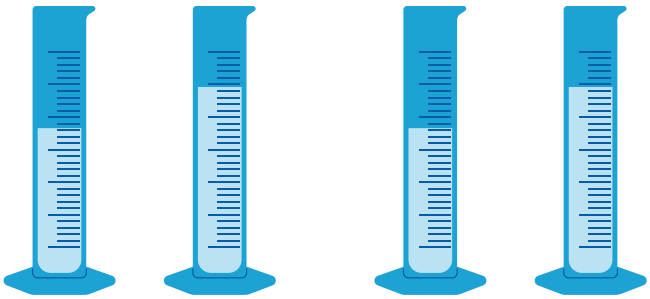
ACTIVITY 3: VISUALIZING THERMAL STRATIFICATION



The purpose of this activity is for students to understand how temperature affects water density and its implications for lake stratification.

Materials:

- Large (500mL) beakers or clear containers
- Thermometers
- Food coloring
- Ice
- Water
- Salt
- 100mL graduated cylinders

First, inform students that they will investigate thermal stratification—how temperature differences in waters affect the density and how the density of waters at different temperatures gets layered in lakes. Begin with a simple demonstration of adding vegetable oil to a graduated cylinder and then slowly adding some room temperature water to the same graduated cylinder by pouring it down the side of the graduated cylinder. Ask students to predict what will happen when the two are combined. Allow time for the two liquids to settle and then look again at the graduated cylinder to see that the oil layer floats atop the water later.

Then, explain to the students that the oil is less dense than water and review what that means by drawing particle diagrams* to represent the two substances (e.g., two boxes of the same size, one with more dots to represent the denser water, one with less dots to represent the less dense oil.) Make the connection that, due to molecular motion, water molecules at lower temperatures move less and are closer together, thus denser than warmer, faster, more spread out water.

Teaching Tip: If your students are less experienced with particle diagrams, practice a couple other examples first.

Next, have them partner up, get their materials, and conduct their experimental procedure:

1. Fill one clear plastic container half with ice cold water (no ice), hot water in the other
2. Add a few drops of different colored food coloring to each container (e.g., blue for cold water and red for warm water) to visually distinguish between the two and mix
3. Use thermometers to measure and record the initial temperatures of both the ice water and the warm water
4. Slowly and carefully pour the hot colored water into the container with the ice water Tilt the ice water contain and slowly pour the hot water down the side to avoid splashing
5. Observe and note what happens initially
6. Observe the interaction between the warm and cold water over time. (Note that the warmer water stays on top of the cold water, indicating differences in density due to temperature.)
7. Continue observing the waters interact and mix over time every minute or two for about 10 minutes.

Salt Water Variation:

- For a variation, add salt to some other ice water to increase its density further and add a different (third) color. Repeat the pouring process by combining the three different waters and observe any differences in the behavior of the water layers.
- Note: students can also test this experiment out initially with the two temperatures and then design an experiment to layer several different colors based on density using a combination of salt and temperature.

Last, have students create a series of particle diagrams to represent a time lapse of what happened before, during, and later on after their experiment took place and the waters mixed for some time. Transfer those particle diagrams to chart paper or large dry erase boards, and then facilitate a class discussion to compare and connect observations and results of what happened at the macroscopic and microscopic level. Relate this to what happens with thermal stratification in Lake Superior.