

※ 注意：有機化學 Part I. 單選題請作答於試卷內之「選擇題作答區」，其餘題目均請作答於「非選擇題作答區」，並標明作答部分及題號依序作答。

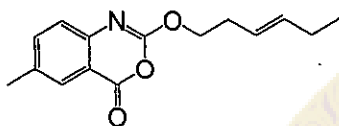
注意：有機化學試題包含單選題及問答題兩部份

Part I. 單選題 (15 題, 30 分) ※ 本大題請於試卷內之「選擇題作答區」依序作答。

1. Which of these is **not** a Lewis acid?

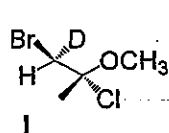
- (A)  $\text{AlCl}_3$       (B)  $\text{H}_3\text{O}^+$       (C)  $\text{FeCl}_3$       (D)  $\text{SO}_3$       (E)  $\text{PPh}_3$

2. What is the index of hydrogen deficiency for the following compound?

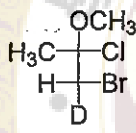


- (A) 5      (B) 6      (C) 7      (D) 8      (E) 9

3. I and II are:



I



II

- (A) constitutional isomers.      (B) diastereomers.      (C) identical.  
(D) enantiomers.      (E) not isomeric.

4. Reaction of sodium ethoxide with 1-bromopentane at  $30^\circ\text{C}$  yields primarily:

- (A)  $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{OCH}_2\text{CH}_3$       (B)  $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{OH}$   
(C)  $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_3$       (D)  $\text{CH}_3\text{CH}_2\text{CH}=\text{CHCH}_3$   
(E)  $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}=\text{CH}_2$

5. Which is **not** a satisfactory procedure for the synthesis of 3-methyl-1-butene?

- (A)  $(\text{CH}_3)_2\text{CHC}\equiv\text{CH} + \text{Li/liq. NH}_3$       (B)  $(\text{CH}_3)_2\text{CHCH}_2\text{CH}_2\text{Br} + \text{CH}_3\text{ONa/CH}_3\text{OH}$   
(C)  $(\text{CH}_3)_2\text{CHCHOHCH}_3 + \text{conc. H}_2\text{SO}_4$       (D)  $(\text{CH}_3)_2\text{CHC}\equiv\text{CH} + \text{H}_2/\text{Ni}_2\text{B}$   
(E)  $(\text{CH}_3)_2\text{CHCHBrCH}_3 + (\text{CH}_3)_3\text{COK}/(\text{CH}_3)_3\text{COH}$

6. Which of these compounds belongs to the class of substances commonly known as "halohydrins"?

- (A)  $\text{BrCH}_2\text{CH}_2\text{Cl}$       (B)  $\text{ClCH}_2\text{CO}_2\text{H}$       (C)  $\text{ICH}_2\text{CH}_2\text{OH}$   
(D)  $\text{FCH}_2\text{CH}_2\text{NH}_2$       (E)  $\text{HOCH}_2\text{COCl}$

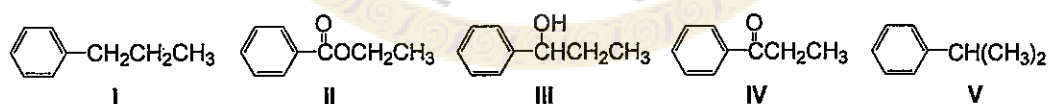
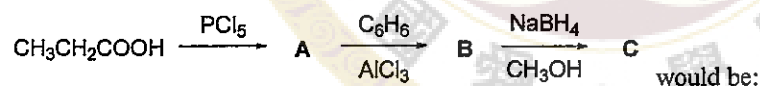
7. An example of a reaction having an  $E_{\text{act}} = 0$  would be:

- (A)  $\text{Br}\cdot + \text{Br}-\text{Br} \longrightarrow \text{Br}-\text{Br} + \text{Br}\cdot$       (B)  $\text{F}\cdot + \text{CH}_4 \longrightarrow \text{H}-\text{F} + \text{CH}_3\cdot$   
(C)  $\text{CH}_3\cdot + \text{CH}_3\text{CH}_3 \longrightarrow \text{CH}_4 + \text{CH}_3\text{CH}_2\cdot$       (D)  $\text{Br}\cdot + \text{H}-\text{Br} \longrightarrow \text{H}-\text{Br} + \text{Br}\cdot$   
(E)  $\text{CH}_3\cdot + \text{CH}_3\cdot \longrightarrow \text{CH}_3-\text{CH}_3$

