# 大同大學 100 學年度研究所碩士班入學考試試題

考試科目：物理化學　　所別：化學工程研究所　　第2頁

註：本次考試 不可以參考自己的書籍及筆記； 不可以使用字典； 可以使用計算器。

1. (10%) Explain
   (a) triple point,
   (b) azeotropic point,
   (c) eutectic point
   and plot phase diagrams for each phase behavior.

2. (10%) $H_2O$ (*l*, 100 °C, 1 atm) ⇔ $H_2O$ (*g*, 100 °C, 1 atm). The latent heat of vaporization of water is 40.6 kJ/mol. Calculate W, ΔH, ΔU, ΔG and ΔS for the vaporization of one mole of $H_2O$.

3. (10%) The following thermodynamic data apply to the complete oxidation of one mole of butane at 25 °C.

   $C_4H_{10(g)} + 13/2\ O_{2(g)} \rightarrow 4CO_{2(g)} + 5\ H_2O_{(l)}$

   $\Delta H^0 = -2877$ kJ/mole

   $\Delta S^0 = -432.7$ J/mole K

   Suppose that a completely efficient fuel cell could be set up utilizing this reaction. Calculate
   (a) the maximum electrical work, and
   (b) the maximum total work that could be obtained at 25 °C.

4. (20%) Two mole of an ideal monatomic gas ($\overline{C}v = \frac{3}{2}R$), initially at 0 °C and 1 bar, is put through each of the reversible steps below. Calculate W, q, ΔU, ΔH and ΔS for each case. (Each step start from 0 °C and 1 bar)
   (a) Cooling at constant volume to – 100 °C.
   (b) Isothermal compression to 100 bar.
   (c) Constant pressure heating to 100 °C.
   (d) Adiabatic expansion to 0.1 bar.

5. (20%) (a) Write both electrode reactions and the overall reaction for the cell

   $Tl \mid TlCl_{(s)} \mid CdCl_2\ (0.01m) \mid Cd$

   (b) Calculate E and $E^0$ for this cell at 25 °C from the following information:

   $Tl^+ + e^- \rightarrow Tl$ $\quad E^0 = -0.34$ V

   $Cd^{2+} + 2e^- \rightarrow Cd$ $\quad E^0 = -0.40$ V

   The solubility product for TlCl is $1.6 \times 10^{-3}$ $mol^2dm^{-6}$ at 25 °C.

6. (15%) A substance decomposes at 500K with a rate constant of $3.72 \times 10^{-5}$ $s^{-1}$.
   (a) Calculate the half-life of the reaction.
   (b) What fraction will remain undecomposed if the substance is heated for 2 h at 500 K?

7. (15%) Nitrogen pentoxide reacts with nitric oxide in the gas phase according to the equation

   $N_2O_5 + NO \Leftrightarrow 3NO_2$

   The following mechanism has been proposed.

   $N_2O_5 \rightarrow NO_2 + NO_3$

   $NO_2 + NO_3 \rightarrow N_2O_5$

   $NO + NO_3 \rightarrow 2NO_2$

   Assume the steady state approximation can be applied for the intermediate; derive an equation for the consumption of $N_2O_5$.