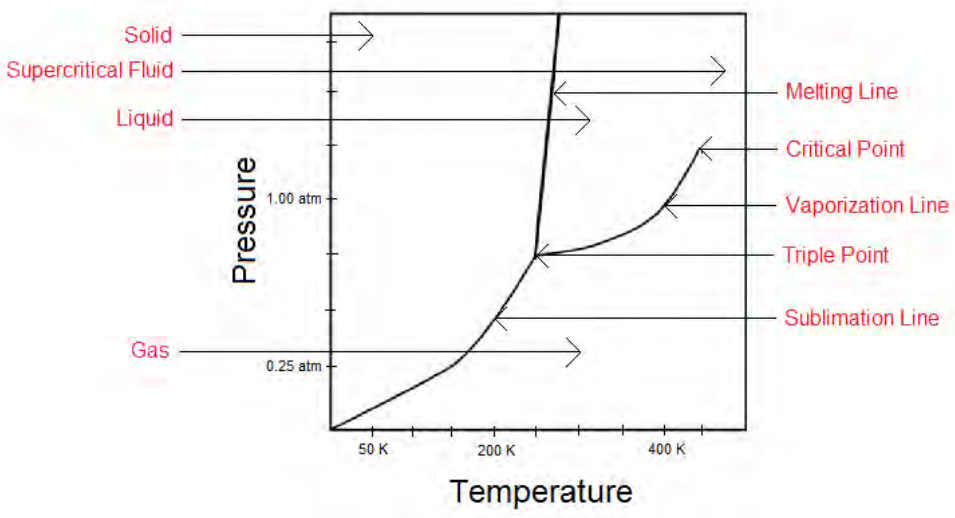
CH302 LaBrake and Vanden Bout

Phase Diagrams, Phase Transitions and Vapor Pressure

Labeling a Phase Diagram

Label the different elements of the phase diagram below.



Defining elements of a Phase Diagram

Define the elements you labeled above.

- Solid – In this region, the Solid phase is the most stable phase or the phase with the lowest Free Energy for the pressure and temperature conditions.
- Liquid – In this region, the Liquid phase is the most stable phase or the phase with the lowest Free Energy for the pressure and temperature conditions.
- Gas – In this region, the Gas phase is the most stable phase or the phase with the lowest Free Energy for the pressure and temperature conditions.
- Supercritical Fluid (SCF) – In this region, Supercritical Fluid is the most stable phase or the phase with the lowest Free Energy for the pressure and temperature conditions. SCF is a fluid (it takes the shape of its container) like a liquid and a gas, but it has a density that can vary between the two extremes of the liquid and the gas.
- Sublimation Line – These are the temperatures and pressures at which the gas and solid phases are in equilibrium. Thus, this line gives the vapor pressure of the solid.
- Melting Line – These are the temperatures and pressures at which the solid and gas phases are in equilibrium.

- Vaporization Line – These are the temperatures and pressures at which the liquid and gas phases are in equilibrium. Thus, this line gives the vapor pressure of the liquid.

- Triple Point – This is the temperature and pressure at which three phases are in equilibrium.

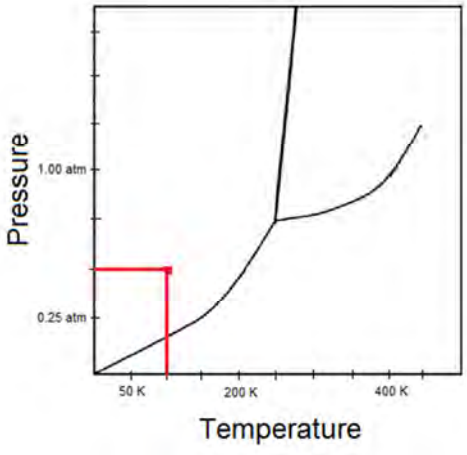
- Critical Point – At temperatures and pressures greater than this point, the definition of a liquid and a gas disappear and the substance exists as a super-critical fluid (SCF). SCF is a fluid (it takes the shape of its container) like a liquid and a gas, but it has a density that can vary between the two extremes of the liquid and the gas.

Further Questions

Using the phase diagram above, answer the following questions.