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8. Fundamentally, 2-methyl-2-pentanol does not undergo oxidation by  $\text{H}_2\text{CrO}_4$  because:
- the intermediate chromate ester is not formed.
  - the oxidant isn't in a sufficiently high oxidation state.
  - the alcohol undergoes dehydration.
  - the intermediate chromate ester cannot lose hydrogen.
  - Actually, this oxidation does occur.
9. A thermodynamically-controlled reaction will yield predominantly:
- the more/most stable product.
  - the product whose formation requires the smallest free energy of activation.
  - the product that can be formed in the fewest steps.
  - the product that is formed at the fastest rate.
  - the product which possesses the greatest potential energy.
10. Cyclopentadiene is unusually acidic for a hydrocarbon. An explanation for this is the following statement.
- The carbon atoms of cyclopentadiene are all  $sp^2$ -hybridized.
  - Removal of a proton from cyclopentadiene yields an aromatic anion.
  - Removal of a hydrogen atom from cyclopentadiene yields a highly stable free radical.
  - Removal of a hydride ion from cyclopentadiene produces an aromatic cation.
  - Cyclopentadiene is aromatic.
11. Which of the following is not a meta-directing substituent when present on the benzene ring?
- $-\text{NHCOCH}_3$
  - $-\text{NO}_2$
  - $-\text{N}(\text{CH}_3)_3^+$
  - $-\text{C}\equiv\text{N}$
  - $-\text{CO}_2\text{H}$

12. The product, C, of the following reaction sequence,



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

13.  $\delta$ -Hydroxy acids can be esterified intramolecularly to form compounds known as which of these?
- Anhydrides
  - Cycloalkenes
  - Lactams
  - Lactones
  - Cyclic ketones

14. The overall conversion  $\text{RBr} \longrightarrow \text{RCH}_2\text{NH}_2$  can be accomplished by successive application of which of these sets of reagents?

- Mg, ether; then  $\text{NH}_3$
- $\text{NaCN}$ ; then  $\text{LiAlH}_4$ , ether
- $\text{NaN}_3$ ; then  $\text{LiAlH}_4$ , ether
- $\text{H}_2\text{C}=\text{O}$ ; then  $\text{NH}_3$
- $\text{H}_2\text{NOH}$ ; then  $\text{LiAlH}_4$ , ether

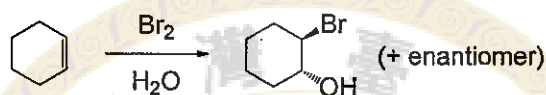
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15. Which reagent would best serve as the basis for a simple chemical test to distinguish between 2-pentanone and 3-pentanone?

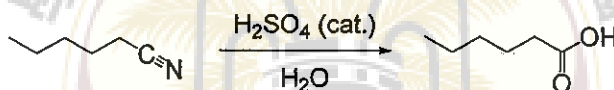
- (A)  $\text{Br}_2/\text{CCl}_4$  (B)  $\text{CrO}_3/\text{H}_2\text{SO}_4$   
(C)  $\text{I}_2$  in  $\text{NaOH}$  (D)  $\text{NaHCO}_3/\text{H}_2\text{O}$   
(E)  $\text{Ag}(\text{NH}_3)_2^+$

Part II. 問答題 (3 題, 20 分)

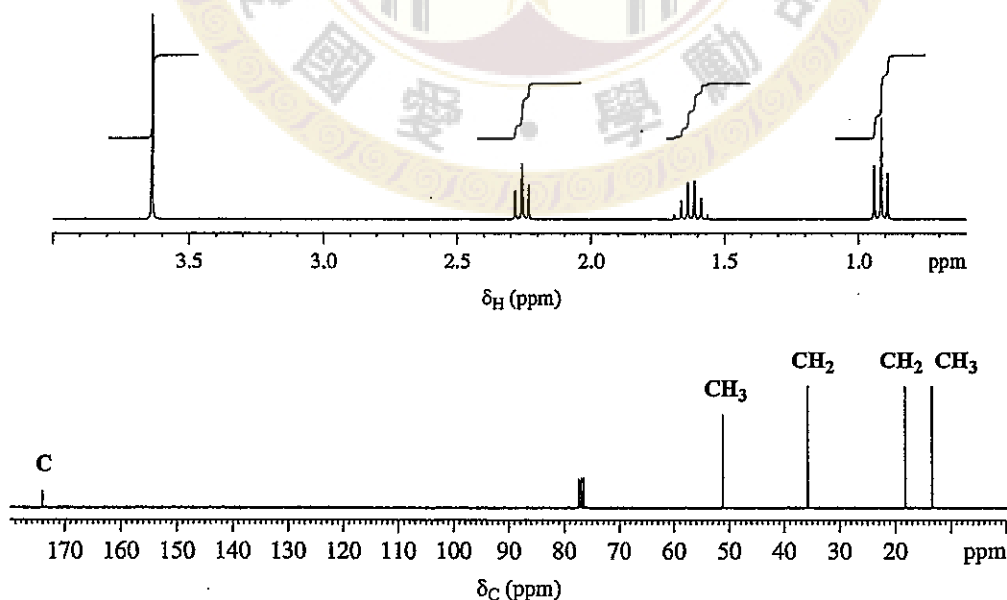
1. Write a mechanism for the following reaction. (5 points)



