PHASE EQUILIBRIUM

1) The boiling point of benzene is 80.1 °C at 1 atm. Estimate the vapor pressure of benzene at 25 °C.

2) Liquid mercury has a density of 13.690 g/cm^3, and solid mercury has a density of 14.193 g/cm^3, both being measured at the melting point, -38.87 °C, at 1 bar pressure. The heat of fusion is 9.75 J/g. Calculate the melting points of mercury under a pressure of (a) 10 bar and (b) 3540 bar. The observed melting point under 3540 bar is -19.9 °C.

3) For the decomposition reaction of $CaCO_3$ at equilibrium:

$CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$

How many degrees of freedom are there when all three phases are present at equilibrium?

4) For each of the following systems, find the number of degrees of freedom F:
(a) Aqueous solution of sucrose (b) An aqueous solution of sucrose and ribose (c) Solid sucrose and an aqueous solution of sucrose and ribose (d) Solid sucrose, solid ribose and an aqueous solution of sucrose and ribose (e) Liquid water and water vapor (f) An aqueous sucrose solution and water vapor (g) Solid sucrose, an aqueous sucrose solution and water vapor.

5) n-Propyl alcohol has the following vapor pressure at different temperatures:

T, °C	40	60	80	100
P, kPa	6.69	19.6	50.1	112.3

Plot these data so as to obtain nearly straight line, and calculate
a) The enthalpy of vaporization **b)** The boiling point at 1 atm.

6) The vapor pressures of benzene and toluene have the following values in the temperature range between their boiling points at 1 bar;

T, °C	**79.4**	**88**	**94**	**100**	**110**
P*(C_6H_6), bar	**1.00**	**1.285**	**1.526**	**1.801**	
P*(C_7H_8), bar		**0.508**	**0.616**	**0.742**	**1.00**

a) Calculate the composition of the vapor and liquid phases at each temperature and plot the boiling point diagram.
b) If a solution containing 0.5 mole fraction benzene and 0.5 mole fraction toluene is heated at what temperature will the first bubble of vapor appears and what will be its composition?

7) The following data were given for the vapor pressures of liquid and solid $SnBr_4$ at various temperatures:

	Solid		**Liquid**	
T, °C	9.8	21.0	30.7	41.4
P, torr	0.116	0.321	0.764	1.493

Calculate (a) the triple point,
(b) the molar enthalpy of sublimation,
(c) the molar enthalpy of fusion, of $SnBr_4$. Solve (b) and (c) both by an algebraic method and by a graphical method.

8) For uranium hexafluoride the vapor pressures for the solid and liquid are given by
In P_s = 29.411 -5893.5/T
In P_I = 22.254 -3479.9/T Calculate the temperature and pressure of the triple point.

9) The heats of vaporization and of fusion of water are 2490 J g-l and 33.5 J g-l at 0 °C. The vapor pressure of water at 0 °C is 611 Pa. Calculate the sublimation pressure of ice at -15 °C, assuming that the enthalpy changes are independent of temperature.

11) A compound containing only boron, nitrogen, and hydrogen was found to be 40.3% B, 52.2% N, and 7.5% H by mass. When 3.301 g of this compound is dissolved in 50.00 g of benzene, the solution produced freezes at 1.30 °C. The freezing point of pure benzene is 5.48 °C; K_b for benzene is 5.12 °C m^{-1}. What is the molecular weight of this compound?
a) Determine the molecular weight of the solid.
b) Determine the molecular formula of the solid
c) Determine the mole fraction of the solid in the solution
d) If the density of this solution is 0.8989 g/mL , calculate the molarity of the solution?

12) For the system of figure suppose that a liquid solution with B mole fraction 0.4 is placed in a closed container.
a) Find out P^*_A ve P^*_B
b) Give the composition of the first vapor formed and the total pressure at that point
c) Give the composition of the last drop of liquid vaporized and the pressure at that point
d) Give the composition of the each phase present when half of the moles of liquid have been vaporized