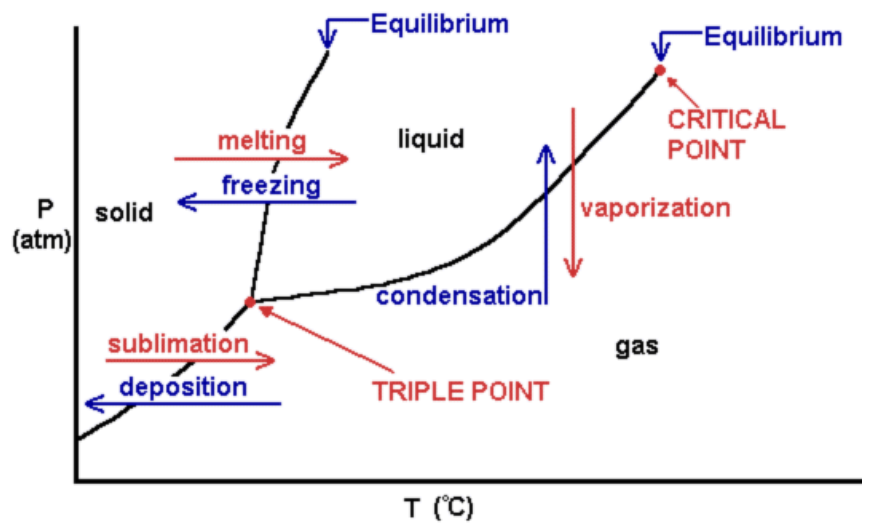


Chemistry - Changes of State, Vapor Pressure, & Phase Diagrams

Generic Phase Diagram

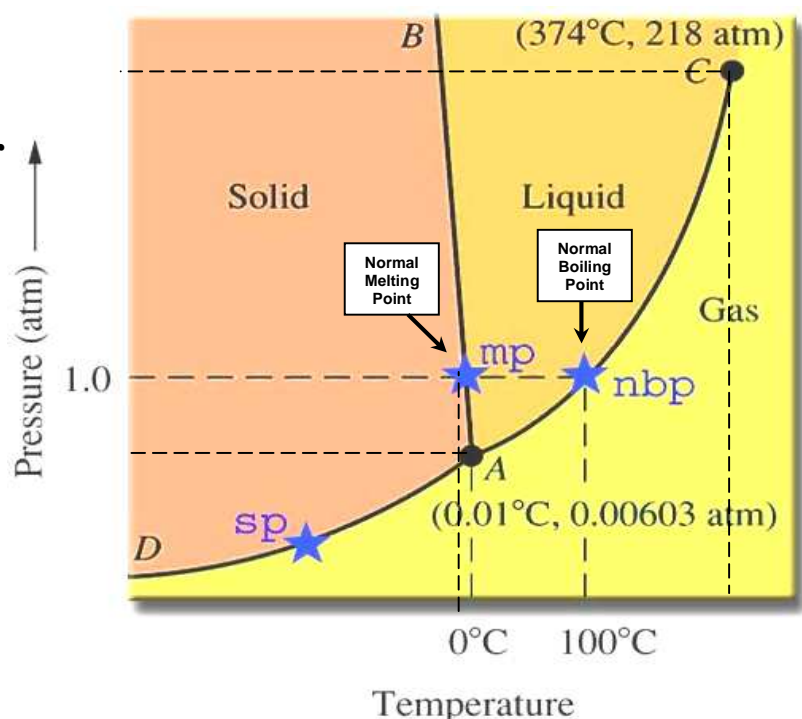
- **Sublimation** is the phase change as a substance changes from a solid to a gas without passing through the intermediate state of a liquid.
- **Deposition** is the phase change as a substance changes from a gas to a solid without passing through the intermediate state of a liquid.
- **TRIPLE POINT** - The temperature and pressure at which the solid, liquid, and gas phases exist simultaneously.