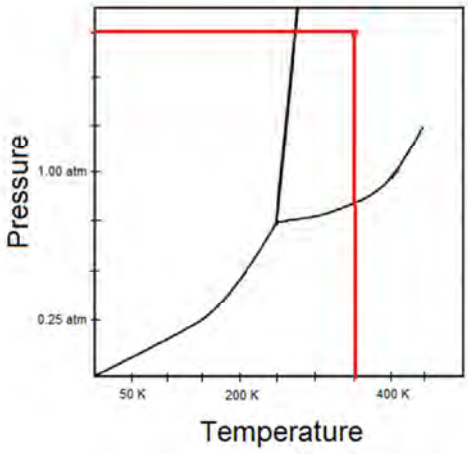
1. Which phase has the lowest free energy at 0.50 atm and 100 K?

   The Solid phase. We can see this on the phase diagram because the point with the P=0.50 atm and T=100 K falls in the Solid phase region.



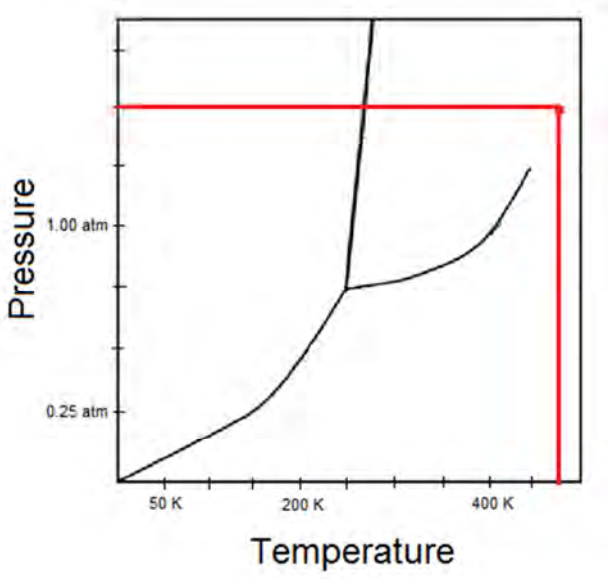
2. Which phase has the lowest free energy at 1.75 atm and 350 K?

   The Liquid phase. We can see this on the phase diagram because the point with the P=1.75 atm and T=350 K falls in the Solid phase region.



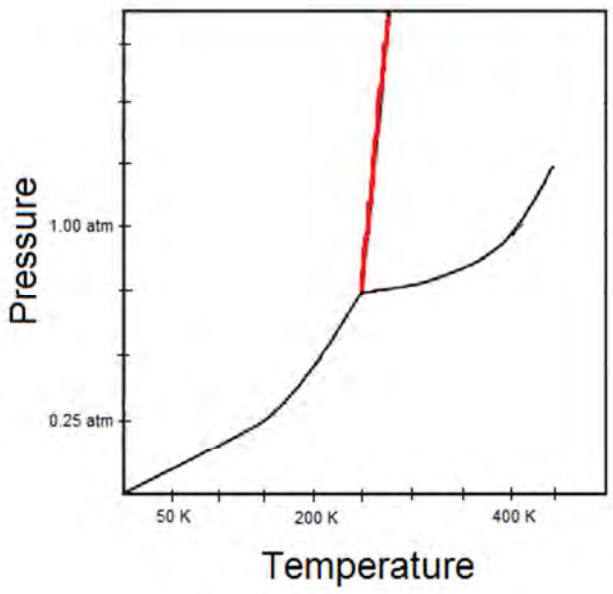
3. Which phase has the lowest free energy at 1.50 atm and 475 K?

   Supercritical Fluid. We can see this on the phase diagram because the point with the P=1.50 atm and T=475 K falls above and to the right of the Critical point or in the Supercritical Fluid region.



