

科目：451 綜合化學

系組：應化系

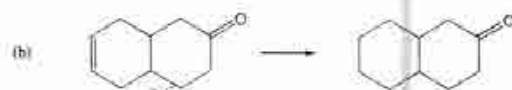
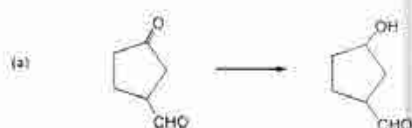
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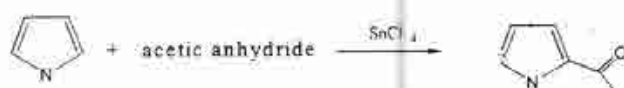
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1. Please complete the following syntheses efficiently in good yields.

You may use any necessary reagents. (12 分; 每小題各 6 分)



2. Pyrrole undergoes electrophilic aromatic substitution more readily than benzene, and mild reagents and conditions are sufficient. The reaction normally occurs at the 2-position rather than 3-position as shown below.



(1) Please propose a mechanism for that and be careful to draw the resonance structures of the intermediates (8 分)

(2) Explain why pyrrole reacts more readily than benzene and why the reaction occurs primarily at 2-position rather than 3-position. (5 分)

3. What is the point group of each compound below: (每小題

各 1 分，共 5 分)

(a) CCl_4

(b) CHCl_3

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(c) benzene

(d) NH_3 (e) BH_3 4. Briefly explain why CO and CN^- are very strong-field ligands. (5 分)

5. In the character table below, P, Q, R, S, and T = ? (每個答案各 1 分，共 5 分)

O	E	$6C_4$	$3C_2(=C_4^2)$	$8C_3$	$6C_2$
A_1	1	1	1	1	1
A_2	1	-1	1	1	-1
E	2	0	2	-1	0
T_1	3	1	-1	0	-1
P	Q	R	S	T	1

6. Determine the number of unpaired electrons and the LFSE for each of the following:

(每小題各 2 分，共 10 分)

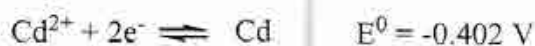
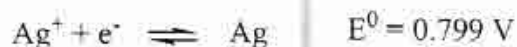
(a) $[\text{Fe}(\text{CN})_6]^{4-}$ (b) $[\text{Fe}(\text{H}_2\text{O})_6]^{3+}$ (c) $[\text{Co}(\text{NH}_3)_6]^{3+}$ (d) $[\text{Cr}(\text{NH}_3)_6]^{3+}$ (e) $[\text{PtCl}_6]^{2-}$ 7. Write the following quantities in exponential notation (e.g., $25 \text{ fC} = 2.5$

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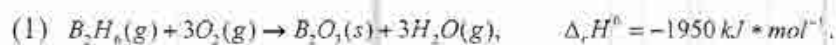
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 $\times 10^{-14} \text{ C}$ (每題 1 分，共 5 分)(a) 867 nm (b) 0.036 μA (c) 62 MHz (d) 23.5 kPa (e) 52 pF8. Calculate the cell potential: $\text{Cd(s)} \mid 0.01 \text{ M Cd(NO}_3)_2 \parallel 0.1 \text{ M AgNO}_3$ $\mid \text{Ag(s)}$ (5 分)

9. Explain the separation theory for reverse-phase chromatography. (5 分)

10. Why EDTA (ethylenediaminetetraacetic acid) is often used in analysis of cations in aqueous solutions? (5 分)

11. Give an example for the gravimetric determination of anions in water. (5 分)

12. From the following data, Please determine the enthalpy of formation

 $\Delta_f H^0$ of diborane, $\text{B}_2\text{H}_6(\text{g})$, at 298K: (5 分)

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13. Please prove that the relationship between C_p and C_v is

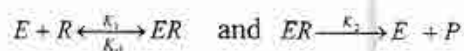
$$C_p - C_v = \frac{TV\alpha^2}{\kappa_T},$$

where α = coefficient of expansion = $\frac{1}{V}(\frac{\partial V}{\partial T})_p$,

κ_T = isothermal compressibility = $-\frac{1}{V}(\frac{\partial V}{\partial P})_T$,

C_p (C_v) = heat capacity per mole at constant pressure (volume). (10 分)

14. Many enzyme systems follow the Michaelis-Menten equation.



where E stands for enzyme, R stands for the reactant, ER stands for the first enzyme-reactant complex, and P is product. When the initial concentration of enzyme and substrate are $[E]_0$ and $[R]_0$, respectively.

(a) Derive the rate law for the forward rate. (5 分)

(b) What is the maximum rate of production of products? (5 分)