

國立清華大學 107 學年度碩士班考試入學試題

系所班組別：生醫工程與環境科學系乙組 (環境與分子科學組)

考試科目 (代碼)：有機化學 (2603)

共 9 頁，第 1 頁 *請在【答案卡與答案卷】作答

一、單選題 (每題 2.5 分共 50 分) 請在【答案卡】作答

- In UV spectroscopy, the closer the energies of the HOMO and LUMO
(A) The longer will be λ_{\max}
(B) The lower will be the frequency of the absorbed light
(C) When the system is highly conjugated
(D) All of above
(E) None of above
- Which one if the following compounds would have the largest value of λ_{\max} (in nm) in its UV-Vis spectrum?
(A) 1,3,5-cycloheptatriene
(B) β -carotene
(C) o-methoxytoluene
(D) bicyclo[2.2.2]octa-2,5-diene
- The singlet appearing at δ 2.2 in the ^1H NMR spectrum of 3-hydroxy-2-butanone corresponds to:
(A) the OH group
(B) the proton at C-1
(C) the proton at C-3
(D) the proton at C-4
- How are reactions between aldehydes and nucleophiles fundamentally different than reactions between acyl chlorides and nucleophiles?
(A) Aldehydes are readily oxidized by nucleophiles to carboxylic acids.
(B) Acyl chlorides have a leaving group, Cl^- , whereas aldehydes do not.
(C) Aldehydes do not form tetrahedral intermediates with nucleophiles.
(D) Acyl chlorides readily form enol tautomers.
(E) a π bond formed by lateral overlap of two sp^2 orbitals and a sigma bond formed by end-on overlap of two sp^2 orbitals

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共 9 頁，第 2 頁 *請在【答案卡與答案卷】作答

9. What statement does NOT apply to the boiling points of alkanes?
5. A hexa-peptide was found to contain the amino acids Phe, Gly, Ala and Ser. N-Terminal analysis yields N-(2,4-dinitrophenyl)phenylalanine. Partial hydrolysis of the peptide gives the dipeptides Phe-Gly, Ala-Ser, Gly-Ala, Met-Met, what is the peptide sequence?
- (A) Phe-Met-Met-Ala-Ser-Gly
- (B) Met-Met-Phe-Gly-Ala-Ser
- (C) Phe-Gly-Ala-Ser-Met-Met
- (D) Gly-Ala-Ser-Met-Met-Phe
10. What is a reasonable explanation for the following observation?
6. Complete hydrolysis of a nucleic acid yields each of the following, except
- (A) a mixture of heterocyclic bases
- (B) an aldopentose, either ribose or deoxyribose
- (C) phosphate ion
- (D) a mixture of amino acid
7. A nucleotide unit in RNA is composed of:
- (A) a five carbon deoxy monosaccharide
- (B) a carboxylic acid group
- (C) a heterocyclic base
- (D) an amino acid
8. The double bond in ethane is made up of
- (A) a pi bond and a sigma bond formed by lateral overlap of two p orbitals
- (B) a sigma bond formed by overlap of two s orbitals and a pi bond formed by lateral overlap of two p orbitals
- (C) a sigma bond formed by end-on overlap of two sp² orbitals and a pi bond formed by lateral overlap of two s orbitals.
- (D) a pi bond formed by end-on overlap of two sp² orbitals and a sigma bond formed by overlap of two s orbitals
- (E) a pi bond formed by lateral overlap of two sp² orbitals and a sigma bond formed by end-on overlap of two sp² orbitals

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共 9 頁，第 3 頁 *請在【答案卡與答案卷】作答

9. What statement does NOT apply to the boiling points of alkanes?
- (A) The boiling point increases as the length of the carbon chain increase.
 - (B) Straight chain alkanes have a higher boiling point than their branched isomers.
 - (C) The boiling points are influenced by hydrogen bonding.
 - (D) Because they are nonpolar, alkanes have lower boiling points than other organic compounds of similar molar mass.
 - (E) The boiling points are affected by van der Waals attractions.
10. What is a reasonable explanation for the following observation?
Acetic acid is a stronger acid than ethanol.
- I. Electronegativity II. Resonance III. Hybridization
- (A) I, II
 - (B) I, III
 - (C) II
 - (D) I
11. The equilibrium that exists between the keto and enol forms of aldehydes and ketones is known as:
- (A) stereoisomerism
 - (B) positional isomerism
 - (C) tautomerism
 - (D) geometric isomerism
 - (E) configurational isomerism
12. What is the major product from the acid-catalyzed hydration of 2-methyl-2-pentene?
- (A) 2-methylpentane
 - (B) 2-methyl-1-pentanol
 - (C) 2-methyl-2-pentanol
 - (D) 2-methyl-2-pentanol
 - (E) 1-methoxypentane

