THE ACTIVITY

Let the students speculate before offering answers to any questions. The answers at right are provided primarily for the teacher's benefit.

Choose questions that are appropriate for your classroom.

Not all packing peanuts are made from the same ingredients. Students will examine the different types of packing peanuts and decide which kind is better for the environment.

What happens to your trash after you throw it away?
Students might say that the garbage man takes it, it goes to the landfill, sits there, some stuff decomposes.

Does all of our trash break down or decompose the same?
No; some waste, such as plant or yard waste, decomposes rather quickly. Other waste, such as plastic and Styrofoam can take 100 years to break down!

Have you ever gotten a package in the mail, and the box is full of little foam peanuts to keep the object in the box safe?
Yes! No. Maybe….

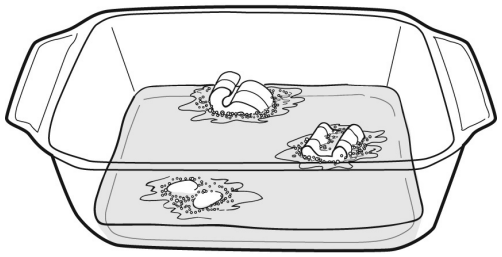
Those peanuts come in two different forms. Some are made of Styrofoam, which is made from plastic, while others are made from corn starch. We are going to look at how the different types of packaging peanuts affect the environment differently.

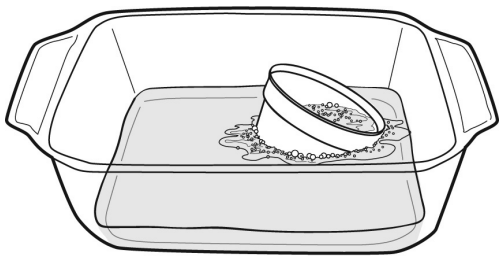
Dissolving Styrofoam

This demonstration is best done at the end of the activity. Show students what it takes to dissolve the Styrofoam peanuts.

Supplies

- acetone (available in most hardware stores)
- Styrofoam cup or leftover Styrofoam peanuts from each group
- shallow glass dish, cup, or jar (at least as large in diameter as the Styrofoam cup, if used)





Demonstration

- In the shallow dish, cup, or jar, pour a small amount of acetone. Drop dry Styrofoam peanuts (water interferes with the reaction) into the acetone. All the Styrofoam will quickly dissolve in the acetone.
- For a more dramatic demonstration, place a small Styrofoam cup into the acetone. It will quickly dissolve.

Explanation

Styrofoam is not biodegradable, but it does dissolve with acetone. Actually, to be more precise, the acetone collapses the physical structure of the Styrofoam, releasing all of the air bubbles trapped within (they can be seen escaping as the Styrofoam dissolves). After the acetone evaporates, there is a small amount of liquid polystyrene left in the dish.

CAUTION: Acetone is flammable and poisonous. Keep away from heat and open flames.

