

# Western Engineering Outreach

## *Homemade Thermometer*

*Grades 3-5*

*Meet Today's ENG HERO!*



*Ying Zheng* – Professor with Western Engineering

Dr. Zheng completed her Ph.D. in Chemical Engineering at Western University. Before joining Western University as a Professor, Dr. Zheng was the tenured Chair Professor of Chemical Reaction/Catalysis Engineering at the University of Edinburgh, UK. Her research interests are in the development of novel catalysts and new intensified catalytic processes with applications in fuel upgrading, renewable energy, waste-to-energy/value-added products.

To learn more about Dr. Zheng visit:

[https://www.eng.uwo.ca/chemical/faculty/zheng\\_y/index.html](https://www.eng.uwo.ca/chemical/faculty/zheng_y/index.html)

## *Learning Goal:*

- To investigate how temperature affects the volume of a liquid.
- Curriculum Connections: Grade 5 - Properties and Changes in Matter

## *Materials Needed:*

- An empty, clear, plastic bottle
- Water
- Rubbing alcohol
- Food colouring
- A clear straw
- Modelling clay
- A marker



## *Engineering and Science Connections:*

### **Chemical Engineering**

Chemistry is a branch of science that studies matter and its interactions. Engineering is the practical application of science and math to solve problems. Chemical engineers work with chemicals. So many everyday things have chemicals in them like medicines, cleaning products, makeup, and artificial flavours. Chemical engineers can work in any of those fields and many others.

### **Thermal expansion and contraction**

Thermal expansion and contraction tell us about the behaviour of matter at various temperatures. Matter is anything that takes up space and has mass. Air, water, and rocks are all examples of matter.

At a certain temperature, a specific matter takes up a certain amount of space. If the temperature of the matter is increased, the atoms and molecules that make up the matter start to move faster and take up more space. Because of that, the matter starts to expand, which is called thermal expansion. Different materials expand at different rates, but this happens to all types of matter - solids, liquids, and gases.

Thermal contraction is the opposite of thermal expansion. It tells us that as the temperature decreases, the atoms and molecules that make up that matter start to slow down and move closer together. Because of that, the matter starts to contract (or decrease in size), which we call thermal contraction.

### **How liquid thermometers work**

Liquid thermometers show the temperature based on how high the liquid is in the center tube. As the temperature of the thermometer surroundings increases, the liquid expands (aka thermal expansion), causing an increase in the height of the liquid in the tube. As the temperature of the thermometer surroundings decreases, the liquid contracts (aka thermal contraction), causing a decrease in the height of the liquid in the tube.

Liquid thermometers have temperatures written along the center tube. So based on where the height of the liquid is in the tube, you can read what the temperature is.

## *Video Recommendations:*

*Learn About Expansion and Contraction for Kids* <https://www.youtube.com/watch?v=4FutJrhTWDA>

*Activity:*

1. Fill the bottle about  $\frac{1}{4}$  full of tap water.



2. Then, add an equal amount of rubbing alcohol so that the bottle is about half full.



3. Add a few drops of food colouring to the bottle. Since you need the food colouring to clearly see the height of the liquid in the straw, use a darker food colouring like blue or red, rather than a lighter colour than yellow.
4. Gently swirl the bottle around to mix the food colouring in. Be careful not to spill the contents.
5. Put the straw into the bottle but do not let go. Hold onto the straw so that it does not touch the bottom of the bottle but is suspended above the bottom in the liquid.
6. Wrap the modelling clay around the top of the bottle and straw. This will hold the straw in place and prevent it from falling into the bottle. Some of the straw will be poking out of the top of the bottle and that is okay. Do not cover the top hole of the straw with modelling clay.



7. Look to see how far the liquid comes up the straw. Use the marker to mark the outside of the bottle where the liquid reaches in the straw. This line represents the current temperature.
8. Move the bottle to different locations where the temperature is different. Notice how the liquid either rises or sinks down in the straw. Because of thermal expansion and contraction, in warmer temperatures, the liquid will rise, and in cooler temperatures, the liquid will lower. You can try places like outside (if it warmer or cooler than the temperature where you made the thermometer) and can even try placing it in the fridge to see what happens.

Note, handle your homemade thermometer with care as you move it. If you squeeze the bottle tightly, it can start to push liquid up the straw. In this case, the increase in the liquid height in the straw is not due to thermal expansion but instead due to pressure.

9. If you have a store-bought thermometer, place it beside your homemade thermometer when you move it to new locations. You can use the readings from the store-bought thermometer to mark the temperatures on your homemade thermometer at each new location.



### What Did You Learn?



- What is thermal expansion and contraction?
- How do liquid thermometers work?

### Future Learning



- How does the temperature of each new location impact the height of the liquid in the straw?
- What other places could you test your thermometer?
- What will happen if you put your thermometer in a location that is below freezing ( $0^{\circ}\text{C}$ )?

### Share your creations!

We would love to see what you made. Email us at [discover@uwo.ca](mailto:discover@uwo.ca) or tag us on social media.

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*Thanks for discovering with us!*