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13. In methyl alcohol solution, bromine reacts with ethylene(ethene) to yield $\text{BrCH}_2\text{CH}_2\text{OCH}_3$ in addition to 1,2-dibromoethane because
- (A) the methyl alcohol solvates the bromine
 - (B) the ion formed initially may react with Br^- or CH_3OH
 - (C) this is a free radical reaction
 - (D) the reaction follows Markovnikov's rule
 - (E) none of these reasons
14. What is the reaction major product when benzene reacts with propene in the presence of HF ?
- (A) propylbenzene
 - (B) isopropylbenzene
 - (C) 3-phenylpropene
 - (D) 1-phenylpropene
15. The rate of an $\text{S}_{\text{N}}2$ reaction run in a polar aprotic solvent relative to the same reaction in a polar protic solvent would be
- (A) the same
 - (B) slower
 - (C) faster
 - (D) unpredictable
 - (E) unimolecular
16. Which of following would react most rapidly with sodium ethoxide to produce an ether?
- (A) chlorobenzene
 - (B) *p*-nitrotoluene
 - (C) *p*-nitrochlorobenzene
 - (D) *m*-(chloromethyl)-toluene
 - (E) *m*-chlorotoluene

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共 9 頁，第 5 頁 *請在【答案卡與答案卷】作答

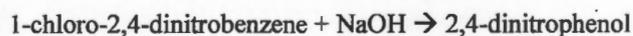
17. Which description about the frontier molecular orbital theory is False?

- (A) HOMO is an acronym for highest occupied molecular orbital.
- (B) Antibonding molecular orbitals are higher in energy than the isolated atomic orbitals from which they made.
- (C) The LUMO of 1,3-butadiene has one node.
- (D) The HOMO of allyl anion has one node.
- (E) The thermal [2+2] cycloaddition of two ethylenes to give cyclobutane is a symmetry-forbidden reaction.

18. Which pair listed below is a Lewis acid-base pair?

- (A) 2,6-di-*tert*-butylpyridine + HCl
- (B) BF_3 + ether
- (C) Benzoic acid + NaOH
- (D) *tert*-butyl chloride + benzene
- (E) acetone + H_2SO_4

19. Which statement is correct for the reaction shown below?



- (A) This reaction is an electrophilic aromatic substitution.
- (B) This reaction is a $\text{S}_{\text{N}}2$ substitution.
- (C) This reaction is a nucleophilic aromatic substitution.
- (D) Substituted benzyne is the reaction intermediate.

20. Which reagent would convert cyclohexene into a *cis*-glycol?

- (A) cold dilute potassium permanganate
- (B) hydrogen peroxide and aqueous acetic acid
- (C) ozone and moist zinc dust
- (D) periodic acid
- (E) sodium *tert*-butoxide in chloroform

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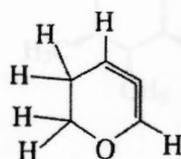
考試科目 (代碼)：有機化學 (2603)

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*請在【答案卡與答案卷】作答

二、問答題 (每題 2.5 分共 50 分) 請在【答案卷】作答

1. Explain why the following compound is not stable:



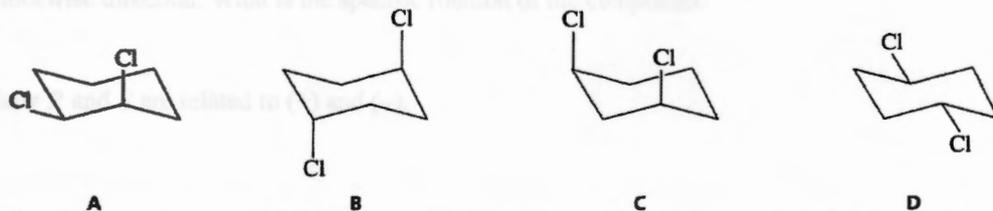
2. Tenormin, a member of the group of drugs known as beta-blockers, is used to treat high blood pressure and improve survival after a heart attack. It works by slowing down the heart to reduce its workload. Which atom in Tenormin is the most basic?



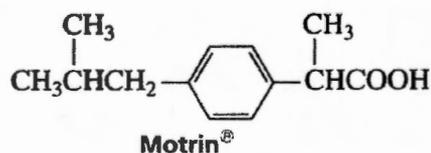
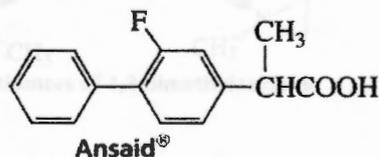
3. Calculate the pH values of the following solution:

1.0 M solution of acetic acid ($pK_a = 4.76$)

4. Which of the following represents a cis isomer?



5. Ansaid and Motrin belong to the group of drugs known as nonsteroidal anti-inflammatory drugs (NSAIDs). Both are only slightly soluble in water, but one is a little more soluble than the other. Which of the drugs has the greater solubility in water?



