

國立中山大學 102 學年度碩士暨碩士專班招生考試試題

科目名稱：有機化學及無機化學【化學系碩士班】

題號：422001

※本科目依簡章規定「不可以」使用計算機

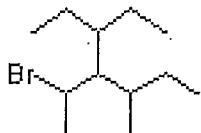
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(一) 選擇題 (20 %)

There is only one correct answer for each question. (2% × 10 = 20%)

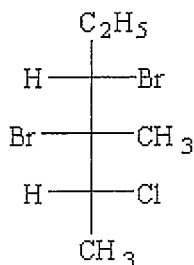
- (1). Calculate the molecular formula for the organic compound whose quantitative elemental analysis showed 48.6% carbon and 8.1% hydrogen by weight.
 (A) CH₂O (B) C₂H₄O₂ (C) C₂H₆ (D) C₃H₆O (E) C₃H₆O₂

- (2). Identify the correct IUPAC name for the compound shown below.



- (A) 2-bromo-3-*sec*-butyl-4-ethylhexane (B) 2-bromo-4-ethyl-3-*sec*-butylhexane
 (C) 3-(1-bromoethyl)-2,4-diethylhexane (D) 4-(1-bromoethyl)-3-ethyl-5-methylheptane
 (E) 4-(1-bromoethyl)-5-ethyl-3-methylheptane

- (3). What is the IUPAC name of the compound shown below?



- (A) (2R,3S,4S)-2-chloro-3,4-dibromo-3-methylhexane
 (B) (2R,3S,4S)-3,4-dibromo-2-chloro-3-methylhexane
 (C) (3S,4S,5S)-3,4-dibromo-5-chloro-4-methylhexane
 (D) (2R,3R,4S)-3,4-dibromo-2-chloro-3-methylhexane
 (E) (2R,3S,4R)-3,4-dibromo-2-chloro-3-methylhexane

- (4). Which of the following is true for the termination step of a free radical chlorination reaction?
 (A) $\Delta H^\circ > 0$ and $\Delta S^\circ > 0$ (B) $\Delta H^\circ > 0$ and $\Delta S^\circ < 0$ (C) $\Delta H^\circ < 0$ and $\Delta S^\circ > 0$
 (D) $\Delta H^\circ < 0$ and $\Delta S^\circ < 0$ (E) $\Delta H^\circ = 0$ and $\Delta S^\circ = 0$

- (5). Which of the following compounds will undergo an S_N2 reaction most readily?

- (A) (CH₃)₃CCH₂I (B) (CH₃)₃CCl (C) (CH₃)₂CHI
 (D) (CH₃)₂CHCH₂CH₂CH₂I (E) (CH₃)₂CHCH₂CH₂CH₂Cl

- (6). Which of the following alkenes has the largest molar heat of hydrogenation (ie, releases the most heat upon hydrogenation)?

- (A) 2,3-dimethyl-2-butene (B) 2-methyl-2-butene
 (C) trans-2-butene (D) cis-2-butene (E) 1-hexene

- (7). The mass spectrum of which compound has M⁺ and M⁺² peaks of approximately equal intensity?

- (A) 3-bromopentane (B) 3-pentanol (C) pentane
 (D) 3-chloropentane (E) 3-iodopentane

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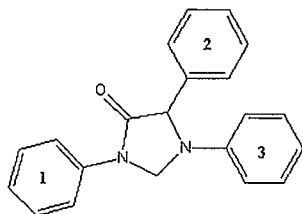
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- (8). Describe the number of signals and their splitting in the ^1H NMR spectrum of $(\text{CH}_3)_2\text{CHOCH}_3$.
- (A) 3 signals: 2 doublets and a septet
 - (B) 2 signals: a doublet and a septet
 - (C) 3 signals: a doublet, a quartet, and a septet
 - (D) 4 signals: 2 doublets, a singlet, and a septet
 - (E) 3 signals: a singlet, a doublet, and a septet

- (9). In electrophilic aromatic substitution reactions, a bromine substituent:
- (A) is a deactivator and a m-director.
 - (B) is a deactivator and an o,p-director.
 - (C) is an activator and a m-director.
 - (D) is an activator and an o,p-director.
 - (E) none of the above

- (10). Derivatives of the compound shown below are currently being examined for their effectiveness in treating drug addiction and metabolic syndrome (*J. Med. Chem.* **2006**, 872). Which sequence ranks the following aromatic rings of this compound in order of increasing reactivity in an electrophilic aromatic substitution reaction (slowest to fastest reacting)?



