國立臺北科技大學 103 學年度碩士班招生考試
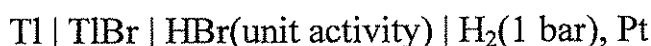
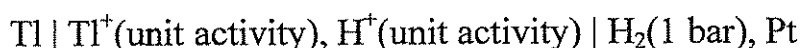## 系所組別：3520 化學工程與生物科技系化學工程碩士班乙組

第二節　物理化學　試題

注意事項：

1.本試題共 7 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. The equilibrium constant K_c for the hydrolysis of adenosine triphosphate (ATP) to adenosine diphosphate (ADP) and phosphate is 1.66×10^5 mol dm^{-3} at 37°C, and $\Delta H°$ is -20.1 kJ mol^{-1}. Calculate $\Delta S°$ for the hydrolysis at 37°C. On the assumption that $\Delta H°$ and $\Delta S°$ are temperature independent, calculate K_c at 20°C.　(15%)

2. (a) Calculate the emf at 298.15 K for the cell:　(7%)

    Tl | TlBr | HBr(unit activity) | H$_2$(1 bar), Pt

    (b) Calculate ΔH for the cell:　(7%)

    Tl | Tl$^+$(unit activity), H$^+$(unit activity) | H$_2$(1 bar), Pt

    For the half-cell: Tl$^+$ + e$^-$ → Tl, $E°$ = -0.34 V, $\partial E/\partial T$ = -0.003 V K^{-1} and K_{sp}(TlBr) = 10^{-4} mol^2 dm^{-6}.

3. The entropy of argon is given to a good approximation by the expression

$$S_m / \text{J K}^{-1}\,\text{mol}^{-1} = 36.36 + 20.79 \ln(T / \text{K})$$

Calculate the change in Gibbs energy of 3 moles of argon if it is heated at constant pressure from 25°C to 60°C.　(15%)

4. The following are the volumes of ammonia, reduced to STP, adsorbed by 1 g of charcoal at 0°C:

Pressure / kPa	6.8	13.5	26.7	53.1	79.4
Volume adsorbed / cm^3	74	111	147	177	189

Make a plot to see if the data are consistent with the Langmuir isotherm. If so, evaluate the equilibrium constants K and V_0, the volume adsorbed when the surface is saturated. (15%)

5. Someone proposed the following mechanism for a unimolecular gas reaction:

$$A + A \underset{k_{-1}}{\overset{k_1}{\rightleftharpoons}} A* + A$$

$$A* \xrightarrow{k_2} Y + Z$$
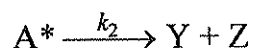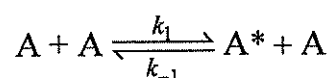
The species A* is an energized molecule that is present in low concentrations. Apply the steady-state treatment to A* and obtain an expression for the rate in terms of [A], k_1, k_{-1} and k_2. Show that the mechanism predicts first-order kinetics at higher A concentrations and second-order kinetics at lower ones. (15%)

6. The density of water at 25°C is 0.997 g cm^{-3} and the surface tension is 7.12 × 10^{-2} N m^{-1}. Calculate the ratio between the vapor pressure of a mist droplet having a mass of 10^{-12} g and the vapor pressure of water at a plane surface. (13%)

7. The diffusion coefficient for horse hemoglobin in water is 6.3 × 10^{-11} m^2 s^{-1} at 20°C. The viscosity of water at 20°C is 1.002 × 10^{-3} kg m^{-1} s^{-1} and the specific volume of protein is 0.76 cm^3 g^{-1}. Assume the hemoglobin molecule to be spherical and to obey Stokes's law, and estimate its radius and the molecular weight. (13%)