

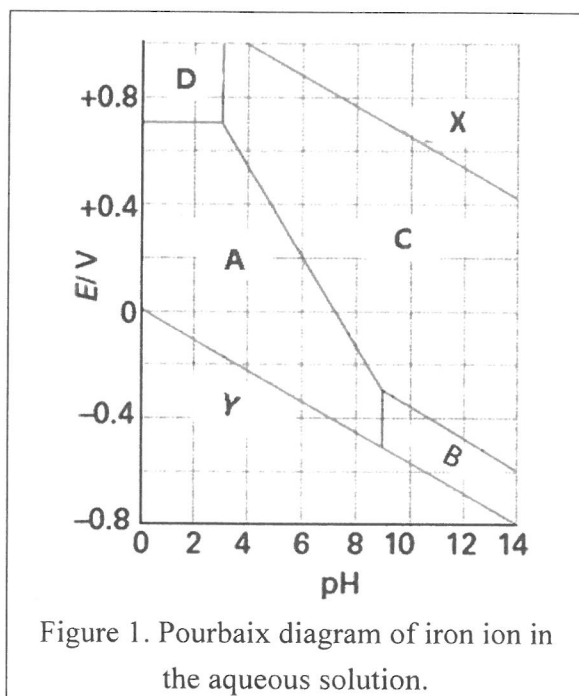
國立臺灣師範大學 114 學年度碩士班招生考試試題

科目：無機化學

適用系所：化學系

注意：1.本試題共 3 頁，請依序在答案卷上作答，並標明題號，不必抄題。2.答案必須寫在指定作答區內，否則依規定扣分。

Q1. Fe(II) ion is stable in the weak-acidic aqueous solution at room temperature without applying any electrochemical potential as shown in Figure 1.



- 1-1 Please provide the balance chemical equations between each pair of specie transformation ($A \rightarrow B$, $A \rightarrow C$, $A \rightarrow D$, $D \rightarrow C$, $B \rightarrow C$). You can ignore the concern of solubility and assume each species is soluble in water. (points * 5 = 15 points)
- 1-2 For $A \rightarrow B$ transformation at the equilibrium condition, can it be measured by cyclic voltammogram (CV) directly? Please explain. (8 points)
- 1-3 Please provide the redox equations for X and Y. (3 points * 2 = 6 points)
- 1-4 For oxidizing a metal ion M^{n+} to $M^{(n+1)+}$ in the aqueous solution, it requires to apply +0.9V vs. standard hydrogen electrode at pH = 7 condition. Can this oxidation be able to measure by CV? Please explain. (6 points)

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Q2. For a given redox reaction, it can be expressed as the followed: (15 points)



where the reaction of quotient can be expressed as $Q = \frac{[\text{RedH}_m]}{[\text{Ox}][\text{H}^+]^m}$ given $RT \cdot \ln K$

$= vFE^\ominus$ (v denotes the number of electron change for a given redox reaction.)

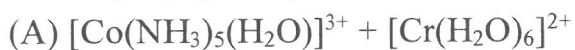
Please derive the explicit terms of Nernst equation for the influence of pH.

Q3. Please sketch the d orbitals splitting diagram for $[\text{Co}(\text{H}_2\text{O})_6]^{2+}$, and indicate each orbital and the symmetry they belong to. Please fill its d electrons into the diagram. (10 points)

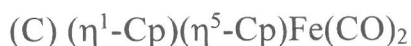
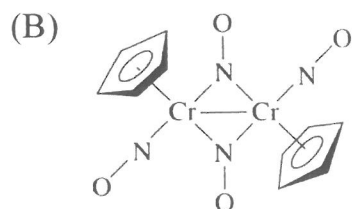
Q4. (A) How many microstates for a $3d^1 4s^1$ configuration? (2 points)

(B) Determine all free-ion terms and the ground-state term for a $3d^1 4s^1$ configuration. (8 points)

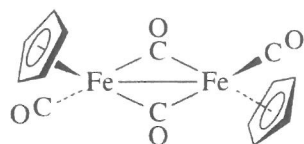
Q5. What kind of electron transfer reaction will occur in the following pairs of reactants, and why? (8 points)



Q6. Count the electrons surrounding the metal center of complexes. (Write down how you count the electrons.) (12 points)



(D)



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Q7. The character table for D_{2d} is listed below. (10 points)

D_{2d}	E	$2S_4$	C_2	$2C_2$	$2\sigma_d$
Γ_a	8	0	0	2	2
Γ_b	4	0	4	0	0

D_{2d}	E	$2S_4$	C_2	$2C_2'$	$2\sigma_d$		
A_1	1	1	1	1	1		$x^2 + y^2, z^2$
A_2	1	1	1	-1	-1	R_z	
B_1	1	-1	1	1	-1		$x^2 - y^2$
B_2	1	-1	1	-1	1	z	xy
E	2	0	-2	0	0	$(x, y), (R_x, R_y)$	(xz, yz)

(A) What is the order of D_{2d} ?

(B) Reduce functions of Γ_a and Γ_b .