淡江大學九十學年度碩士班招生考試試題

系別：化學工程學系　　科目：物 理 化 學

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Problem One (25 points)

(1) For an ideal gas undergoing an adiabatic compression, show that temperature and volume are related by the following equation:

$$V_f T_f^c = V_i T_i^c$$

where V_i and T_i are initial volume and temperature. V_f and T_f are final volume and temperatures. $c = C_v/R$ and C_v is the molar heat capacity.

(2) A sample of argon at 1.0 atm pressure and 25 °C expands reversibly and adiabatically from 0.5 liter to 1.0 liter. Calculate its final temperature, the work done during expansion and the changes in internal energy. The molar heat capacity of argon at constant volume is 12.48 J mol^{-1} K^{-1}.

Problem Two (25 points)

A laboratory needs an antifreeze solution consisting of a 30 mole percent solution of methanol in water. What volume of pure methanol and pure water at 25 °C must be mixed to form a 2,000 ml antifreeze, also at 25 °C. Partial molar volumes of methanol and water in a 30 mole percent methanol solution at 25 °C are:

Methanol : $\overline{V}_1 = 38.632\ cm^3\ mol^{-1}$

Water: $\overline{V}_2 = 17.765\ cm^3\ mol^{-1}$

For the pure species at 25 °C:

Methanol : $V_1^* = 40.727\ cm^3\ mol^{-1}$

Water: $V_2^* = 18.068\ cm^3\ mol^{-1}$

Hint: total volume $V = x_1\overline{V}_1 + x_2\overline{V}_2$, x_i is the mole fraction of component *i*.

Problem Three (25 points)

The standard Gibbs energy of reaction for the decomposition of $H_2O(g) \rightarrow H_2(g) + \frac{1}{2}O_2(g)$ is 118.08 $kJmol^{-1}$ at 2300 K. What is the equilibrium constant and the degree of dissociation of H_2O at 2300 K and 1 bar.

Hint: (1) $-\Delta G^{\circ} = RT \ln K$ $K = \prod_j a_j^{\nu_j}$; (2) at a low pressure, the fugacity can be replaced by partial pressure.

Problem Four (25 points)

Consider the following mechanism for the thermal decomposition of R_2

(1) $R_2 \rightarrow 2R$

(2) $R + R_2 \rightarrow P_B + R'$

(3) $R' \rightarrow P_A + R$

(4) $2R \rightarrow P_A + P_B$

where R_2, P_A, and P_B are stable hydrocarbons and R and R' are radicals. Find the dependence of the rate of decomposition of R_2 on the concentration of R_2.

Hint: $\frac{d[\text{intermediate}]}{dt} \approx 0$