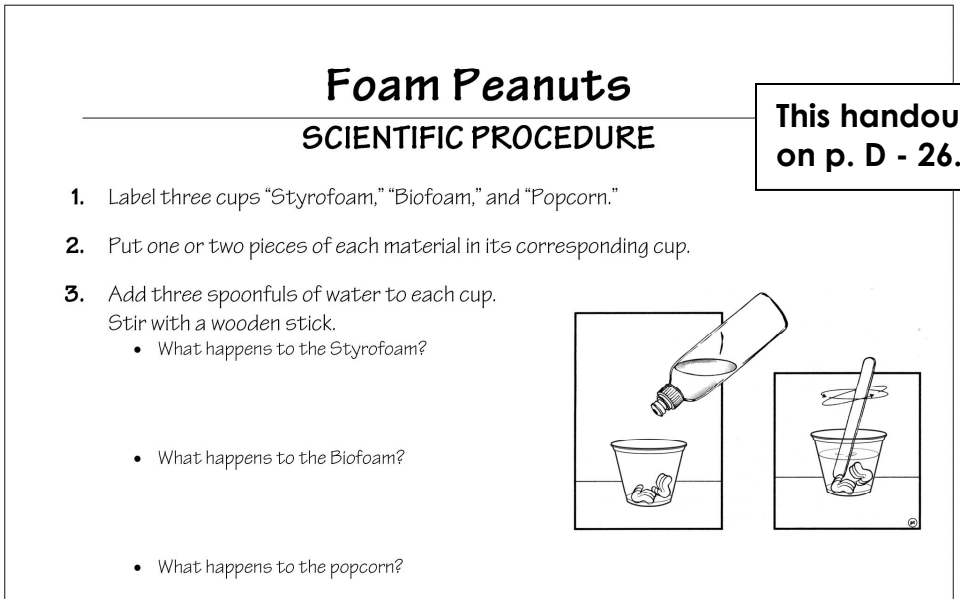
Safety and Disposal

- Filter and collect the used acetone for reuse.
- Solid waste may go in the trash.

CLASSROOM ACTIVITY

Have students follow the Scientific Procedure on page D - 26, working in groups of 1–3. Below are suggestions to help the teacher facilitate the activity.

NOTES



Foam Peanuts

SCIENTIFIC PROCEDURE

This handout is on p. D - 26.

1. Label three cups "Styrofoam," "Biofoam," and "Popcorn."
2. Put one or two pieces of each material in its corresponding cup.
3. Add three spoonfuls of water to each cup. Stir with a wooden stick.
   - What happens to the Styrofoam?
   - What happens to the Biofoam?
   - What happens to the popcorn?

Running Suggestions

- You may decide to set up the lab with the Styrofoam, biofoam, and popcorn at a central location. Students can collect their own materials.

Ongoing Assessment

- How are the different packing materials similar? How are they different?
- Why do you think iodine changes color with popcorn and with the biodegradable foam? *(They both contain something similar that reacts with the iodine [starch].)*

Safety and Disposal

- All materials may go in trash. If possible, rinse the Styrofoam peanuts off and reuse for another class.

CAUTION: Iodine is poisonous and may stain skin and clothing.

CLASSROOM DISCUSSION

Ask for student observations and explanations. Let the students guide the discussion and present their hypotheses before discussing explanations.

Choose questions that are appropriate for your classroom.

Students learned how different substances used for the same purpose can affect the environment in very different ways.

What happened when you put water on the popcorn? On the biofoam? On the Styrofoam?
The popcorn dissolved in the water. The biofoam dissolved in the water. Styrofoam didn't dissolve in the water.

Based on how it reacted with water, is the biodegradable foam more similar to the popcorn or to the Styrofoam? Why do you think so?
The popcorn, because the popcorn got mushy in water, just like the biodegradable foam.

What happened when you put iodine on the popcorn? On the biofoam? On the Styrofoam?
Iodine turns dark bluish-purple with popcorn and biofoam. This indicates that biodegradable foam peanuts are made of starch, like the popcorn. Iodine stays yellowish or amber on Styrofoam.

Because the popcorn and biofoam both reacted the same to iodine, we know they must both contain the same ingredient.

Has anyone heard of starch or know what it is?
Starch is a molecule that plants use to store energy. Some common places starch can be found is in foods like pasta, potatoes, corn, rice, and wheat.

Do you think it is better to use Styrofoam peanuts or the starch peanuts? Why?
Starch peanuts are better. Styrofoam will not biodegrade. It remains in the environment for decades. Only harsh chemicals will deflate it. The biodegradable packing foam is starch based and will degrade when exposed to water and is not harmful to the environment.

Can biodegradable foam be a substitute for all the uses of Styrofoam?
Biodegradable foam cannot substitute for Styrofoam in all cases; for example, it would never work as a coffee cup.

