

## Course: CHM202

### Energetics and dynamics of chemical reactions

#### Assignment – VI

- Q.1** When a certain liquid freezes at  $-3.65\text{ }^{\circ}\text{C}$  its density changes from  $0.789\text{ gcm}^{-3}$  to  $0.801\text{ gcm}^{-3}$ . Its enthalpy of fusion is  $8.68\text{ kJ mol}^{-1}$ . Calculate the freezing point of the liquid at 100 MPa.
- Q.2** The partial molar volumes of two liquids A and B in a mixture in which the mole fraction of A is 0.3713 are  $188.2\text{ cm}^3\text{ mol}^{-1}$  and  $176.14\text{ cm}^3\text{ mol}^{-1}$ , respectively. The molar masses of A and B are  $241.1\text{ gmol}^{-1}$  and  $198.2\text{ gmol}^{-1}$ . What is the volume of a solution of mass 1.000 kg?
- Q.3** Consider a container of volume  $250\text{ cm}^3$  that is divided into two compartments of equal size. In the left compartment there is argon at 100 kPa and  $0\text{ }^{\circ}\text{C}$  while in the right compartment there is neon at the same temperature and pressure. Determine the entropy and Gibbs energy of mixing when the partition is removed. Assume that the gases are perfect.
- Q.4** At 373.6 K and 372.6 K, the vapor pressure of water is 1.018 and 0.982 atm, respectively. Evaluate the molar entropy of vaporization and  $\Delta V$ , the change of volume per mole when liquid water vaporises at 373 K. Assume the vapor behaves ideally.
- Q.5** Heavy water boils at  $101.42\text{ }^{\circ}\text{C}$  and its molal elevation constant ( $K_b$ ) is 10% higher than that of pure water. (a) How does its latent heat compare with that of pure water?, (b) What will be vapor pressure of pure  $D_2O$  if its  $L_V = 9960\text{ Cal. mol}^{-1}$ ?
- Q.6** An aqueous solution contains 5% by weight of urea and 10% by weight of glucose. What will be its freezing point?
- Q.7** Blood is said to be isotonic with 0.85% NaCl solution at  $40\text{ }^{\circ}\text{C}$ . Assuming complete dissociation of  $NaCl$ ; calculate total concentration of various solutes in blood. What is its approximate freezing point? [Given: Cryoscopic constant  $K_f = 1.86\text{ }^{\circ}\text{C g mol}^{-1}$ ].
- Q.8** A mixture which contains 0.550 gm of camphor and 0.045 gm of an organic solute (containing 93.46% C and 0.6.54% H) freezes at  $157\text{ }^{\circ}\text{C}$ . Find out the molecular formula of the organic compound. [Given freezing point and Cryoscopic constant for camphor are 178.4 and  $37.7\text{ }^{\circ}\text{C Kg mol}^{-1}$ , respectively].
- Q.9** If boiling point of an aqueous solution is  $100.1\text{ }^{\circ}\text{C}$ , what is its freezing point? Given  $l_V$  and  $l_f$  for water are  $80\text{ Cal.gm}^{-1}$  and  $540\text{ Cal.gm}^{-1}$ , respectively.
- Q.10** Chemical potential of  $O_2$  at 300 K is supposed to be  $10\text{ kCal. mol}^{-1}$  at 1 atm. A 1:4 (mole ratio) mixture of  $O_2$  and  $N_2$  is prepared at 1 atm and 300 K. The pressure of the mixture is

increased to 5 atm. Calculate the chemical potential of oxygen in the mixture and in the pure state at 5 atm and 300 K.

**Q.11** Calculate the change in free energy when 2 moles of  $H_2$ , 3 moles of  $O_2$  and 5 moles of  $N_2$  are mixed at 1 atm, 300 K. Also determine  $\Delta G$  when the pressure of the mixture is increased to 5 atm. Calculate  $\Delta S_{mix}$  and  $\Delta H_{mix}$ .