- **CRITICAL POINT** - The temperature above which a substance will always be a gas regardless of the pressure.
- **NOTE:**
 - The solid phase is more dense than the liquid phase.
 - The line between the solid and gas phases is the equilibrium of solid and gas phases at that specific pressure and temperature, i.e. a curve of all the deposition/sublimation points.
 - The line between the solid and liquid phases is the equilibrium of solid and liquid phases at that specific pressure and temperature, i.e. a curve of all the freezing/melting points.
 - The line between the liquid and gas phases is the equilibrium of liquid and gas phases at that specific pressure and temperature, i.e. a curve of all the vaporization/condensation points.
- **Melting Point (Freezing Point)** - The temperature at which the solid and liquid phases of a substance are in equilibrium at atmospheric pressure.
 - **Normal Melting Point (Freezing Point)** - The temperature at which the solid changes to a liquid at Standard Pressure (1.00 atm = 760 mmHg = 760 torr = 101.325 kPa)
- **Boiling Point (Condensation Point)** - The temperature at which the vapor pressure of a liquid is equal to the pressure on the liquid.
 - **Normal Boiling Point (Condensation Point)** - The temperature at which the vapor pressure of a liquid is equal to Standard Pressure (1.00 atm = 760 mmHg = 760 torr = 101.325 kPa)

Phase Diagram for Water

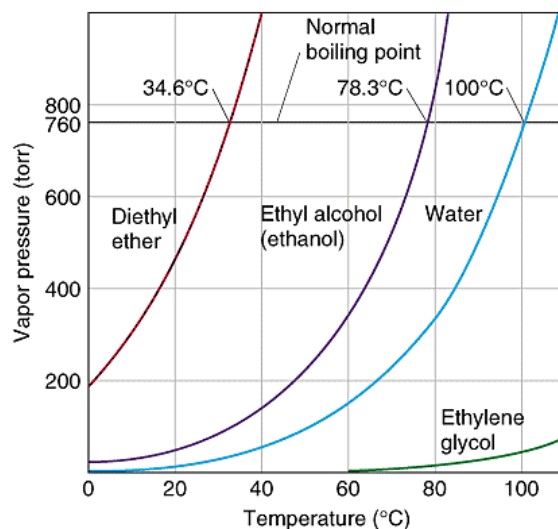
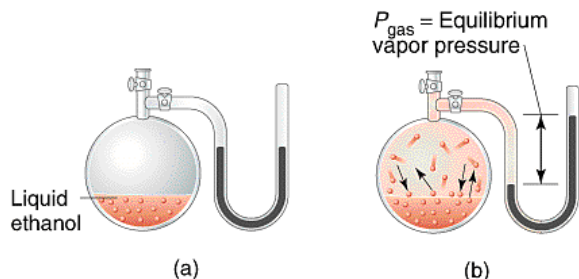
For water, the liquid phase is more dense than the solid phase due to hydrogen bonding.



Vapor Pressure

If you put any liquid in a sealed vessel and wait long enough, (b) the liquid will come into equilibrium with its vapor, and a constant (steady; dependent only of the temperature) equilibrium vapor pressure will be established.

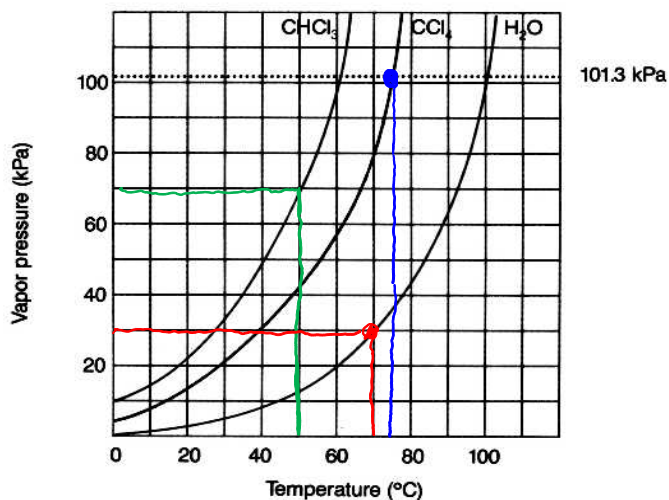
Normal Boiling Point - The temperature at which the vapor pressure of a liquid is equal to Standard Pressure (1.00 atm = 760 mmHg = 760 torr = 101.325 kPa)



PART B – VAPOR PRESSURE GRAPH

Use the graph at right to answer the following questions:

