Liquid Nitrogen Video Conference

Post-class experiments to be performed after the video conference

Creating ice cores: A record in the ice

You will need:

- Dry ice from a local gas supplier
- A small plastic container 1/2 filled with water
- Detergent and food colouring
- Tongs

1. Add a few drops of food colouring to the water.
2. Add dry ice piece by piece and allow it to sublimate rapidly.
3. As you add the dry ice you will notice it starting to form clumps at the bottom of the container. This is where the surrounding water cools down enough to freeze.
4. Keep adding dry ice until a solid clump of ice/dry ice is at the bottom of the container. Within the ice you will no doubt have small white 'frozen bubbles' of carbon dioxide.
5. If you wish, you can add a small squirt of detergent into the mix to trap the bubbles of carbon dioxide leaving the solution.

When you make an ice cube, you invariably trap very minute air bubbles within the ice. The humble ice cube effectively is acting as a time capsule, holding air inside it from when it was formed. Air contains many gases, some of which are suggested to enhance global warming. As polar ice can be thousands of years old, climatologists work within these remote regions to study the ice for changes in composition of atmospheric gases over thousands of years

The data is collected from ice cores, effectively long tubes of ice taken from vertical sections of glaciers. As each season produces a different layer of snow, the ice cores can be 'read' quite accurately, a process similar to dating sedimentary deposits in riverine areas or the determining seasonal variation using growth rings of trees. Each year has it's own record of gases within it, therefore scientists can use this record as a monitoring tool for dramatic changes in our atmosphere. One such dramatic change has been the rapid rise in carbon dioxide levels found within the these ice cores, a gas strongly suspected as causing the most damage in trapping excess solar heat energy within our atmosphere.

Brady, J. E. & Holum, J. R. (1993). *Chemistry. The Study of Matter and Its Changes.* John Wiley & Sons, New York

Experiment: Does hot water freeze faster than cold water?

You will need:

- 1 cup of cold water, 100mL in volume
- 1 cup of hot water 100mL in volume
- 1 stopwatch, 1 stirrer and a freezer
- Pen and paper

1. Stir both water cups for the same amount of time.
2. Place both cups of water inside your freezer and start the timer.
3. Keep checking at 5 minute intervals to see which freezes first.
4. Record your observations.

Hmmmm, you've completed an experiment whose results are quite tricky to explain.
Did you find that the hot water froze first? Under some conditions this can happen...

We started with two containers of water, which were identical in shape and held identical amounts of water. The only difference between the two was that the water in one was at a higher (uniform) temperature than the water in the other. Of course, if the hot water had started at 99.9° C, and the cold water at 0.01° C, then clearly under those circumstances, the initially cooler water would have frozen first. However, under some conditions the initially warmer water will freeze first -- if that happens, you have seen the Mpemba effect which describes the phenomenon. How does it work you might ask? Several ideas have been put forward and no-one really is sure as to which effect plays the biggest role:

1. As the initially warmer water cools to the freezer temperature, it may lose significant amounts of water to evaporation. The reduced mass will make it easier for the warmer water to cool and freeze than the colder water.

2. A convection current may have been setup in the warmer water. As the warmer water cooled it lost heat primarily through the surface of the liquid faster than the colder water. This is due to a great temperature difference between the cold freezer air and the warm water. The water from the bottom of the cup then rose to the water surface, bringing more heat energy to the cold freezer air. As the current is greater in the warmer water than the cold water, a greater amount of liquid got exposed to the cold freezer air. Think of a fan forced oven, circulating the hot air through the oven heats the oven faster than just allowing the air to sit still... bakers have known this over a thousand of years!
More on temperature and water rising or falling

3. The surrounding air around the cups may have more movement around the warmer cup, therefore drawing heat energy away from the warmer cup more effectively.

4. Warm water holds less dissolved gas than cold water. There have been some suggestions that the presence of dissolved gases impede the production of convection currents in the colder water.

5. The cold water may have supercooled, therefore not forming a solid as quick as the hot water.

Quote: I often put boiling water in the freezer.
Then whenever I need boiling water, I simply defrost it. *Gracie Allen.*

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