

Western Engineering Outreach

Bottle Rockets

Grade 3-5

Meet Today's ENG HERO!



Kelly Ogden - Assistant professor in Mechanical Engineering at Western University

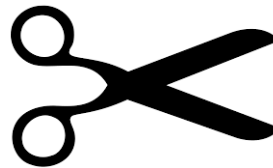
Dr. Kelly Ogden is an Assistant Professor in Mechanical and Materials Engineering at Western University. Before joining Western, she was a post-doctoral associate at MIT. She completed her Ph.D. in the MIT/WHOI joint program in physical oceanography. She obtained her masters in applied mathematics and bachelor's in mechanical engineering, both from the University of Waterloo. Dr. Ogden conducts numerical and analytical research to further understand mixing, waves, and hydraulic processes in coastal flows. For more information about Dr. Ogden please visit: https://www.eng.uwo.ca/mechanical/faculty/ogden_k/index.html

Learning Goal:

- Investigate the properties of air (e.g., the air takes up space, has mass, can be compressed).
- Follow established safety procedures for using tools and materials and operating flying devices.
- Use engineering problem-solving skills to design, build, and test a flying device.
- Curriculum connections: Grade 3- Forces causing movement, Grade 4- Light and Sound, Grade 5- Conservation of energy and resources

Materials Needed

- 2 tbsp baking soda
- 1/2 cup vinegar
- 1 empty plastic bottle (e.g. water bottle)
- 1 cork that fits into the end of the water bottle
- 3 pencils
- Scissors
- Funnel (Or can make one out of a piece of cardboard)



Engineering and Science Connections:

What is Chemistry?

Chemistry is the study of matter and its interactions. A chemist or chemical engineer may study things like the reaction between two different substances when they are put together.

What is matter?

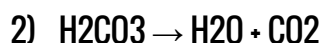
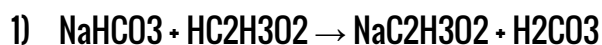
Matter is everything around you, anything that has mass or takes up space.

What is a chemical reaction?

A chemical reaction is the mixing of two substances to form a completely new substance.

Examples of chemical reactions

Examples of chemical reactions can be things like the baking soda or vinegar volcano or a fire. In today's activity, we will be recreating an acid-base reaction. Vinegar is the acid and baking soda is the base in this chemical reaction. In today's activity, the hydrogen (H) ions in the vinegar react with the sodium (Na) and the bicarbonate (HCO₃) in the baking soda, creating carbonic acid and sodium acetate. The second reaction is the carbonic acid that was formed decomposing into the water and carbon dioxide (CO₂) gas. The CO₂ bubbles rise to the top of the mixture, which is what creates the bubbles and foam you see. Today we are going to be using a reaction between vinegar and baking soda to power our rocket. When these two chemicals are combined, the reaction creates an excess amount of gas. Because that gas is inside a small space, it will want to escape and it will cause the cap to pop off, shooting our rocket upwards!



How to detect a chemical reaction?

There are four ways to determine if a chemical reaction occurred. If a temperature change occurs, so if the temperature increases or decreases, a chemical reaction occurred. If a gas forms or a precipitate (which is a solid separated from the solution) forms there's a chemical reaction. Also, if a colour change that is not due to mixing, there's a chemical reaction occurring.

How to speed up a chemical reaction?

Some of the ways we can speed up a chemical reaction are by adding heat or mixing because it increases the frequency of collisions between molecules (tiny particles that make up every matter that exists).

What is a force?

A force is a push or a pull that can make an object change speed, shape, or direction.

Types of forces that will be acting on this rocket

- Drag (Air resistance which slows the object down)
- Gravity/Weight/ Load (What is pulling the rocket down)
- Force of the pressurized air/water (considered the “THRUST” in this case - compare to gas in real rockets/ cars)

What is Aerodynamics?

Aerodynamics is the study of the properties of moving air and the interaction between the air and the solid bodies moving through it.

What is Pascal's Law?

Pascal's law states that if pressure is applied to fluids that are confined, the fluids will transmit that same pressure in all directions at the same time. An example of Pascal's Law is when the air is pumped into a confined space, the air inside the space will become pressurized. This air and water will exert a force on all sides of the bottle, including the bottom where the cork is placed. Eventually, the pressure will build up and the rocket will “blast off” releasing the cork in the process.

Activity:

Today you will be designing your rocket and with the chemical reaction between baking soda and vinegar, you will be able to launch your rocket!

Step 1: Design the astronaut that will go on your rocket!

- Using paper and markers design an astronaut that you will put on your rocket to launch it.

Step 3: Make the launching pad for the rocket

- Tape the pencils around the outside of the bottle to act as the launching pad for the rocket.
- Remember the lid of the bottle needs to be pointing down for launch.



BOTTLE ROCKETS

- By placing the pencils around the outside of the bottle you want the lid of the rocket not quite touching the ground.

Step 4: The cork

- Ensure that your cork fits into your bottle tightly

Step 5: Decorate!

- Decorate your rocket with markers and paper
- Make a funnel with cardboard if don't have one



Step 6: Test the rocket with ADULT supervision and OUTSIDE!

- Go outside
- Pour in $\frac{1}{2}$ cup of vinegar
- Add 2 tbsp of baking soda by using a funnel
- Quickly close the lid and place upside down for launch
- Move away from the bottle
- Watch the launch from a safe distance away



Recommended Video:

Watch the following video to learn more about the acid-base reaction between baking soda and vinegar. <https://www.youtube.com/watch?v=nvOn02QjmRU>



What Did You Learn?



- What is chemistry?
- What is matter?
- What is a force?
- Pascal's law
- Chemical Reactions

Future Learning



- Turn this activity into a fun science experiment and use the chemical reaction between vinegar and baking soda that releases gas into something fun. Put some vinegar in an empty water bottle and then add baking soda. Very quickly cover the top of the bottle with a balloon. The balloon will inflate on its own due to the release of gas. Watch the balloon inflate on it's on without blowing it!
- Add different elements to your bottle rocket to make it fly farther! You might add fins or a nose to help it soar.

Share your creations!

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

Instagram: @westernueng

Twitter: @westernueng

Facebook: @westernueng

Thanks for discovering with us!