115op01

國立臺北科技大學 115 學年度碩士班招生考試

系所組別：3700 分子科學與工程系有機高分子碩士班

第一節　有機化學　試題

注意事項：

1.本試題共三大題，共 100 分。(第一大題是非題，計 10 題，每題 2.5 分；第二大題單選題，計 10 題，每題 5 分；第三大題，計 1 大題 5 小題，每小題 5 分)。
2.不必抄題，作答時請將試題題號及答案依照順序寫在答案卷上。
3.全部答案均須在答案卷之答案欄內作答，否則不予計分。

一、是非題 (每小題 2.5 分，共計 25 分)

1. (　) In an E2 elimination, the hydrogen atom being removed must be antiperiplanar to the leaving group.
2. (　) Hyperconjugation involves overlap between a filled σ orbital and an empty or partially filled p orbital or π orbital.
3. (　) Resonance structures represent rapidly interconverting molecules in equilibrium.
4. (　) In cyclohexane, axial substituents experience greater steric strain than equatorial substituents due to 1,3-diaxial interactions.
5. (　) The major product of a reaction under thermodynamic control is determined by the lowest activation energy.
6. (　) A nucleophile is always a strong base.
7. (　) Amides are less basic than amines because the lone pair on nitrogen is delocalized by resonance with the carbonyl group.
8. (　) In ^{1}H NMR spectroscopy, increasing electronegativity of a neighboring atom generally shifts a proton signal downfield.
9. (　) Aldol reactions require the presence of at least one α-hydrogen in the carbonyl compound.
10. (　) In a reaction coordinate diagram, the transition state corresponds to a local minimum in potential energy.

二、單選題 (每小題 5 分，共計 50 分)

1. (　) Which condition is required for a molecule to be aromatic according to Hückel's rule, and directly relates to orbital overlap?
(A) Cyclic structure.
(B) 4n + 2π electrons.
(C) Complete planarity.
(D) Low molecular weight.

2. (　) Why does increasing conjugation in an organic molecule lead to a bathochromic shift in UV–Vis absorption?
(A) The HOMO energy decreases significantly.
(B) The LUMO energy increases.
(C) The HOMO–LUMO gap decreases.
(D) σ → σ* transitions become dominant.

3. (　) Which feature most directly enables autonomous self-healing in hydrogen-bond-based polymer systems at room temperature?
(A) High covalent bond dissociation energy.
(B) Fast segmental mobility of polymer chains.
(C) Permanent cross-linking density.
(D) Irreversible network formation.

4. (　) In free-radical polymerization, which of the following most directly affects the rate of polymerization?
(A) Monomer molecular weight.
(B) Rate of initiator decomposition.
(C) Glass transition temperature of the polymer.
(D) Crystallinity of the polymer.

5. (　) Which factor most strongly disrupts effective π conjugation in an organic molecule?
(A) Increased resonance stabilization.
(B) Planar molecular geometry.
(C) Torsional twisting between aromatic units.
(D) Electron-withdrawing substituents.

6. (　) Which of the following compounds is the strongest acid?
(A) Ethanol (CH_3CH_2OH).
(B) Phenol (C_6H_5OH).
(C) Cyclohexanol.
(D) *tert*-Butanol.

7. (　)Which of the following reactions is a condensation reaction, characterized by carbon–carbon bond formation accompanied by the elimination of a small molecule?
(A) Hydrogenation of an alkene.
(B) Aldol condensation between two aldehydes.
(C) SN2 substitution of an alkyl halide.
(D) Electrophilic aromatic substitution.

8. (　) During step-growth polymerization forming a polyester, removal of a small molecule byproduct drives polymer formation. Which principle explains why removal of this byproduct increases molecular weight?
(A) Le Châtelier's principle.

注意：背面尚有試題

(B) Hammond postulate.
(C) Markovnikov's rule.
(D) Ziegler–Natta coordination.

9. (　　) In the acid-catalyzed dehydration of 2-butanol, the major product is trans-2-butene. Which factor most directly explains this outcome?
(A) The reaction is kinetically controlled.
(B) The more substituted alkene is thermodynamically more stable.
(C) The cis isomer is formed faster at low temperature.
(D) Elimination occurs through a radical pathway.

10. (　　)Which transformation is achieved by pyridinium chlorochromate(PCC)?
(A)Primary alcohol → carboxylic acid.
(B) Secondary alcohol → alkane.
(C) Primary alcohol → aldehyde.
(D) Aldehyde → carboxylic acid.

三、簡答題 (一大題，每小題 5 分，共計 25 分)

1. An unknown compound **X** has the molecular formula $C_9H_{10}O_2$. Its spectroscopic data are given below:

- IR (neat): strong absorption at 1715 cm^{-1}
- ^1H NMR (*d*-$CDCl_3$): δ 7.2–7.4 (*m*, 5H), δ 4.1 (*q*, 2H), δ 1.3 (*t*, 3H)
- ^{13}C NMR: one signal observed at approximately δ 170 ppm

(1) Based on the spectroscopic information above, deduce and draw the structure of compound **X**. (5 pts)

(2) Compound **X** reacts with a primary amine under basic conditions to form compound **Y**. Propose a detailed reaction mechanism for this transformation and explain why the reaction proceeds readily.

(3) If compound **X** is reduced with $LiAlH_4$, predict the major product **Z** and explain the chemoselectivity of the reaction.

(4) If compound **X** is replaced by its para-nitro–substituted derivative, discuss how the reaction rate in part (2) would change, and explain your reasoning in terms of electronic effects.

(5) If the reaction in part (2) is carried out using a tertiary amine (R_3N) instead of a primary amine, no amide product is observed. Explain why the reaction fails, based on both steric and mechanistic considerations.