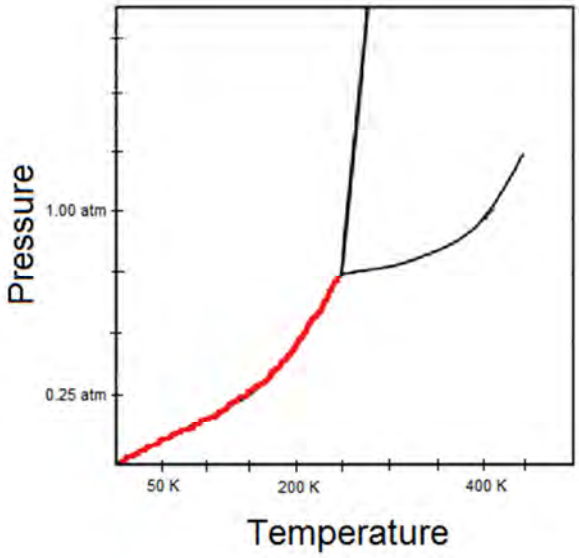
4. Give a set of pressure and temperature conditions where liquid and solid exist in equilibrium?

   Any pressure and temperature combination that make up the Melting Line will work. One example is P=1.75 atm and T=275 K.



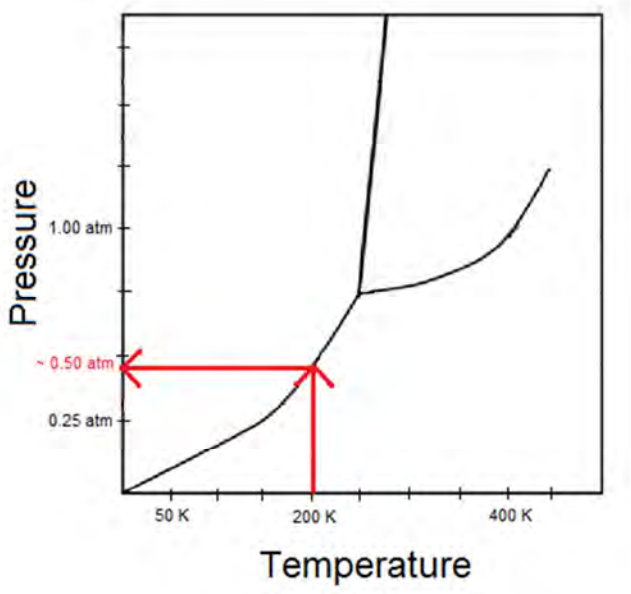
5. Give a set of pressure and temperature conditions where solid and gas exist in equilibrium?

   Any pressure and temperature combination that make up the Sublimation Line will work. One example is P=0.25 atm and T=150 K.



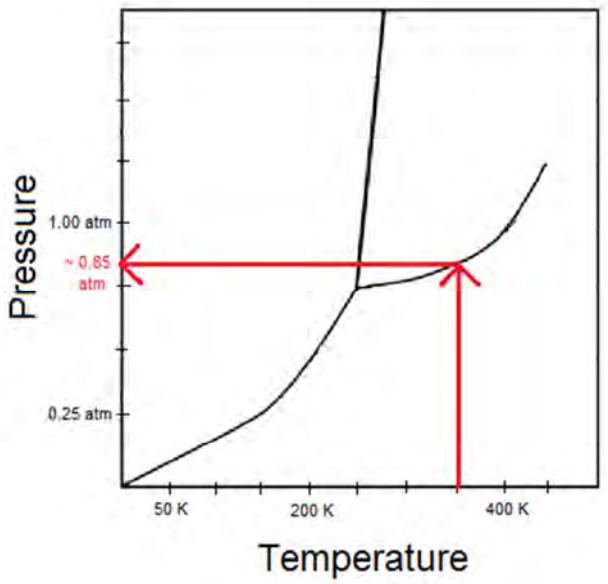
6. What is the vapor pressure of this substance at 200 K?

   To find the VP at 200K, you start at 200K on the temperature axis, go up till you reach the Sublimation line and then go over to the pressure axis to read that the VP of the substance at 200K is about 0.50 atm.



7. What is the vapor pressure of this substance at 350 K?

To find the VP at 350K, you start at 350K on the temperature axis, go up till you reach the Vaporization line and then go over to the pressure axis to read that the VP of the substance at 350 is about 0.85 atm.



8. What is the normal boiling point of this substance?

The normal boiling point is the temperature at which the substance boils at P = 1 atm. To find the Normal boiling, you start at 1 atm on the pressure axis, go across till you reach the Vaporization line and then go down to the temperature axis to read that the normal boiling point of the substance is about 400 K.