Now would be an appropriate time to do the Teacher Demonstration showing how Styrofoam can be dissolved with acetone.

EXPLANATION

This background information is for teachers. Modify and communicate to students as necessary.

When products are mailed or sold in stores, they are wrapped in some kind of packaging. This packaging is useful to keep the product intact but can be harmful to the environment.

BACKGROUND FOR ALL GRADES

Packing and the Environment

When we buy products, we usually don't want the packaging. Depending on what the packaging is made of, it can sometimes be **recycled** and used for another purpose. If the packaging cannot be recycled, then it is trash. When trash is thrown away, it is taken to a **landfill** or other storage facility. If trash can **biodegrade**, or break down by natural processes, it eventually becomes soil. Eventually, non biodegradable trash accumulates in the landfill and can pollute the environment.

Styrofoam versus Biofoam

Styrofoam and **biodegradable foam** (Biofoam) are both made of air bubbles trapped inside a solid. This makes the foams lightweight and good for cushioning and for insulating. For this reason, they are used in packaging to protect materials from damage.

When biodegradable foam is exposed to water, it **dissolves** and washes away. It does not accumulate to pollute the environment. In contrast, Styrofoam does not dissolve in water and can last in landfills for over a hundred years or more.

Styrofoam can be dissolved by various materials. However, these are usually irritating, flammable chemicals such as acetone or paint thinner. These chemicals deflate the Styrofoam and release the trapped air. Although it takes up less space, the deflated Styrofoam is still present. Also, the chemicals used to dissolve the Styrofoam are harmful to the environment.

Iodine

Iodine can be used to test for starch. Iodine is normally a yellowish-amber color. When iodine combines with starch, it turns dark purple.

EXTRA INFORMATION FOR OLDER STUDENTS

Styrofoam and Biofoam Polymers

Both Styrofoam and Biofoam are made from very long molecules known as **polymers**. Polymers are made of repeating smaller units.

Styrofoam molecules are made from smaller units of styrene, and long chains are known as **polystyrene** plastic (see Figure 1). This plastic is designated for recyling with the number 6 surrounded in arrows.

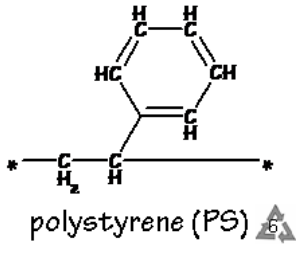


Figure 1 Molecules of styrene connect together at the stars to form long chains of polystyrene molecules.

Biofoam molecules are made from smaller units of sugar, and long chains are known as **starch**. Plants store energy in the form of starch. Starch is a major component of potatoes, pasta, bread, grains, cereal, and other foods (see Figure 2).

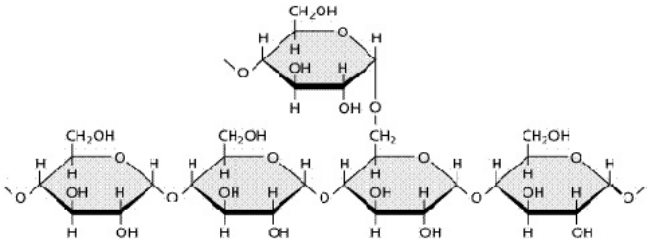


Figure 2. Each sugar molecule is a ring of carbons with hydrogen and oxygen extending off of it. Many sugar molecules (networks of 100's) link together to form starch.

Starch-Iodine Reaction

Iodine solution contains iodine in this form, I_2, where two atoms of iodine are connected. Starch chains are in a double helix form, similar to DNA, but the helix is much wider. The center of this helix selectively absorbs certain molecules, including I_2. When the iodine solution is mixed with starch, the iodine (I_2) molecules enter the center of the helix, where they bind to the starch to form a dark blue complex.

EXTENSIONS

Extension A: Iodine Starch Test

Use the iodine solution to find other items that contain starch.

