

注意：考試開始鈴響前，不得翻閱試題，
並不得書寫、畫記、作答。

國立清華大學 115 學年度碩士班考試入學試題

系所班組別：分析與環境科學研究所

科目代碼：3005

考試科目：有機化學

—作答注意事項—

1. 請核對答案卷（卡）上之准考證號、科目名稱是否正確。
2. 考試開始後，請於作答前先翻閱整份試題，是否有污損或試題印刷不清，得舉手請監試人員處理，但不得要求解釋題意。
3. 考生限在答案卷上標記「由此開始作答」區內作答，且不可書寫姓名、准考證號或與作答無關之其他文字或符號。
4. 答案卷用盡不得要求加頁。
5. 答案卷可用任何書寫工具作答，惟為方便閱卷辨識，請儘量使用藍色或黑色書寫；答案卡限用 2B 鉛筆畫記；如畫記不清（含未依範例畫記）致光學閱讀機無法辨識答案者，其後果一律由考生自行負責。
6. 提早交卷者不可攜出試題，請將試題連同答案卷(卡)交予監考人員，攜出將以違規論處。當節考試結束後試題將置於講台，可自行取回，本試場不負保管責任。
7. 其他應考規則、違規處理及扣分方式，請自行詳閱准考證明上「國立清華大學試場規則及違規處理辦法」，無法因本試題封面作答注意事項中未列明而稱未知悉。

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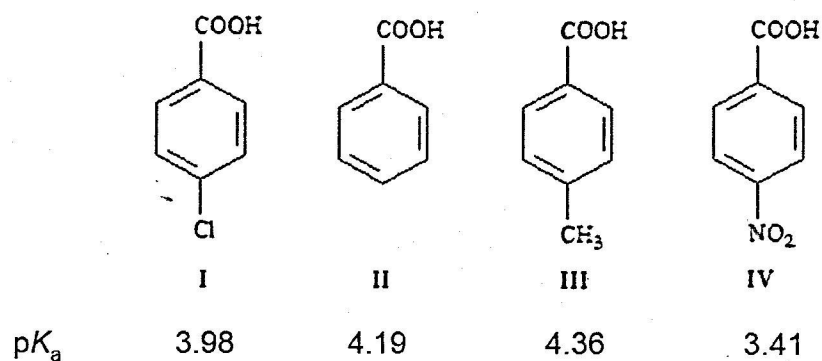
考試科目（代碼）：有機化學（3005）

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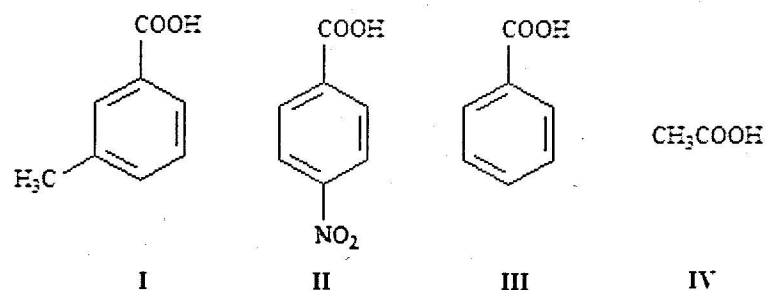
一、單選題（每題 4 分，共 100 分）

1. Arrange the following substituted benzoic acids in the order of their increasing reactivity toward electrophilic aromatic substitution. Rank them from the least reactive to the most reactive.



- (A) IV, I, II, III
(B) III, II, I, IV
(C) II, III, I, IV
(D) III, II, I, IV
(E) III, I, IV, II

2. What is the order of increasing acidity for the following compounds? (least to most)



- (A) IV, I, III, II
(B) IV, II, III, I
(C) II, III, I, IV
(D) I, III, II, IV
(E) III, I, IV, II

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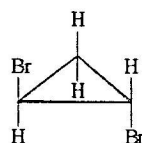
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*請在【答案卡】作答

3. Which of the following sets of reaction conditions would successfully obtain the product.



- (A) 1. KMnO_4 2. LiAlH_4
(B) 1. Mg , ether, 2. CO_2 , 3. LiAlH_4
(C) 1. NaOH , H_2O , 2. LiAlH_4
(D) 1. SOCl_2 , benzene, 2. LiAlH_4
(E) either B or C
4. Which of the following statements regarding the comparison between nitriles (RCN) and carboxylic acids (RCOOH) is NOT TRUE?
- (A) Contain a carbon atom with three total bonds to electronegative atoms
(B) Contain two π bonds.
(C) Act as electrophiles
(D) Undergo nucleophilic substitution reactions
(E) All are characteristic of both nitriles and carboxylic acids.
5. How many distinct signals (resonances) would you expect to observe in the ^1H NMR spectrum of the compound shown below?



