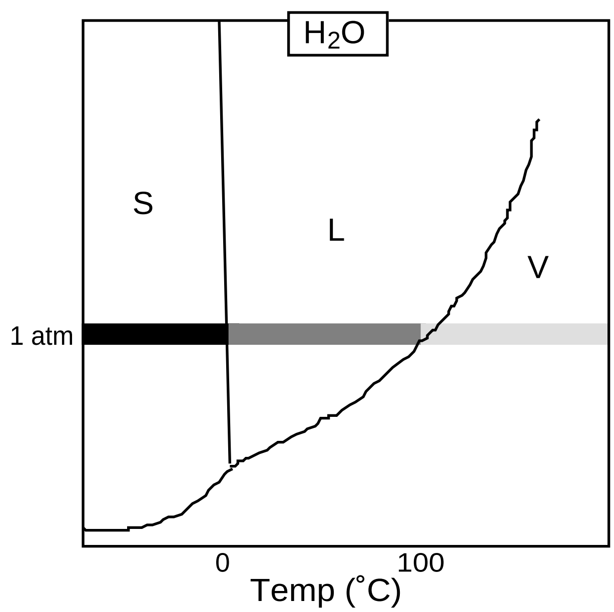
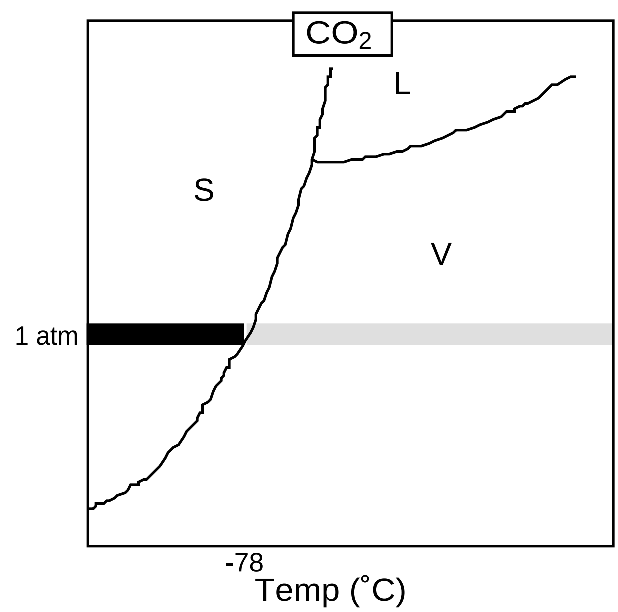
Wet Dry Ice Lab Name: _______________ Partner: ___________

When a chunk of ice is taken from a freezer and placed in a warm room, it gains heat and its temperature increased to 0˚C, then it melts (phase change). If it is heated further, at 100˚C, the water will boil (another phase change). Another way to think of these transitions is as follows: for water at standard pressure, below 0˚C, only the solid state is stable. Between 0˚ and 100˚C, only the liquid state is stable. And above 100˚C, only the vapor (gas) state is stable. This can be diagramed along a line as follows:

0˚C is referred to as the "melting point" and 100˚C is known as the "boiling point". Let's say a chunk of dry ice (carbon dioxide) is taken out of a very cold freezer and placed in a warm room. Rather than melting, when it reaches -78˚C, it "sublimes", changing directly from a solid to a gas, with no liquid state being stable in between. This can be diagramed along a line as follows:

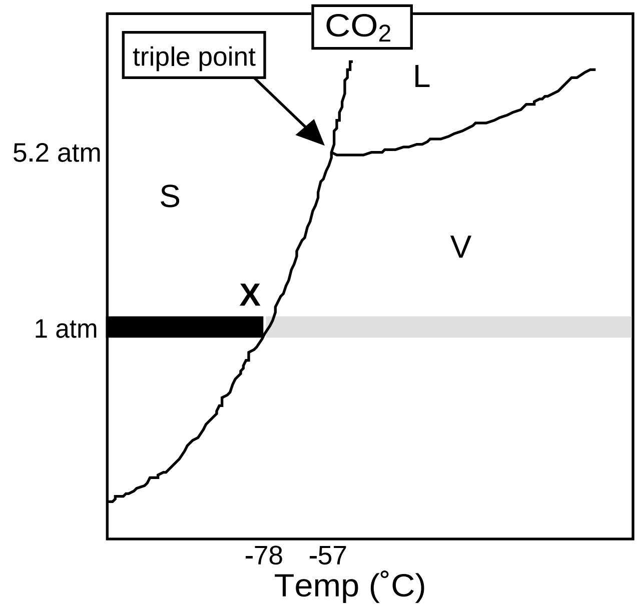
These lines, however, are very narrow-minded views of the two substances; they are only small fractions of the overall picture, for they apply only to the changes that occur **at a pressure of 1 atm**. It is as though we are seeing the two situations with our eye lids almost completely closed, so all we can see is the narrow horizontal strip that represents standard pressure. If we open our eyes wider, to see what states are stable and where these transitions take place at higher pressures and lower pressures, we get the "whole picture". These whole pictures are called *phase diagrams*, and they show not only what states or phases are stable under various conditions of temperature and pressure, but they also show that water and carbon dioxide are fundamentally not all that different. Their phase diagrams have the same general Y-shape, just shifted relative to one another.



