Drexel-SDP GK-12 ACTIVITY

Activity: Mystery Polymer

Subject Area(s) **Chemistry**

Associated Unit **Environments, module 4**

Associated Lesson **N/A**

Activity Title **Activity: Identify a Mystery Polymer**

Grade Level 6 (3-7)

Activity Dependency **None**

Time Required **40 minutes**

Group Size **1**

Expendable Cost per Group **$0**

Image 1

ADA Description: Picture shows a scientist at work.

Caption: A scientist at work

Image file name: scientist.png

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Summary

Disposable diapers have the single largest impact landfills – disposable diapers make up anywhere from 16-30 percent of our domestic landfill waste. An estimated 27.4 billion disposable diapers are used each year in the US, resulting in about 3.4 million tons of used diapers adding to landfills each year. About 3.5 billion gallons of oil are used to produce the 18 million disposable diapers that end up in landfills each year.

Still, disposable diapers remain the overwhelmingly popular choice for diapering babies because of their super-absorbent qualities and convenience. In this demonstration, students will try to guess what a 'mystery' polymer is by testing its properties in a scientific procedure.

Engineering Connection

Engineers have designed materials that we use everyday that are intended to make life easier and more convenient. Some examples of these materials include the plastic in our disposable soda bottles, the nylon in our umbrellas, and the padding inside a baby's disposable diapers. All of these materials are examples of polymers, or long repeating chains of carbon-based laboratory made materials. However, engineers sometimes cannot foresee the total environmental impact of these non-biodegradable polymers given how hugely popular their use has become. In this exercise, students will participate in a classroom demonstration to guess the identity of a mystery polymer, along with some discussion of what is a polymer, and the pros and cons of their widespread use.

Keywords

Chemical engineering, landfills, polymers, scientific inquiry

Educational Standards (PA)

- Environments: Environmental Health – Environmental Health Issues 4.3.A., Human Actions 4.3.B., Humans and the Environment – Societal Needs 4.8.A., Human Impacts 4.8.C.
- Science: Inquiry and Design – Scientific Method 3.2.C, Science, Technology and Human Endeavors – Meeting Human Needs 3.8.B., Consequences and Impacts, 3.8.C

Pre-Requisite Knowledge

None.

Learning Objectives

After this lesson, students should be able to:

- Describe what a polymer is
- Express the difference between qualitative and quantitative data
- Describe some of the desirable and undesirable properties of polymers

Materials List

Each individual needs:

- Diaper sample (piece of filler torn from diaper)
- Gram weights
- Balance
- Pipette

Introduction / Motivation

Sometimes, engineers and scientists invent something that might be an unexpected surprise that even they don't fully understand. Other times, engineers will invent something with properties they didn't expect. How do we quantify the physical properties of a material? In this demonstration, we will learn about the difference between qualitative and quantitative descriptions of a material's physical properties. We will form a hypothesis about an "unknown" material, experiment upon it, take measurements, and estimate its physical properties. You will be asked if you observe what you expected to observe.

Vocabulary / Definitions

Word	Definition
physical property	any aspect of an object or substance that can be measured or perceived without changing its identity.
qualitative description	A verbal description of an essential or distinctive characteristic, property, or attribute
quantitative description	A numeric description of an essential or distinctive characteristic, property, or attribute
polymer	A substance consisting of long chains of repeating sub-units.
super absorbent	Capable of absorbing an unusual amount of water or liquid.
sodium polyacrylate	A super absorbent polymer used in super absorbent diapers.

Procedure

Background

Discuss three types of engineering:

Chemical Engineering: Chemical engineers are involved in the design and production of products including high performance materials needed for aerospace, automotive, biomedical, electronic, environmental and military applications. Examples include ultra-strong fibers, fabrics, adhesives and composites for vehicles, bio-compatible materials for implants and prosthetics, gels for medical applications, pharmaceuticals, and films with special properties (self-cleaning class, digital televisions).

Materials Engineering: An interdisciplinary field involving the study of the properties of matter and its applications to various areas of science and engineering. It includes elements of physics and chemistry, as well as chemical, mechanical, civil and electrical engineering. In materials science, rather than haphazardly looking for and discovering materials and exploiting their properties, a materials engineer instead aims to understand materials fundamentally so that new materials with the desired properties can be created.

Nano Engineering: The practice of engineering on the nanoscale. It derives its name from the nanometer, a unit of measurement equaling one billionth of a meter.

Before the Activity

Gather the materials, including one diaper.

Discuss the properties of some materials:

a. Some substances form a gel when combined with water.
b. Some chemical substances, called polymers, consist of long chains of repeating subunits.

Review the vocabulary.

With the Students

Require that the students record their observations and notes into a notebook.

Step 1: One morning, the engineers spilled a cup of tea next to their invention and observed that the tea 'disappeared' into the material. The engineers have decided to experiment on the material's physical properties.

Step 2: Form a hypothesis about one physical property of the material with regard to its absorbency.

Step 3: Ask the class if they can name some other physical properties of the material simply by observing it.

Step 4: Estimate the water absorbency of the material (take estimates from each of the two demonstrators). Specify units of the quantity.

Step 5: Calculate the volume of water to be absorbed per volume of water. Compare the results of the two experimenters. Are they the same? Construct a ratio table to find out.

Step 6: Ask the students to propose some uses for the material.

Step 7: Ask the students if their observations about the material conformed to their hypotheses.

Safety Issues

- Make sure students do not touch the diaper material (it crumbles), and if they do, to wash their hands immediately (to avoid contact with eyes, nose).

Troubleshooting Tips

Students are often frustrated on competition day because they did not test the design first. The best way to help ensure success is to test each iteration of the design, and to keep a notebook of what they think or observed to have succeeded and failed about each design.

Remind students who might be bickering about design ideas that they should build them and test them by throwing the eggs to simulate the drop. If more than one competing design survives the "drop," then they can evaluate the designs on weight and size parameters (remember, awards are given for lightest and smallest designs surviving the drop).

Investigating Questions

Question: Did both experimenters arrive at the same conclusions about the material's absorbency? Why or why not?

Assessment

Pre-Activity Assessment

Perform a quick oral quiz of the vocabulary.

Activity Embedded Assessment

Question: What are some other physical properties we might have experimented upon? (Does the sample hold more hot or cold water? How long does it take to absorb a volume of hot versus cold water? Is the material toxic to dogs? Does the material retain the water for two hours? Two days? If salt is present in the water, do the same properties hold true?)

Post-Activity Assessment

Ask to see the student's notebooks and evaluate their writing on the following.

Students will be evaluated on a scale from 0 to 4 on:

_____	_____	_____
Participation	Task Completion	Quality of Analysis

Activity Extensions

Question 1: What are some problems that polymers present to the environment? (by the mid 1990s, over ½ of the volume of U.S. landfills was occupied by disposable diapers. They neither decompose nor compress in anaerobic landfills. It takes centuries for a synthetic diaper to decompose.) If you were an engineer, what is one way we could address this problem? (Invent biodegradable super-absorbent materials – soy-based super absorbent polymers, lysine animal (carp)-based proteins.) Do you think these materials are more expensive to produce? How do you think the cost affects how pervasively they are used?

Question 2: What are some other uses for super-absorbent materials besides diapers? (Cat litter, contact lenses, absorbing rain water runoff, hydrating plants, fire-retardant sprays,

hair products). A firefighter in Florida noticed that a used super-absorbent diaper was the only object that survived a dumpster fire unburned

Owner

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Contributors

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