

Western Engineering Outreach

Baking Soda Boats

Grade 3-5

Meet Today's ENG HERO!



Cedric Briens - Professor with Western Engineering

Cedric Briens is a professor with the Chemical and Biochemical Engineering Department at Western University. He has a Ph. D in Chemical Engineering and is the director of the Institute for Chemical and Fuels from Alternative Resources (ICFAR). He has applied his areas of expertise to develop new reactor technology for the conversion of biomass and heavy oils into valuable products.

To learn more about Dr. Briens visit:

<https://www.eng.uwo.ca/chemical/faculty/briens.c/index.html>

Learning Goal:

- Students will explore chemical engineering
- Students will explore and discuss the states of matter
- Curriculum Connections: Grade 3 - Forces Causing Movement, Grade 5 - Properties of and Changes in Matter

Materials Needed:

- 1 plastic bottle
- 1 straw
- 1 large bin
- Baking soda
- Vinegar
- Scissors
- Water
- Glue



Engineering and Science

Today, we will learn about the states of matter. Matter makes up everything in the world and it comes in three different states: solid, liquid, and gas.

One of the most important decisions chemical engineers have to make is which material to use for each specific task. To determine which materials to use, engineers look at the many different properties of the materials available to them. Properties are characteristics that help to describe the material. Every material is made up of something called matter. Matter is defined as anything that takes up space and has mass. That means that you are made up of matter, as is your desk, your backpack, your books, your juice box, your pencil - and anything else that you can imagine! Everything is made up of matter, and matter has several different states. The most common three states are solid, liquid and gas. Can you think of some examples of these different states?

Solids, liquids and gasses all behave in different ways. One important difference is in their shapes and volumes. Solids have a fixed shape and a fixed volume. For example, a sugar cube. No matter in what shape container you place the cube, it will stay the same shape and size. Liquids, on the other hand, have a fixed volume, but they take the shape of their container. If you pour juice into a round cup, or a square box, it will take the shape of the cup or box. Gasses expand to fill the container they are in, so they have neither a fixed shape nor a fixed volume.

Some other properties of materials include mass, colour, shape, volume and texture. When building or designing something, engineers have to consider all of these properties and decide which material is best suited for their task. Let's imagine that you have been asked to design the official Canadian Olympic team's warm-up suits. What kind of materials would you want to use? What properties should these materials have? Materials for the warm-ups would all be solids, and we would assume they should be soft, light and comfortable. Naturally, for team Canada, the specific colors red, white would be used. You would not want to choose a really textured material, such as cork, because it would not be at all comfortable for the athletes to wear.

Solids

Solids are items that you can hold that have a certain size and shape. Some examples of solids would be wood, phones, the floor, etc. Solids do not have to be hard: they can be soft and fluffy, like a pillow or a cotton ball. Solids hold their shape unless a force is applied. The shape of a solid can be changed by squishing, cutting or twisting the object.

Liquids

Liquids are items that have volume, but no set shape. Liquids take the shape of the container in which they are placed. Some examples are pop, juice, or even a spoon full of cough syrup. When you pour a liquid from one

container to the other, the shape of the liquid changes, but the volume of liquid stays the same.

Gases

Gas is matter that has no set size or shape. Gas will expand to fill a container or if not contained, will continue to spread. An example would be the gas filling a pressurized bag of chips. The air we breathe is made up of many different gases.

Fluids

Being a fluid is not a state of matter, but more of a characterization of a substance that has no fixed shape. This means that gases and liquids are both fluids.

Video Recommendation: *The States of Matter*

<https://www.youtube.com/watch?v=JQ4WduVp9k4>

Activity:

Before beginning, think about the following questions:

- Can a solid, liquid or gas change state? What are some examples?
- What are the state of matter of the items on our materials list?
- What state of matter do you think vinegar and baking soda will they be when we mix them all together? What about after time has passed?

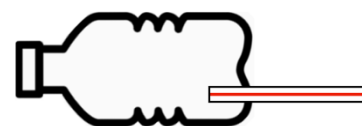
Part 1: Building our Boat and Ocean

The boats we're going to be making are going to be propelled by the energy of the reaction between baking soda and vinegar.

- Take your plastic bottle and make a hole in the bottom of it that's big enough for your straw to fit through
- Stick your straw through the bottom of the hole leaving the straw stuck into the bottle at least 5cm and use your glue to seal the bottom of the bottle shut
- Also, make sure the lid of your plastic bottle is not on so you can pour contents in the hole
- Fill up a large bucket with water to act as the ocean for your boat

Part 2: The Reaction

- Pour about $\frac{1}{2}$ of a cup of vinegar into the bottle via the lid hole



BAKING SODA BOATS

- Make sure the vinegar doesn't flow out of the straw at the bottom
- Add 2 tablespoons of baking soda and watch your boat propel itself!

Every action has an equal and opposite reaction (Newton's Third Law). When the reaction between the baking soda and the vinegar occurs it travels backwards, and this then propels the boat forwards. Therefore, obeying Newton's Third Law, acting as a propellant for your boat. Can you think of other examples of Newton's Third Law?

What Did You Learn?

- What are the three states of matter?
- What state of matter is the baking soda? What about the vinegar?
- What state of matter is the baking soda and vinegar combination now?



Future Learning



- Try different amounts and ratios of baking soda and vinegar to find what works best
- Try and add a sail so you can propel it with air in addition to baking soda and vinegar

Share your creations!

We would love to see what you made. Email us at discover@uwo.ca or tag us on social media.

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Twitter: @westernueng

Facebook: @westernueng

Thanks for discovering with us!