國立成功大學

112學年度碩士班招生考試試題

編　號：78

系　所：化學工程學系

科　目：無機化學及分析化學

日　期：0206

節　次：第 2 節

備　註：可使用計算機

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※ 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。

Part I Inorganic Chemistry (50%)

(1) (a) For each of the following bonds, indicate which atom is more negative. (5%)

(b) Rank the series in order of polarity. (5%)

(i) C-N　(ii) N-O　(iii) C-I　(iv) O-Cl　(v) P-Br

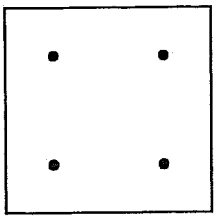
Additional information: Electronegativity (Pauling Unit): C (2.544), N (3.066), O (3.610), I (2.359), Cl (2.869), P (2.253), Br (2.685).

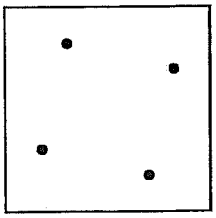
(2) The Cl・・・Cl distance in CCl_4 is 289 pm, and the C-Cl bond distance is 171.1 pm. Using the LCP model, calculate the C-Cl distance in Cl_2CO, which has a Cl-C-Cl angle of 111.8°. (10%)

(3) (a) Show that a cube has the same symmetry elements as an octahedron. (10%)

(b) Suppose a cube has four dots arranged in a square on each face as shown in the left figure. What is the point group? (5%)

(c) Suppose that this set of dots is rotated as a set 10° clockwise on each face as shown in the right figure. Now what is the point group? (5%)





(4) Using the following D_{2d} character table,

(a) Verify that the E irreducible representation is orthogonal to each of the other irreducible representations. (5%)

(b) For each of the irreducible representations, verify that the sum of the squares of the characters equals the order of the group. (5%)

D_{2d}	E	$2S_4$	C_2	$2C_2'$	$2\sigma_d$
Γ_1	6	0	2	2	2
Γ_2	6	4	6	2	0

Part II Analytical Chemistry (50%)

(5) The solubility products for a series of iodides are

CuI　$K_{sp} = 1 \times 10^{-12}$

AgI　$K_{sp} = 8.3 \times 10^{-17}$

PbI_2　$K_{sp} = 7.1 \times 10^{-9}$

BiI_3　$K_{sp} = 8.1 \times 10^{-19}$

List these four compounds in order of decreasing molar solubility in

(a) water (5%)

(b) 0.20 M NaI (5%)

(6) A series of sulfate samples is to be analyzed by precipitation as $BaSO_4$. If it is known that the sulfate content in these samples ranges between 20% and 55%, what minimum sample mass should be taken to ensure that a precipitate mass no smaller than 0.200 g is produced? What is the maximum precipitate mass to be expected if this quantity of sample is taken? (MWs of $BaSO_4$ and SO_4^{2-} are 233.39 and 96.064 g/mol, respectively.) (10%)

(7) A 0.4126-g sample of primary-standard Na_2CO_3 was treated with 40.00 mL of dilute perchloric acid. The solution was boiled to remove CO_2, following which the excess $HClO_4$ was back-titrated with 9.20 mL of dilute NaOH. In a separate experiment, it was established that 26.93 mL of the $HClO_4$ neutralized the NaOH in a 25.00-mL portion. Calculate the molarities of the $HClO_4$ and NaOH. (MWs of Na_2CO_3 is 105.88 g/mol.) (10%)

(8) Given the formation constants

$$Fe^{3+} + Y^{4-} \rightleftharpoons FeY^- \quad K_f = 1.3 \times 10^{25}$$

$$Fe^{2+} + Y^{4-} \rightleftharpoons FeY^{2-} \quad K_f = 2.1 \times 10^{14}$$

calculate E^0 for the process (10%)

$$FeY^- + e^- \rightleftharpoons FeY^{2-}$$

(9) The equilibrium constant for the conjugate acid-base pair

$$HIn + H_2O \rightleftharpoons H_3O^+ + In^-$$

is 8.00×10^{-5}. From the additional information in the following table,

(a) calculate the absorbance at 430 nm and 600 nm for the following indicator concentrations: 3.00×10^{-4} M, 1.00×10^{-4} M, and 5.00×10^{-5} M. (6%)

(b) plot absorbance as a function of indicator concentration. (4%)

Species	Absorption Maximum, nm	Molar Absorptivity	
		430 nm	600 nm
HIn	430	8.04×10^3	1.23×10^3
In^-	600	0.775×10^3	6.96×10^3