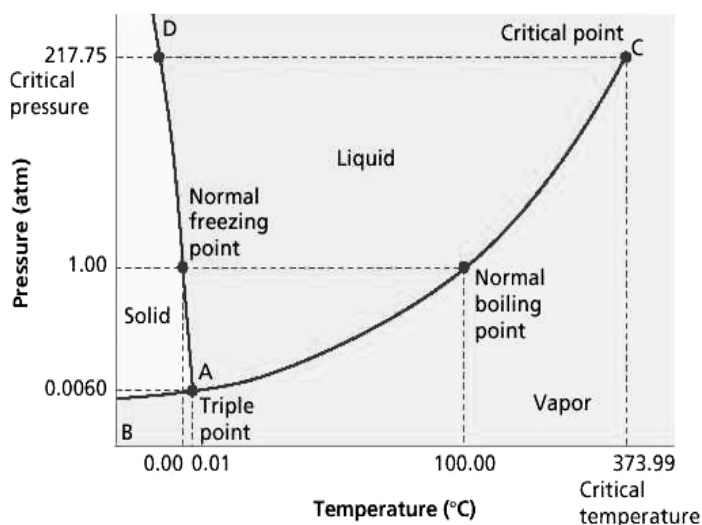
- What is the vapor pressure of CHCl_3 at 50°C ?
70 kPa
- What is the boiling point of H_2O when the external pressure is 30 kPa?
70°C
- What is the normal boiling point of CCl_4 ?
*↳ b.p. at 1 atm pressure = 101.3 kPa
75°C*
- Which substance has the weakest IMF?
The substance w/ the lowest bp @ a given pressure has the weakest IMF ⇒ CHCl_3
- What does each VP curve represent?
The VP curve represents the vapor pressure's dependence on temp



Phase Diagram 1

Use the phase diagram for water at right to answer the following questions:

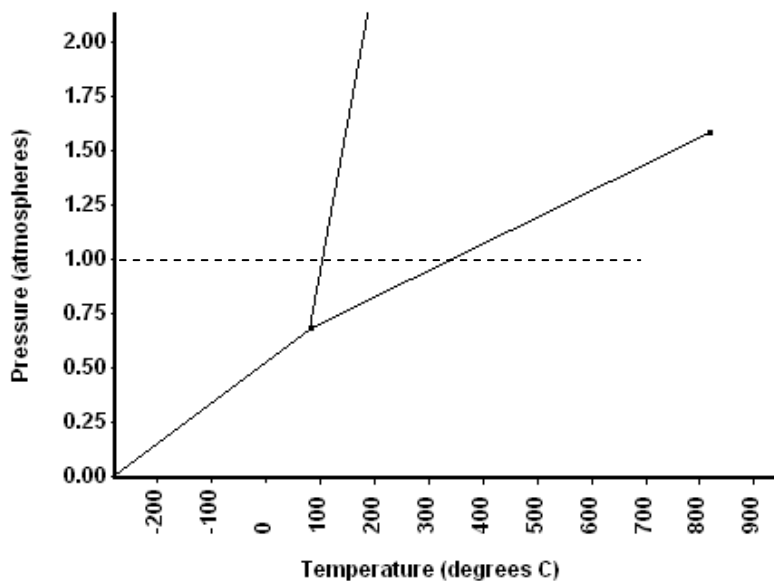
- What is the state of water at 2 atm and 50° ?
- What phase change will occur if the temperature is lowered from 80°C to -5°C at 1 atm?
- You have ice at -10°C and 1 atm. What could you do in order cause the ice to sublime?



Phase Diagram 2

Refer to the phase diagram at right when answering the questions on this worksheet:

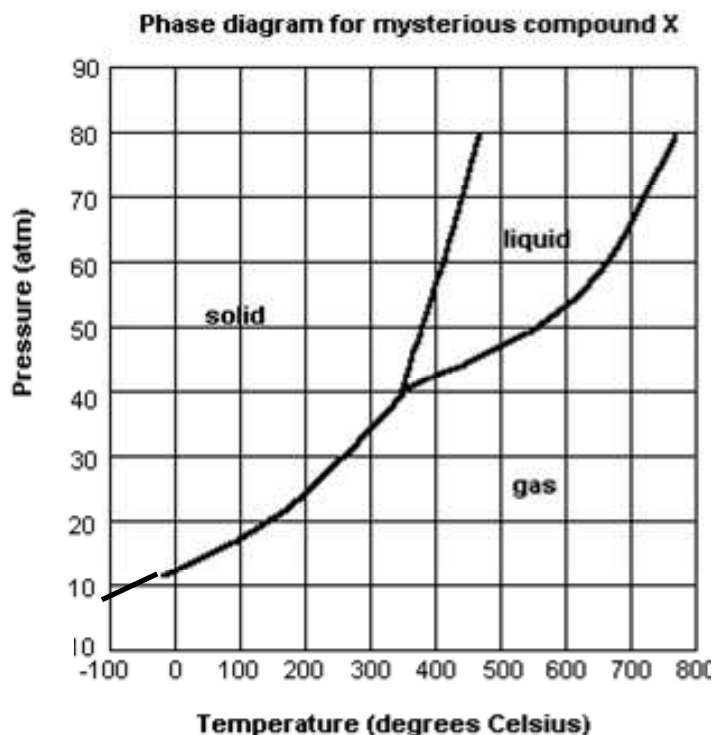
1. What is the normal freezing point of this substance?
2. What is the normal boiling point of this substance?
3. What is the normal melting point of this substance?
4. If I had a quantity of this substance at a pressure of 1.25 atm and a temperature of 300°C and lowered the pressure to 0.25 atm, what phase transition(s) would occur?
5. At what temperature do the gas and liquid phases become indistinguishable from each other?
6. If I had a quantity of this substance at a pressure of 0.75 atm and a temperature of -100°C , what phase change(s) would occur if I increased the temperature to 600°C ? At what temperature(s) would they occur?



