

## MID-SEM EXAMINATION 2018

(CH4103: Chemical Thermodynamics, Date: 18 Sept. 2018)

Total Marks: 20; Time: 11 am (Venue: G08). Duration: 1 hr

(Attempt ALL questions).

Q1. Using Carnot cycle show that efficiency of a reversible engine is always greater than an irreversible one, working under same temperature reservoirs. Compare and discuss the efficiencies of a refrigerator and heat pump. (2, 1)

Q2. The experimental value of the partial molar volume ( $^PV_i$ ) of  $K_2SO_4$  (aq) at 298 K is given by  $^PV_i$  ( $cm^3mol^{-1}$ ) =  $32.280 + 18.216(b)^{1/2}$  ( $b$  = molality of  $K_2SO_4$ ). Use the Gibbs-Duhem equation to derive the partial molar volume of water in solution. Molar volume of pure water at 298 K is given as  $18.079 cm^3mol^{-1}$ . (3)

Q3. What is Clausius inequality? Briefly explain its significance. (2)

Q4. Show that:

$$\begin{aligned} \text{i) } A &= U + T(\delta A/\delta T)_v & \text{ii) } \Delta_r A &= \Delta_r U + T(\delta(\Delta_r A)/\delta T)_v & \text{iii) } (\delta(\Delta_r A/T)/\delta T)_v &= -\Delta_r U/T^2 \\ \text{iv) } (\delta(\Delta_r A/T)/\delta(1/T))_v &= \Delta_r U \end{aligned} \quad (4)$$

Q5. The fugacity of a certain gas is given by the expression

$$F = p + \alpha p^2 \quad \text{in which } \alpha \text{ is a function of temperature.}$$

(a) Show that the gas must obey the following equation of state

$$PV_m/RT = 1 + \alpha p/(1 + \alpha p)$$

(b) Also show that  $(\delta H_m/\delta p)T = -(RT^2/(1 + \alpha p)^2)(d\alpha/dT)$  (4)

Q6. Show that the free energy of mixing of three gases has a minimum value with respect to each gas only when  $x_1 = x_2 = x_3 = 1/3$  (2)

Q7. Briefly explain Raoult's and Henry's Law (2)

Q7  
03/11/18

(Please attach the question paper with the answer script. Use the remaining space for rough)