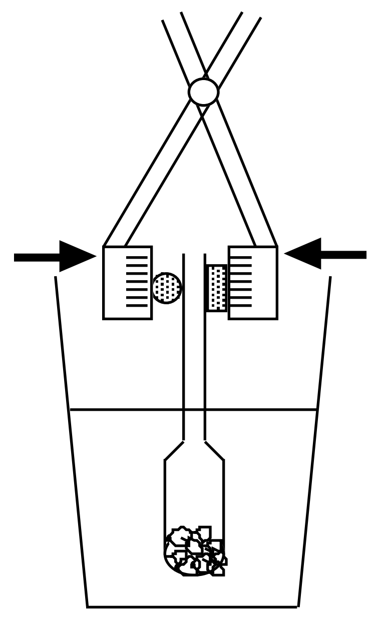


Note also: phase diagrams show us that terms like melting point and boiling point are actually misleading. "Melting line" and "boiling line" would really be more appropriate, for the conditions that allow melting or boiling to occur depend on temperature and pressure. The temperature / pressure coordinates define an entire line (usually curved) across the phase diagram. The reason we call them "points" is because we usually only see a small portion of these lines... those points where they intersect the P = 1 atm line.

In this lab you will have a chance to observe first hand something that very few people ever see and which most people probably think doesn't exist: liquid carbon dioxide! You will also witness a rather unusual phenomenon known as the "*triple point*". The triple point of a substance is a specific pressure and temperature at which all three phases can exist together at equilibrium. For any given substance there is one and only one point at which this can happen: for carbon dioxide, the triple point is -57˚C and 5.2 atm, as shown at right. (for water, the triple point is 0.01˚C and 0.006 atm).



A chunk of subliming dry ice in the room is at point **X** on the phase diagram at right. In order for us to experience the triple point we must raise the temperature from -78˚C up to -58˚C, but that happens automatically in a room that is at 25˚C! We must also raise the pressure from 1 atm up to 5.2 atm. To do this, we will put the dry ice in a container and close it off. As the dry ice sublimes, it will build up its own pressure. But we must be ***careful***: Any container that is being pressurized runs the risk of ***exploding***!!! Rather than try to safeguard against explosions, in this lab we will safeguard **for** them. We will do this by using a soft container (plastic) rather than a rigid one (like glass), and by keeping it small so any explosions that may occur will be small ones.



Procedure:

1.Cut off the tip of a plastic pipet, then scoop up into it enough dry ice to fill the bulb about half-way.

2. Slip the metal clamp assembly over the pipet opening, then close down on the assembly with a pair of pliers (see diagram).

3. Immediately lower the pipet into a plastic cup half filled with water. (You should be able to think of a few good reasons why it is important to do this.)

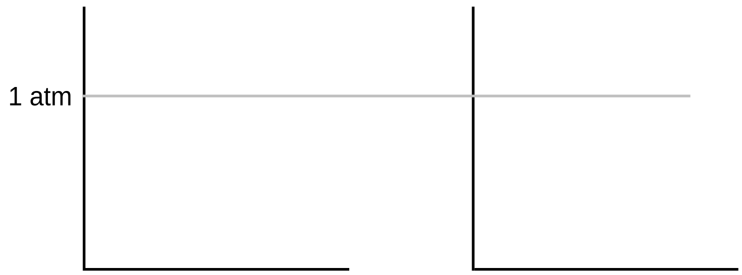
4. Observe the contents of the bulb from the side-- look for signs of melting and boiling. Once you see them, try releasing your grip quickly and see what happens. Re-establish the triple point pressure and now try releasing pressure gradually, to ***just keep*** the contents right at the triple point. Note: if you do not release the pressure in time, it will explode. But that's okay, just be prepared for it.

Record all observations below:

Wet Dry Ice Lab questions

1. What is sublimation?

2. Use two phase diagrams to explain why some substances melt and then boil, while other substances sublime:



3. What is misleading about the terms "melting point" and "boiling point"?

4. The statement below is not completely true. Change it to make it completely true.

"Water always boils at 100°C"

5. The statement below is not completely true. Change it to make it completely true.

"Liquid CO_2 is not stable, so we usually never see it."

6. Is it possible to have boiling ice water? If so, explain how. If not, why not?

7. Two identical pots of water... one in St. Louis, one in Denver, are placed on identical stoves and identical eggs are dropped in at the same time. Which water will start to boil first? _________ Which egg will finish cooking first? _________ Explain, using a phase diagram, labeling each city:

8. In the lab, you witnessed what few people ever witness: ***liquid CO_2***. Using a phase diagram, explain how you did this:

9. List 2 reasons why water was used in this lab.

10. Why do you think you used a plastic cup rather than a glass beaker?

11. If you were observant, you might have noticed that the unmelted solid CO_2 was at the bottom of the liquid CO_2. Why was this? (think *density*)

Can you think of a substance that would behave differently? ____________

Which behavior is more typical of all substances? Solid floating in its liquid, or solid sinking in its liquid?