- (A) $1 < 2 < 3$
- (B) $2 < 3 < 1$
- (C) $3 < 2 < 1$
- (D) $3 < 1 < 2$
- (E) $2 < 1 < 3$

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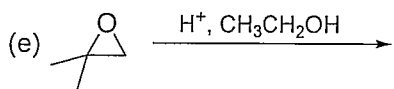
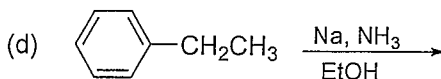
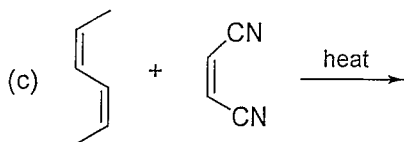
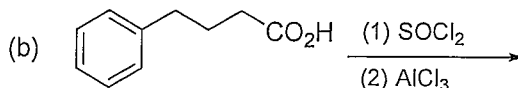
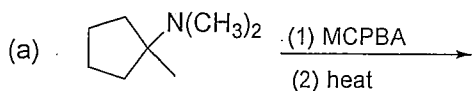
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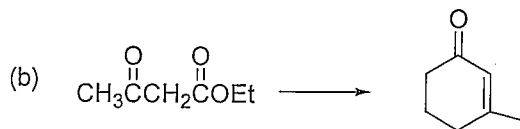
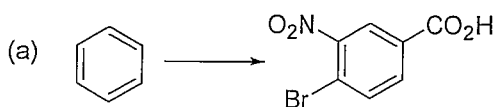
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(二) 非選擇題 (80%)

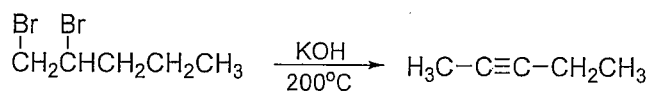
1. Predict the main product of the following reactions (Be specific about stereochemistry). (3% x 5 = 15%)



2. Accomplish the following syntheses. (5% x 2 = 10%)



3. Propose a reasonable mechanism for the following reaction (5% x 1 = 5%)



4. 請解釋/回答下列各小題 (10 小題；每小題 5 分；共 50 分)

- Inner-sphere mechanism of redox reactions
- Berry pseudorotation (for five-coordination complexes)
- Zintl phases
- Endohedral fullerenes
- Water gas shift reaction
- Draw the structure for Al₂Me₆
- Determine the point group for [Ru(NH₂CH₂CH₂NH₂)₃]²⁺
- 'Leveling Effect' in acid-base chemistry
- LMCT bands of electronic spectra
- Draw the structure for cisplatin

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科目名稱：物理化學及分析化學【化學系碩士班】

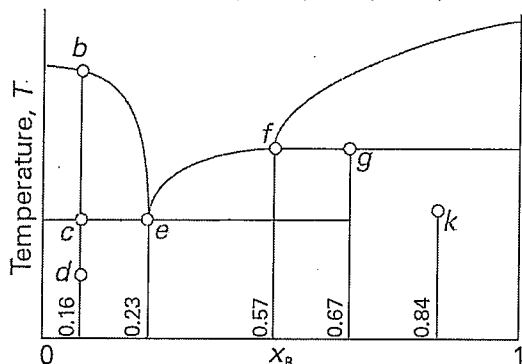
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物理化學部分

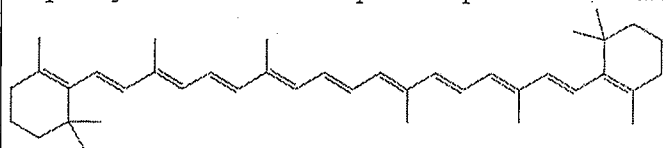
1. (5%) Consider the following phase diagram, which represents a solid - liquid equilibrium. Sketch cooling curves for compositions $x_B = 0.16, 0.23, 0.57, 0.67,$ and 0.84 .



2. (5%) Explain why the standard entropy of He gas is lower than the standard entropy of Kr gas under the same temperature.

3 (10%) Show that at constant temperature and pressure, the maximum non-expansion work is given by the change in Gibbs energy.

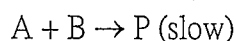
4. (10%) When β -carotene is oxidized in vivo, it breaks in half and forms two molecules of retinal, which is a precursor to the pigment in the retina responsible for vision. The conjugated system of retinal consists of 11 C atoms and one O atom. In the ground state of retinal, each level up to $n = 6$ is occupied by two electrons. Assuming an average internuclear distance of 140 pm, calculate (a) the separation in energy between the ground state and the first excited state in which one electron occupies the state with $n = 7$, and (b) the frequency of the radiation required to produce a transition between the two states.



β -carotene

5. (10%) The rotational constant for CO is 1.9314 cm^{-1} and 1.6116 cm^{-1} in the ground and first excited vibrational states, respectively. By how much does the internuclear distance change as a result of this transition?

6. (10%) The reaction mechanism



involves an intermediate A. Deduce the rate law for the reaction in two ways by (a) assuming a pre-equilibrium and (b) making a steady-state approximation.

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分析化學部分

7. Define the following terms
 - (a) Systematic error and random error
 - (b) Buffer solution and buffer capacity
 - (c) Standard addition calibration method(5% each, 15% total)

8. Define the following terms
 - (a) Fellgett advantage
 - (b) Source modulation in atomic absorption spectroscopy
 - (c) Anti-Stokes shift in Raman Spectroscopy
 - (d) Fluorescence emission spectrum and fluorescence excitation spectrum
 - (e) Electrospray ionization (ESI) source(5% each, 25% total)

9. Define the following terms
 - (a) Plate height and number of plates
 - (b) Isocratic and gradient elution in liquid chromatography(5% each, 10% total)