Extra Supplies

- other starch sources (e.g., crackers, pasta, bread, potatoes, paper towels)—1–2 pieces per group
- non-starch sources (e.g., cheese, apples, plastic, sponge, leaves)—1–2 pieces per group
- iodine solution from main activity

Extra Instructions

- Provide an assortment of items for students to test with iodine solution.
- Younger students can sort the items as those containing starch or not containing starch as a simple data table.
- Older students should create a data table to list items that contain starch and those that do not.

Explanation

Iodine solution turns blue in the presence of starch. Items that contain starch should show a blue or dark stain from the iodine.

Extension B: Compost in a Bottle

- 2-liter plastic bottle— per group
- soil—2 cups per group
- trash items (e.g., food scraps, Styrofoam, biodegradable packing foam, grass, paper, plastic, foil)—1 cup per group
- water
- scissors—1 pair per group
- tape—roll per group

Extra Instructions

- Cut the 2-liter bottle in half horizontally. Cut air holes in the top section of the bottle.
- Fill the bottom half of the bottle with a layer of soil, a layer of trash, and a layer of soil.
- Slip the top half of the bottle back onto the bottom half. Tape the bottle halves together.
- Add some water ("rain") from the top.
- Store the bottle in a warm place for at least a month. Add a little water daily.
- Record observations. Which things break down, or are biodegradable?

CROSS-CURRICULAR CONNECTIONS

SOCIAL STUDIES

Waste Management
Students can track their usage of materials for a week. They can categorize their materials by whether the items they use can be recycled or reused. Have students compare their material usage and trash accumulation to other Americans, and to other countries.

Landfill Structure
Research how landfills are built and how extra precautions are made to keep trash and toxins from entering the environment. Does landfill structure promote or delay decomposition? For instance, students might research whether or not food decomposes in landfills.

ART

Foam Sculptures
Let the students build structures by wetting an edge of one biodegradable-foam packing peanut with a few drops of water. The drops of water create a sticky surface on the foam. The sticky surface of a foam piece will stick to paper, cardboard, or another piece of biodegradable packing foam. Structures can be built from these pieces.

ENGINEERING

Potato Chip Mailer
Give students a large envelope, a potato chip, and various packaging materials (cotton balls, egg cartons, Styrofoam, Biofoam, popcorn, newspaper, plastic bags, tape). Their goal is to design a package that will keep the potato chip from breaking during transit. Mail the packages through the U.S. Postal Service to the school. When you receive the packages, students should evaluate which methods were best in various categories: chip protection, environmental impact, artistic impression, minimal materials use, reusability.

RESOURCES

Web – http://www.worldwise.com/biodegradable.html
Even though things are biodegradable, they may not break down in a landfill. Since a landfill has many layers, air and water cannot get to all items to help them break down. This site discusses this issue and includes a table of the degradation times of common materials.

Web – http://www.worldcentric.org/store/bioplastics.htm
Styrofoam and most plastics are made from petrochemicals (oil and gas). Bioplastics are created from plant materials, a potentially renewable resource. They are more likely to break down than traditional plastic, depending upon landfill conditions.

Showers, Paul, *Where Does the Garbage Go?*, Harper Trophy Publishing
Reading level: kindergarten to 3rd grade
Clearly written and accessible to young children, the book explains what happens to solid waste, what goes into landfills, and how aluminum, newspapers, glass bottles and jars, and plastics are recycled today.

Gibbons, Gail, *Recycle! A Handbook for Kids*, Little, Brown Young Readers
Reading level: 2nd to 5th grade
A very readable and well-organized offering that's filled with information. Gibbons' cartoons in primary shapes and colors graphically illustrate the contents of a landfill and how to recycle various products to cut down on the need for landfills—which in some areas are in short supply. Discussing paper, plastic, glass, cans, and polystyrene, the author describes how and why to recycle, as well as the benefits of recycling.