- (A) 2
(B) 5
(C) 1
(D) 4
(E) 3

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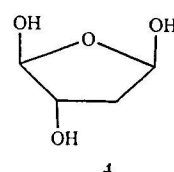
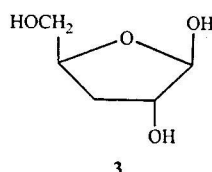
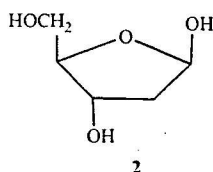
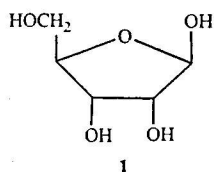
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6. Which of the following structure is the correct identification for 2-deoxy-D-ribose?



- (A) 1
(B) 2
(C) 3
(D) 4
(E) None of the above

7. Which of the following statements correctly describes the components and linkages found in the structure of a DNA molecule?

- (A) The nitrogenous bases and phosphate groups alternate to form the exterior backbone.
(B) The sugar-phosphate backbone is located on the exterior, while the nitrogenous bases are on the interior.
(C) The bond between the nitrogenous base and the deoxyribose sugar is a peptide bond.
(D) The individual nucleotides are linked by phosphodiester bonds specifically from the 2' position to the 5' position.
(E) Base pairs are oriented parallel to the long axis of the double helix.

8. A double-stranded DNA molecule is found to contain 22% Thymine (T) on a mole basis. Based on Chargaff's rules and the information regarding nucleic acid sequences, which of the following must also be TRUE?

- (A) The molecule contains 22% Guanine (G).
(B) The molecule contains 28% Guanine (G).
(C) The complementary mRNA sequence will replace all Thymine with Deoxyribose.
(D) The molecule contains 78% Guanine (G).
(E) The total amount of Purines (A+G) must equal 44%.

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9. In the biosynthesis of fatty acids, which specific step is responsible for forming the new carbon-carbon bond that extends the fatty acid chain?

- (A) Nucleophilic acyl substitution
- (B) Carboxylation
- (C) Dehydration
- (D) Condensation
- (E) Reduction

10. When soaps disperse in water, the long hydrocarbon tails cluster together in a hydrophobic ball, while the ionic heads on the surface of the cluster stick out into the water. These spherical clusters are called:

- (A) Fatty acid esters
- (B) Triacylglycerols
- (C) Lipid bilayers
- (D) Micelles
- (E) Liposomes

11. Which of the following statements regarding the biochemical properties and biosynthesis of cholesterol is FALSE?

- (A) It is classified structurally as a steroid.
- (B) It serves as the primary metabolic precursor for the synthesis of other steroid hormones.
- (C) It is biosynthetically produced from the triterpene lanosterol.
- (D) Its rigid tetracyclic ring geometry allows for frequent chair-to-chair ring-flips.
- (E) It is a critical structural component of mammalian cell membranes.

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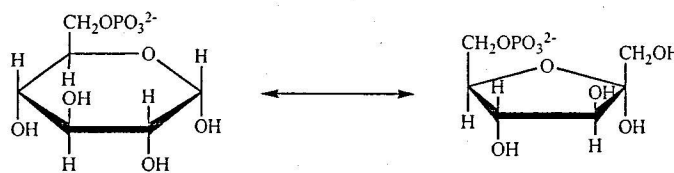
12. Which of the following chemical processes is typically employed to "harden" a liquid vegetable oil, converting it into a solid fat?

- (A) Oxidation
- (B) Hydrogenation
- (C) Hydrolysis
- (D) Hydration
- (E) Saponification

13. Which of the following enzymes catalyzes the rate-limiting step and serves as the primary regulatory control point for the glycolytic pathway?

- (A) Glyceraldehyde-3-phosphate dehydrogenase
- (B) Enolase
- (C) Phosphofructokinase-1
- (D) Aldolase
- (E) Pyruvate kinase

14. Which class of enzyme is responsible for catalyzing the chemical transformation shown below?



- (A) Epimerase
- (B) Isomerase
- (C) Mutase
- (D) Dehydrogenase
- (E) Kinase

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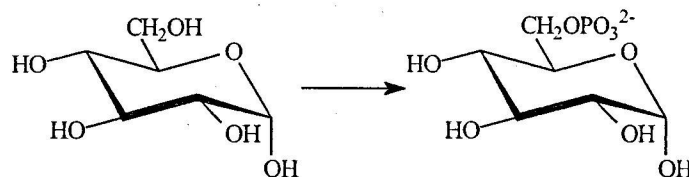
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*請在【答案卡】作答

15. The chemical reaction shown below represents the first step of the glycolytic pathway. Which of the following statements correctly describes the energetics and mechanism of this transformation?



