Triple Point of CO_2

Recommended for Chapter(s): 16

Demo #046

Materials NOT in box

1. Safety goggles
2. Document camera (the document camera is on the bottom shelf of the shelving on your right as you come into the demonstration room next to demo # 049).
3. Dry ice (dry ice holder, hammer, and bag are in the general cabinet; get dry ice from cage near shipping and receiving).

Procedure

1. (Prep) Gets Styrofoam container and take it to get dry ice. The dry ice is located in the cage outside chemistry shipping and receiving. If you do not have a project code, contact Darby (feldwinn@chem.ucsb.edu) for a code to use. You will need less than 0.1 lb of dry ice for the demo.
2. (Prep) Using the hammer in the general cabinet, crush the dry ice into powder and load the CO2 powder into the cut off plastic pipettes until the bulbs are 1/4 of the way full. To load the pipettes use the spatula to force the CO_2 powder into them. Note: if you fill them too full the pressure will build up to quickly to see the triple point. The pipettes with CO_2 can be stored in the dry ice container with dry ice around them until you are ready to use. Occasionally the bulbs do not work therefore you should make at least three.
3. (Prep) Pour ~750 mL of water into the 1000 mL beaker.
4. (Prep) Set up the document camera so that it is looking at the side of the beaker where you are going to insert the pipette.
5. Roll the end of the pipette down until you reach the bulb. This should result in several turns.
6. Using the pliers grab the roll that you made in step 5.
7. Squeeze the pliers firmly and insert the bulb into the water in the beaker.
8. Just before the bulb ruptures you will see solid and liquid CO_2 signifying the triple point.
    a. If the pipette bubbles when you put it into the beaker you have not gripped it tight enough to build the pressure inside of the bulb and you will not be able to see the triple point.

Safety

1. Wear safety goggles.

2. Water will most likely spill out of the container when the bulb bursts.
3. This should not be done with anything bigger than a pipette bulb.

Clean Up

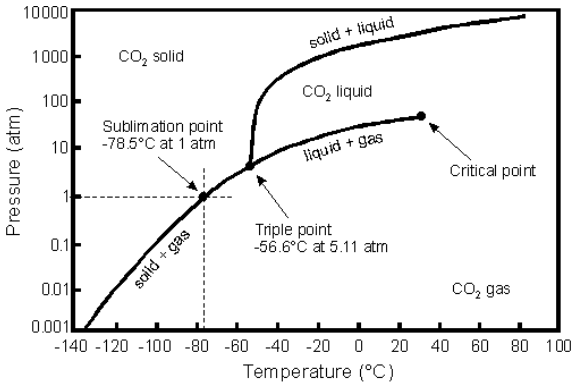
1. Wipe off table with paper towels.
2. Return the materials to the cart in the demonstration library room.

Stockroom Notes

1. Pour the waste down the drain.
2. Replace the glassware with clean glassware.
3. If needed refill any materials that have been used up.
    a. Make sure that there are at least 5 cut off pipettes.
4. Return items to demonstration tub.
5. Return tub to the demonstration library.
    a. The goggles go in the goggle box.
    b. The document camera goes on the bottom shelf of the shelving on your right as you come into the demonstration room next to demo # 049.
    c. The dry ice holder goes in the general cabinet as well as the hammer and the dry ice bag.

Discussion

Below is the phase diagram from CO_2



Pressure-Temperature phase diagram for CO_2.

Under normal pressure conditions (1 atm) as CO_2 warms up it transitions from a solid to a gas without passing through the liquid phase. When a solid turns directly to a gas this is called sublimation.

From the graph it can be seen if the pressure is raised to ~5 atm as the CO_2 warms up, it will pass through its triple point.

As the dry ice in the pipette sublimes the pressure the in the pipette raises which allows one to see the triple point of CO_2 before the pressure in the pipette gets high enough to burst the pipette.

If you look closely as soon as the pipette ruptures the CO_2 turns back into the solid phase this is a result of the pressure dropping.

Materials that *Will Need* to be Reordered

- Cut off plastic pipettes
- Paper towels
- Bottle of tap water

Other Materials in the Box

- 1000 mL Beaker
- Pliers
- Spatula