1. (10%) A scientist proposed the following equation of state:

$$p=\frac{RT}{V_m}-\frac{B}{V_m^2}+\frac{C}{V_m^3}$$

Find the critical constants (V_c, T_c, and p_c) of the gas in terms of B and C, and an expression for the critical compression factor (Z_c).

2. (10%) A 1.388 mol sample of ice at 273.15 K is added to 8.326 moles of water at 360 K at constant pressure (1 bar) in an adiabatic container. Caculate ΔS for this process. ΔH_f^0 of water is 6.008 kJ/mol. C_p of water is 75.4 J/K/mol and is independent of temperature.

3. (10%) When 2.25 mg of anthracene, $C_{14}H_{10}$(s), was burned in a bomb calorimeter at 25°C, the temperature rose by 1.35°C. Calculate the calorimeter constant. $\Delta H_c^0(C_{14}H_{10}, s)$ is -7061 kJ/mol.

4. (10%) The excess Gibbs energy of solutions of methylcyclohexane (MCH) and tetrahydrofuran (THF) at 303.15 K was found to fit the expression

$$G^E = RTx(1-x)\left[0.4857-0.1077(2x-1)+0.0191(2x-1)^2\right]$$

where x is the mole fraction of the methylcyclohexane. Calculate the Gibbs energy of mixing when a mixture of 1.00 mol of MCH and 3.00 mol of THF is prepared.

5. (10%) Two equimolar solutions A and B with equal volume are mixed together and the reaction A + B → C takes place. After 1 hr, A is 75% reacted. Calculate how much of A will not react after 2 hrs if the reaction is first order in A and zero order in B.

6. (10%) 50.0 L of dry air was slowly bubbled through a thermally insulated beaker containing 250 g of water initially at 25°C. Calculate the final temperature. The vapor pressure of water is approximately constant at 3.17 kPa, the heat of vaporization is 44.0 kJ/mol, and the heat capacity is 75.4 J/K/mol. Assume that the air is not heated or cooled and that water vapor is a perfect gas.

7. (10%) The partial molar volume V_2 (cm^3/mol) of K_2SO_4 in water solutions at 25°C is given by
$V_2 = 32.280 + 18.216m^{1/2} + 0.0222m$
where m is molality. Derive an expression for V_1, the partial molar volume of H_2O, as a function of m.

8. (10%) How much work is required to break up a mol of water in spherical form into small droplets of radius 1 cm? The surface tension of water is 72.75×10^{-3} N/m.

9. (10%) The following is an autocatalytic reaction,

$$A \xrightarrow{B} B + \cdots$$

where $-d[A]/dt = k[A][B]$. Assume that the initial concentrations $[A]_0$ and $[B]_0$ are not zero. Express [B] as a function of $[A]_0$, $[B]_0$, k, and t.

10. (10%) The ionization constant of lactic acid at 25°C is 1.4×10^{-4}. A buffer solution is prepared by adding 1.00 mol of lactic acid and 0.80 mol of sodium lactate to 1 kg of water. Assume that water is at unit activity. The activity coefficient of lactic acid is 1.00 and that of each univalent ion is 0.65. Find the pH (in the activity sense) of this solution at 25°C.

試題隨卷繳回