VOCABULARY

biodegradable foam: a form of packaging material made of starch that has been filled with many bubbles of air; primarily used for protecting materials during shipping

biodegrade: to break down by natural processes

dissolve: when the molecules of a substance become completely surrounded by the molecules of another substance

landfill: location designated to collect trash

polymer: a large molecule made up of many repeated molecules

polystyrene: a polymer made of styrene molecules; this plastic is mainly used for cups and food containers

recycle: use again; break down products into their component parts and remake into the same or different product

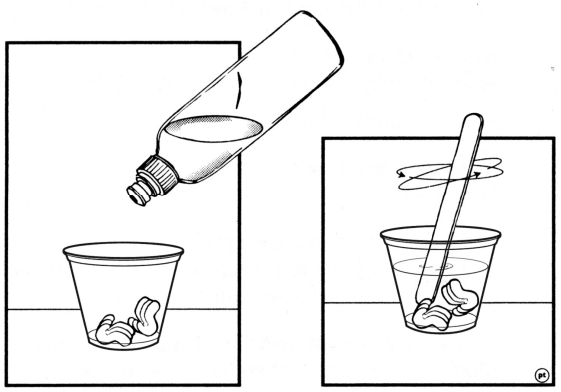
starch: a polymer made of sugar molecules; plants create this molecule as a way to store energy

Styrofoam: brand name for polystyrene plastic that has been filled with many bubbles of air; primarily used for protecting materials during shipping

Foam Peanuts

SCIENTIFIC PROCEDURE

1. Label three cups "Styrofoam," "Biofoam," and "Popcorn."
2. Put one or two pieces of each material in its corresponding cup.
3. Add three spoonfuls of water to each cup.
   Stir with a wooden stick.
   - What happens to the Styrofoam?
   - What happens to the Biofoam?
   - What happens to the popcorn?



4. Add half a spoonful of iodine solution to each cup.
   Stir with a wooden stick.
   - What happens in the Styrofoam cup?
   - What happens in the Biofoam cup?
   - What happens in the popcorn cup?
5. Clean up your area
   - Follow your teacher's directions.

SUPPLY WORKSHEET

This worksheet is available online at **www.omsi.edu/k8chemistry**.

Foam Peanuts

Recommended group size: 1–3

Number of Students: ☐ Number of Groups: ☐

Supplies	Amount Needed	Supplies on Hand	Supplies Needed
tincture of iodine	1–2 teaspoons per class		
Styrofoam packing peanuts	1–2 per group		
biodegradable packing peanuts (e.g. Biofoam™)	1–2 per group		
microwaveable popcorn (or other starch source)	1 package per class		
pop-top squeeze bottles (e.g., water or sports drink)	2 per group		
water	1 cup per group		
large spoons (e.g., tablespoons)	1 per group		
small spoons (e.g., teaspoon measures)	1 per group		
clear plastic cups	3 per group		
wooden craft sticks	3 per group		
Extension A			
other starch sources (e.g., crackers, pasta, bread, potatoes, paper towels)	1–2 pieces each item per group		
non starch sources (e.g., cheese, apples, plastic, sponge, leaves)	1–2 pieces each item per group		
Extension B			
2-liter plastic bottle	1 per group		
soil	2 cups per group		
trash items (e.g., food scraps, Styrofoam, biodegradable packing foam, grass and leaves, paper, plastic, foil)	1 cup per group		
water	a little each day		
scissors	1 pair per group		
tape	1 roll per group		

Supply Worksheet continues on next page.

Teacher Demonstration			
acetone (available in most hardware stores)	approximately 1 cup		
Styrofoam cup or leftover Styrofoam peanuts from each group	a few pieces		
shallow glass dish, cup, or jar (at least as large in diameter as the Styrofoam cup, if used)	1 per class		
waste container for used acetone, with lid	2 cup capacity		
funnel	1 per class		
coffee filter	1 per class		