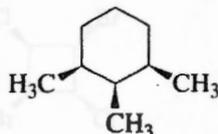
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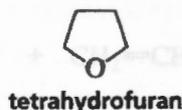
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共 9 頁，第 7 頁 *請在【答案卡與答案卷】作答

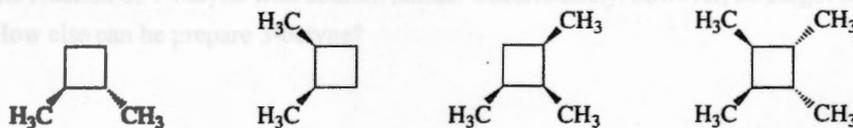
6. Draw the most stable conformer of the following molecule. (A solid wedge points out of the plane of the paper toward the viewer.)



7. Diethyl ether has very limited solubility in water, but tetrahydrofuran is completely soluble.



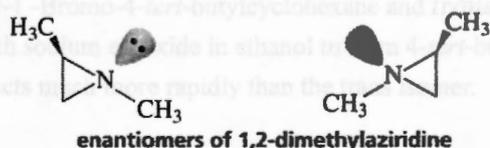
8. Which of the following is/are optically active?



9. A solution of an unknown compound (3.0 g of the compound in 200 mL of solution), when placed in a polarimeter tube 2.0 dm long, was found to rotate the plane of polarized light 18° in a counterclockwise direction. What is the specific rotation of the compound?

10. Explain how *R* and *S* are related to (+) and (-).

11. Explain why the enantiomers of 1,2-dimethylaziridine can be separated even though one of the "groups" attached to nitrogen is a lone pair.



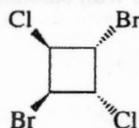
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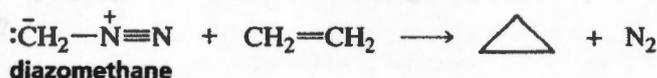
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12. Is the following compound optically active?

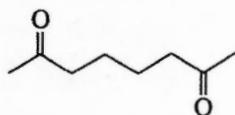


13. The reaction of an alkene with diazomethane forms a cyclopropane ring. Propose a mechanism for the reaction. (*Hint*: It is a concerted reaction.)



14. A chemist is planning to synthesize 3-octyne by adding 1-bromobutane to the product obtained from the reaction of 1-butyne with sodium amide. Unfortunately, however, he forgot to order 1-butyne. How else can he prepare 3-octyne?

15. How could you synthesize the following compound from starting materials containing no more than six carbons? (*Hint*: A 1, 6-diketone can be synthesized by oxidative cleavage of a 1,2-disubstituted cyclohexene.)



16. Cyclopentadiene can react with itself in a Diels-Alder reaction. Draw the endo and exo products.
17. *cis*-1 -Bromo-4-*tert*-butylcyclohexane and *trans*-1 -bromo-4-*tert*-butylcyclohexane both react with sodium ethoxide in ethanol to form 4-*tert*-butylcyclohexene. Explain why the *cis* isomer reacts much more rapidly than the *trans* isomer.

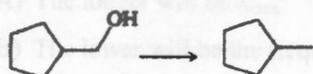
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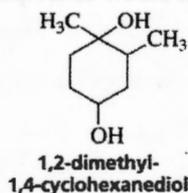
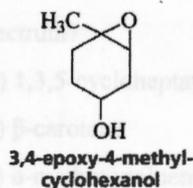
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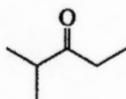
18. Using the given starting material, any necessary inorganic reagents, and any carbon-containing compounds with no more than two carbons, indicate how the following syntheses could be carried out:



19. A student added an equivalent of 3,4-epoxy-4-methylcyclohexanol to a solution of methylmagnesium bromide in diethyl ether, and then added dilute hydrochloric acid. He expected that the product would be 1,2-dimethyl-1,4-cyclohexanediol. He did not get any of the expected product. What product did he get?



20. What peaks in their mass spectra can be used to distinguish between the following compounds?



4. How are reactions between aldehydes and nucleophiles fundamentally different than reactions between acyl chlorides and nucleophiles?

- (A) Aldehydes are readily oxidized by nucleophiles to carboxylic acids.
 (B) Acyl chlorides have a leaving group, Cl^- , whereas aldehydes do not.
 (C) Aldehydes do not form tetrahedral intermediates with nucleophiles.
 (D) Acyl chlorides readily form enol tautomers.