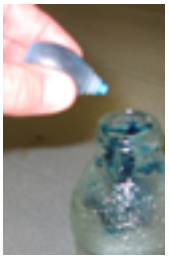
Inverted Bottles
The rise and fall of hot and cold.

Introduction:
Investigate convection by using food coloring and water of different temperatures.

Tools and Materials:

- 4 Identical wide mouth glass bottles
- Index cards
- Food Coloring – two colors
- A source of hot and cold water
- Plastic plates or tray to hold any spilled water.

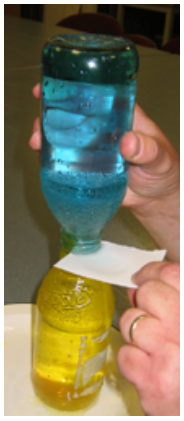


Assembly:

1. Completely fill two bottles with **hot** water. Fill until a meniscus forms (an upward bulge) on the surface of the water.
2. Completely fill two bottles with **cold** water. Fill until a meniscus forms (an upward bulge) on the surface of the water.
3. Add food coloring to the bottles. Use the same color for the the two hot water bottles and a different color for the two cold water bottles. (In the Examples presented, I used blue coloring for the cold and yellow for the hot water bottles)

4. Watch how the drops of food coloring mix in the water (this can be made into a lesson unto itself).
5. Place two plastic plates on the table.
6. Place one of the cold bottles on one plate.
7. Place one of the hot bottles on the other plate.
8. Take a piece of index card (slightly bigger than the mouth of the bottle) and place it on the mouth of hot water bottle not on the plate.

9. Gently tap the card stock. This will help to make sure that the card is in contact with the entire rim of the bottle.
10. Carefully and slowly invert the bottle without touching the paper (Yet another lesson - this portion of the activity can lead to discussions of air pressure and surface tension).
11. Place the hot water bottle with the card on it directly on top of the cold bottle on the plate.
12. Line-up the mouths of the hot and cold bottles (with the piece of index card between).
13. Repeat these steps 8 – 12 for the cold water bottle. Invert it and place it on top of the hot water bottle on the plate.
14. You should now have two experiments set up: a hot water bottle on top of cold water bottle and a cold water bottle on top of a hot water bottle.



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To do and notice:

1. Try to do this next step at the same time to both sets of bottles.
2. Carefully slide the paper out from between each set of bottles. You might need help with this step.
3. Watch what happens next.

What's going on?
The hot water stayed on top and the cold water stayed on the bottom in one set of bottles and the colors stayed pretty much the same. However, in the other set, something very different happened. The hot water rose and the cold water sank. As this motion occurred, the colored water mixed.

This all happened because of differences in density. Everything is made of molecules. Hot molecules move more than cold molecules. Therefore things that are hot take up more room or volume then the same things that are cold. This means, bottles filled with hot water require less water than bottles filled with cold water. Hot water, is therefore less dense than cold water.

Gravity can separate fluids by their density. Because the cold water is denser, it seeks a lower elevation than the hot water. This motion of cold fluid going downward causes the hot liquid to be pushed or lifted upward. This motion of fluids is called convection.

Originally: Cold was on top *After:* Cold sank and fluids mixed	*Originally:* Hot was on top. *After:* Hot stayed on top…no mixing.

Going Further:

Have you ever used a step-stool or ladder to change a light bulb?
If you have, you might notice that the air, higher up in the room is warmer. Air is a fluid and is also effected by convection.

Next time you go swimming in a pool, try noticing the tempurature differerce between the water at the surface and the cooler, deeper water. Again, seperation of fluids by density….convection in action.

Compare two bowls of hot soup. Blow across one bowl and leave the other bowl alone. You are driving convection faster in the bowl you blow across! You cool the top surface, it sinks and the hot soup below rises and also gets cooled.

Convection effects fluid movement on very large scales too. It is an important part of the weather cycle. It drives ocean currents as well as the motion of semi-solid rock within the earth. Convection even moves material in stars.