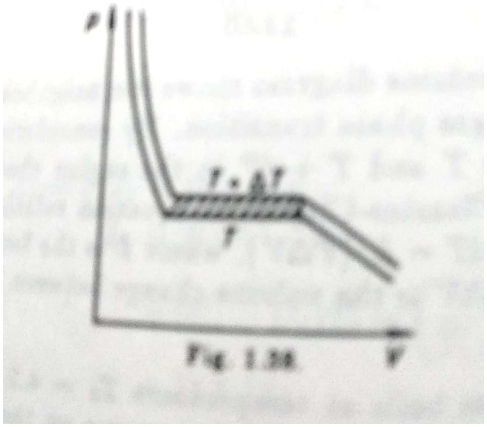
PH207: Year 2023
Problem Set-VI
Instructor: **Subhradip Ghosh**

1. (a) The pressure inside a container enclosing water maintained at -1^0 C is slowly reduced from an initial value of 10^5 mm Hg. Calculate the pressure at which the phase transition occurs. Assume the vapor phase behaves like ideal gas. Use the following data: at the triple point of water P=4.6 mm of Hg, specific volume of solid is 1.12 cm^3/g, specific volume of liquid is 1 cm^3/g, heat of melting is 80 cal/g and heat of vaporisation is 600 cal/g.

   (b) Calculate the change in specific latent heat with temperature dL/dT at a point (P, T) along a phase equilibrium line. Express your result in terms of L and specific heat C_P, coefficient of volume expansion β and specific volume v of each phase at the original temperature T and pressure P.

2. (a) The pressure-volume diagram shows two neighbouring isotherms in the region of a liquid-gas phase transition. By considering a Carnot cycle between temperatures T and $T + dT$ in the region shaded in the diagram, derive the Clasius Clapeyron equation relating vapour pressure and temperature, $dP/dT = L/(T\Delta V)$ where L is the latent heat of vaporisation per mole and ΔV is the volume change between gas and liquid per mole. (b) Liquid Helium boils at $T_0 = 4.2$ K when its vapour pressure $P_0 = 1$ atm. The vapour pressure is now reduced to a much smaller value P. Assuming that the latent heat L is approximately independent of temperature and that the Helium vapor density is much smaller than that of the liquid, calculate the approximate temperature T_m of the liquid in equilibrium with the vapor at pressure P.



3. Calculate the relation between the pressure of a gas above a non volatile solvent and the concentration of the dissolved gas in the solvent.

4. Calculate the vapor pressure of the mixture of two solvents as the function of the molar fraction of solvent 1. Assume that Raoult's law is valid for partial pressure.

5. A solvent with a dissolved material is separated from the pure solvent by a diaphragm which is permeable only for the solvent. Calculate the pressure difference between the systems as a function of the concentration X_m of the dissolved substance. Assume the solution to behave ideally.