Phase Diagram 3

For each of the questions on this worksheet, refer to the phase diagram for mysterious compound X:

1. What is the critical temperature of compound X?
2. If you were to have a bottle containing compound in your closet, what phase would it most likely be in?
3. At what temperature and pressure will all three phases coexist?
4. If I have a bottle of compound X at a pressure of 45 atm and temperature of 100°C , what will happen if I raise the temperature to 400°C ?
5. Why can't compound X be boiled at a temperature of 200°C ?
6. If I wanted to, could I drink compound X?



Name: _____ Period _____ Date _____

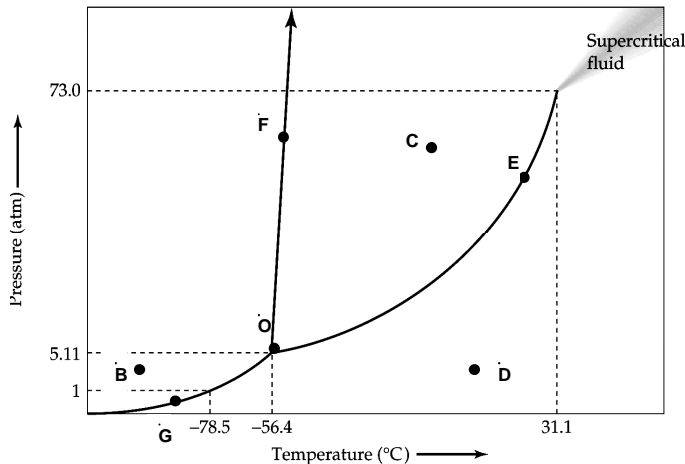
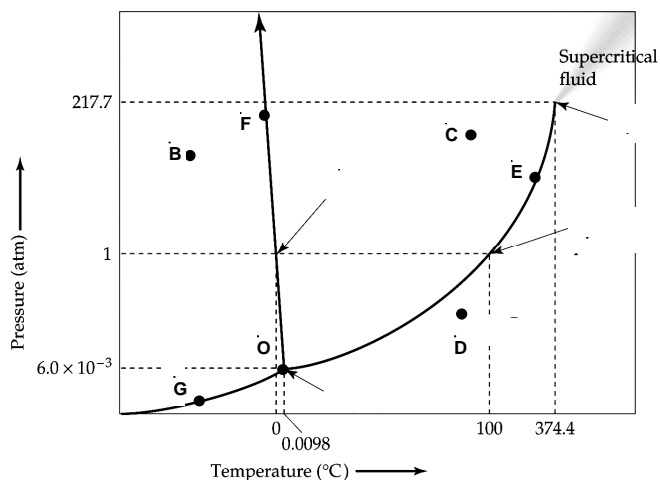
Chemistry I - Phase Diagrams Water & CO₂

Use the diagrams below to answer the following questions:

Phase Diagram for Water

(Not to Scale)

Phase Diagram for Carbon Dioxide



1. What does Point O in both diagrams above represents? And what can you tell me about the phase or phases of matter at those pressures and temperatures?
2. What is the significance of line OF?
3. What is the significance of line OG?
4. What is the significance of line OE?
5. Using the diagrams above indicate the proper temperature or pressure for the following points.

a. Normal melting point °C for water _____	g. Normal boiling point for °C for water _____
b. Triple point temp for water _____	h. triple point pressure for water _____
c. Triple point temp for CO ₂ _____	i. triple point pressure for CO ₂ _____
d. Critical pressure for water _____	j. critical temp for water _____
e. Critical pressure for CO ₂ _____	k. critical temp for CO ₂ _____
f. Normal sublimation temperature for CO ₂ _____	
6. Refer to the phase diagram for water. What changes in temperature, pressure, and physical state would be necessary to go from point D to point C?
7. Refer to the phase diagram for CO₂. What changes in temperature, pressure, and physical state would be necessary to go from point B to point D?