國立成功大學 104 學年度碩士班招生考試試題

系所組別：化學工程學系乙組

考試科目：無機化學及分析化學

考試日期：0211，節次：2

※ 考生請注意：本試題可使用計算機。 請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

Inorganic Chemistry (50 points)

(1) Choose the stronger acid or base in the following pairs and explain your choice:

a. Pyridine or 2-methylpyridine in reaction with trimethylboron (5 points)

b. Triphenylboron or trimethylboron in reaction with ammonia (5 points)

(2) On the basis of VSEPR, predict the structures of $XeOF_2$, $XeOF_4$, XeO_2F_2, and XeO_3F_2. (8 points)

(3) Explain the order of the magnitudes of the following Δ_0 values for Cr(III) complexes in terms of the σ and π donor and acceptor properties of the ligands. (12 points)

Ligand	F^-	Cl^-	H_2O	NH_3	ethylenediamine	CN^-
Δ_0 (cm^{-1})	15,200	13,200	17,400	21,600	21,900	33,500

(4) $Na[(\eta^5\text{-}C_5H_5)Fe(CO)_2]$ reacts with $ClCH_2CH_2SCH_3$ to give **A**, a monomeric and diamagnetic substance of stoichiometry $C_{10}H_{12}FeO_2S$ having two strong IR bands at 1980 and 1940 cm^{-1}. Heating of **A** gives **B**, a monomeric, diamagnetic substance having strong IR bands at 1920 and 1630 cm^{-1}. Identify **A** and **B**. (10 points)

(5) Reduce the following representation for CO_3^{2-} (D_{3h}) to irreducible representations: (10 points)

D_{3h}	E	$2C_3$	$3C_2$	σ_h	$2S_3$	$3\sigma_v$
Γ	12	0	–2	4	–2	2

Character Table of D_{3h}:

D_{3h}	E	$2C_3$	$3C_2$	σ_h	$2S_3$	$3\sigma_v$		
A_1'	1	1	1	1	1	1		x^2+y^2, z^2
A_2'	1	1	–1	1	1	–1	R_z	
E'	2	–1	0	2	–1	0	(x, y)	(x^2-y^2, xy)
A_1''	1	1	1	–1	–1	–1		
A_2''	1	1	–1	–1	–1	1	z	
E''	2	–1	0	–2	1	0	(R_x, R_y)	(xy, yz)

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Analytical Chemistry (50 points)

(6) Continued from (5), determined the IR and the Raman active modes (10 points)

(7) The Ti content (wt%) of five different ore samples (each with a different Ti content) was measured by each of two methods. Do the two analytical techniques give results that are significantly different at 95% confidence level? (10 points)

Sample	Method 1	Method2
A	0.0134	0.0135
B	0.0144	0.0156
C	0.0126	0.0137
D	0.0125	0.0137
E	0.0137	0.0136

(8) Calculate the quotient $[H_2PO_4^-]/[HPO_4^{2-}]$ in a phosphate solution at pH values of 6 and 12? (10 points) $pK_1 = 2.15$, $pK_2 = 7.20$, $pK_3 = 12.35$

(9) From the following reduction potentials,

$I_2(s) + 2e^- \rightleftharpoons 2I^-$ $\quad E^0 = 0.535\ V$

$I_2(aq) + 2e^- \rightleftharpoons 2I^-$ $\quad E^0 = 0.620\ V$

$I_3^- + 2e^- \rightleftharpoons 3I^-$ $\quad E^0 = 0.535\ V$

(a) Calculate the equilibrium constant for $I_2(aq) + I^- \rightleftharpoons I_3^-$ (3 points)

(b) Calculate the equilibrium constant for $I_2(s) + I^- \rightleftharpoons I_3^-$ (3 points)

(c) Calculate the solubility (g/L) of $I_2(s)$ is water (4 points)

(10) Two compounds with partition coefficients of 15 and 18 are to be separated on a column with $V_m / V_s = 3.0$ and $t_m = 1.0$ min. Calculate the number of theoretical plates needed to produce a resolution of 1.5. (10 points)