國立臺北科技大學 101 學年度碩士班招生考試

系所組別：3520 化學工程研究所乙組

第一節　物理化學　試題
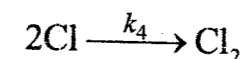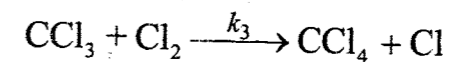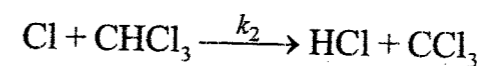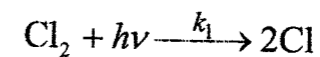
注意事項：

1. 本試題共 6 題，配分共 100 分。
2. 請標明大題、子題編號作答，不必抄題。
3. 全部答案均須在答案卷之答案欄內作答，否則不予計分。

1. (a) Liquid water at 100°C is in equilibrium with water vapor at 1 atm pressure. If the enthalpy change associated with the vaporization of liquid water at 100°C is 40.60 kJ mol^{-1}, what are ΔS and ΔG? (b) Suppose that water at 100°C is contact with water vapor at 0.920 atm. Calculate ΔS and ΔG for the vaporization process. (15%)

2. Toluene $C_6H_5CH_3$ and water are immiscible. If boiled together under an atmospheric pressure of 755 Torr at 83°C, what is the mass ratio of tol-uene to water in the distillate? The vapor pressure of pure toluene and water at 83°C are 322 Torr and 400.6 Torr, respectively. (H = 1.0079, C = 12.0107, O = 15.9994). (10%)

3. At 18°C the electrolytic conductivity of a saturated solution of CaF_2 is 3.86×10^{-5} Ω^{-1} cm^{-1}, and that of pure water is 1.5×10^{-6} Ω^{-1} cm^{-1}. The molar ionic conductivity of $\frac{1}{2}Ca^{2+}$ and F^- are 51.1 Ω^{-1} cm^2 mol^{-1} and 47.0 Ω^{-1} cm^2 mol^{-1}, respectively. Calculate the solubility (g m^{-3}) of CaF_2 in pure water at 18°C and the solubility product. (Ca = 40.078, F = 18.998). (15%)

4. Suppose that a gas phase reaction: $2 A(g) \rightarrow B(g) + 3 C(g)$ follows second-order kinetics and goes to completion. If the reaction is allowed to proceed in a constant volume vessel at an initial pressure of 2 bar (only A is initially present), what will be the partial pressures of A, B, and C and the total pressure at $t = 3t_{1/2}$ and infinity ? (20%)

5. The voltage required to electrolyze certain solutions changes as the electrolysis proceeds because the concentrations in the solution are changing. In an experiment, 1.2 dm^3 of a 0.0555 M solution of copper(II) bromide was electrolyzed until 2.345 g Cu was deposited. Calculate the theoretical minimum voltage required to sustain the electrolysis reaction at the beginning and at the end of the experiment. (Cu = 63.546) (20%)

$$Cu^{2+} + 2\,e^- \rightarrow Cu, \quad E° = 0.3419\ V$$

$$2\,Br^- \rightarrow Br_2 + 2\,e^-, \quad E° = -1.0873\ V$$
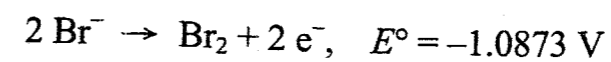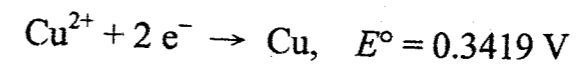
6. The photochemical reaction between chlorine and chloroform in the gas phase follows the stoichiometric equation $CHCl_3 + Cl_2 = CCl_4 + HCl$ is believed to occur by the mechanism

$$Cl_2 + h\nu \xrightarrow{k_1} 2Cl$$

$$Cl + CHCl_3 \xrightarrow{k_2} HCl + CCl_3$$

$$CCl_3 + Cl_2 \xrightarrow{k_3} CCl_4 + Cl$$

$$2Cl \xrightarrow{k_4} Cl_2$$

Assume the rate of formation of Cl atoms in the initiation reaction to be $2I_a$, where I_a is the intensity of light absorbed, and obtain an expression for the overall rate in terms of I_a and $[CHCl_3]$. (20%)