- (A) The reaction is so strongly exergonic that it does not require a biological catalyst.
- (B) The reaction is a simple exergonic process that occurs independently without being coupled to other reactions.
- (C) The reaction is endergonic and only proceeds because it is coupled to the exergonic hydrolysis of ATP.
- (D) The reaction is an exergonic process that provides the energy necessary to drive the endergonic hydrolysis of ATP.
- (E) The reaction is a reversible isomerization that does not require an external energy source like ATP.

16. The following reversible reaction represents a key step in glycolysis. Which of the following statements correctly describes this transformation?



- (A) The reaction is catalyzed by the enzyme triose phosphate isomerase.
- (B) The reaction is a complex process that requires the coordination of several different enzymes.
- (C) The reaction requires the presence of coenzyme A to facilitate acyl group transfer.
- (D) The reaction requires the coenzyme thiamine pyrophosphate (TPP) for decarboxylation.
- (E) The reaction requires the reduction of NAD^+ to NADH to proceed.

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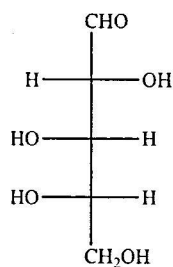
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17. The monosaccharide shown below is



- (A) Aldohexose
- (B) Aldopentose
- (C) Aldotetrose
- (D) Ketohexose
- (E) Ketopentose

18. When Benedict's reagent is used to test for the presence of D-mannose, a characteristic brick-red precipitate forms. This color change is a result of:

- (A) The reduction of Cu^{2+} ions to a Cu^+ state.
- (B) The chemical reduction of the D-mannose molecule into a sugar alcohol.
- (C) The presence of the unreacted, oxidized form of the copper reagent.
- (D) The formation of an oxidized mannose derivative, such as mannonic acid.
- (E) The dehydration of the sugar to form a furfural intermediate.

19. Treatment with dilute NaOH can convert

- (A) An aldose into a ketose
- (B) An aldose into a carboxylic acid
- (C) An aldose into its acetate ester
- (D) A glycoside into a monosaccharide plus an alcohol
- (E) A monosaccharide plus an alcohol into a glycoside

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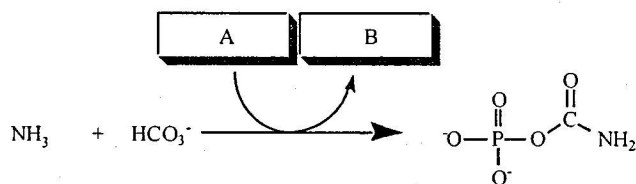
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*請在【答案卡】作答

20. Which of the following is common to both tautomers and resonance forms of a compound?

- (A) Have the same molecular formula
- (B) Differ only in the position of electrons
- (C) Rapidly interconvertible
- (D) Differ in connectivity of atoms
- (E) All of the above describe both tautomers and resonance forms

21. The following reaction represents the first step of the urea cycle, occurring in the mitochondrial matrix. Based on the diagram provided, which of the following best describes the requirements and metabolic location of this process?



- (A) The reaction requires 2 ATP equivalents and is the primary committed step of the urea cycle.
- (B) The reaction requires 1 ATP and serves as a major control point for glycolysis.
- (C) The reaction is an endergonic process coupled with NADPH oxidation to drive fatty acid synthesis.
- (D) The reaction requires the coenzyme pyridoxal phosphate (PLP) to facilitate transamination.
- (E) The reaction is an oxidative deamination catalyzed by glutamate dehydrogenase to release ammonia.

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*請在【答案卡】作答

22. Which of the following amino acids exists predominantly in its zwitterionic form at pH 5.90?

- (A) Aspartic acid ($pI = 2.77$)
- (B) Alanine ($pI = 6.01$)
- (C) Lysine ($pI = 9.74$)
- (D) Glutamic acid ($pI = 3.22$)
- (E) Arginine ($pI = 10.76$)

23. Which of the following amino acids is characterized by a hydrophobic, non-polar aliphatic side chain?

- (A) Histidine
- (B) Arginine
- (C) Glutamine
- (D) Valine
- (E) Asparagine

24. Which of the following reagents can be used to cleave a *tert*-butoxycarbonyl (Boc) protecting group from a peptide?

- (A) H_2/Pd
- (B) CF_3CO_2H
- (C) Na_2CO_3, H_2O
- (D) $LiAlH_4$
- (E) Piperidine in DMF

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25. In the study of protein architecture, the term "secondary structure" specifically describes:

- (A) The linear sequence of amino acid residues linked by peptide bonds.
- (B) The global, three-dimensional spatial arrangement of a single polypeptide chain.
- (C) The functional clustering or association of multiple distinct protein subunits.
- (D) The stable, repeating conformations of the polypeptide backbone in localized regions.
- (E) The specific covalent cross-links, such as disulfide bridges, formed between distant residues.