2. Write a detailed mechanism for the following reaction. (7 points)



3. Deduce the structure of compound E ( $\text{C}_5\text{H}_{10}\text{O}_2$ ) based on the following  $^1\text{H}$ - and  $^{13}\text{C}$ -NMR spectra. Provide step-by-step explanations for your answers. (8 points)



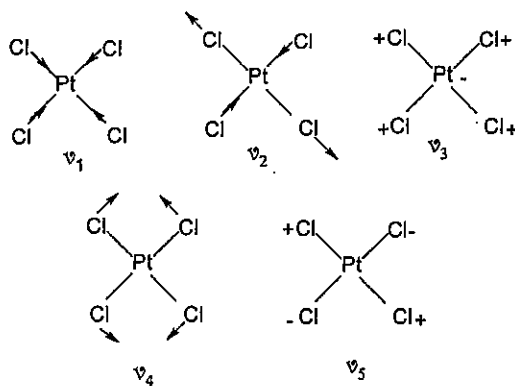
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**Inorganic Chemistry**

1-6. Multiple Choice Questions: (30%; 1 point per choice; -0.5 per mistake)

Mark your answers as: (a) O (b) X (c) O (d) X (e) O

- Which of the following species is optically active?
  - $\text{H}_2\text{O}_2$
  - $\text{CBrClFI}$
  - $[\text{PdBrClFI}]^{2-}$
  - $[\text{Cr}(\text{NH}_3)_6]^{3+}$
  - $[\text{Co}(\text{en})_3]^{3+}$  (where "en" is "ethylenediamine")
- Which of the following cubic lattices contains four cations per unit cell?
  - $\text{NaCl}$
  - $\text{CsCl}$
  - $\text{ZnS}$
  - $\text{CaF}_2$
  - $\text{Na}_2\text{O}$
- The color of which of the following species is due to charge-transfer?
  - $\text{Mn}^{2+}(\text{aq})$
  - $\text{KMnO}_4$
  - $[\text{Cu}(\text{NH}_3)_4]^{2+}$
  - $\text{Fe}_3\text{O}_4$
  - $\text{KFeFe}(\text{CN})_6$
- Which of the following diatomic species is diamagnetic?
  - $\text{BeC}$
  - $\text{BN}$
  - $\text{B}_2$
  - $\text{CN}^+$
  - $\text{OF}^-$
- Which of the following statement is CORRECT?
  - The superconductors have zero electrical resistance at temperatures below their critical temperatures.
  - Metals can be superconductors.
  - $\text{GaAs}$  has a larger energy gap than silicon.
  - Light-emitting diode (LED) is semiconductor materials.
  - P doped  $\text{GaAs}$  has larger band gaps than  $\text{GaAs}$ .
- Which of the following statement about the normal mode vibrations of planar  $\text{PtCl}_4^{2-}$  is CORRECT?
  - $\nu_1$  belongs to  $A_{1g}$  symmetry
  - $\nu_2$  belongs to  $A_{2g}$  symmetry
  - $\nu_3$  belongs to  $A_{2u}$  symmetry
  - $\nu_4$  belongs to  $B_{2u}$  symmetry
  - $\nu_5$  belongs to  $B_{2g}$  symmetry



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Problems:

7.

- (a) Give the symmetry labels for the 3d-, 4s- and 4p-orbitals of the central metal atoms in (i)  $[\text{CrF}_6]^{3-}$  and (ii)  $\text{trans-}[\text{Cr}(\text{en})_2\text{F}_2]^+$ . (where "en" is "ethylenediamine") (8%)  
 (b) How many IR peaks are expected in the Cr-F stretching region for these two complexes? Explain. (12%)

$D_{4h}$ ( $A_{1hmm}$ )	E	$2C_4$	$C_2$	$2C_2'$	$2C_2''$	i	$2S_4$	$\sigma_h$	$2\sigma_v$	$2\sigma_d$	
$A_{1g}$	1	1	1	1	1	1	1	1	1	1	$x^2+y^2, z^2$
$A_{2g}$	1	1	1	-1	-1	1	1	1	-1	-1	$R_z$
$B_{1g}$	1	-1	1	1	-1	1	-1	1	1	-1	$x^2-y^2$
$B_{2g}$	1	-1	1	-1	1	1	-1	1	-1	1	xy
$E_g$	2	0	-2	0	0	2	0	-2	0	0	$(R_x, R_y)$ (xz, yz)
$A_{1u}$	1	1	1	1	-1	-1	-1	-1	-1	-1	
$A_{2u}$	1	1	1	-1	-1	-1	-1	-1	1	1	z
$B_{1u}$	1	-1	1	1	-1	-1	1	-1	-1	1	
$B_{2u}$	1	-1	1	-1	1	-1	1	-1	1	-1	
$E_u$	2	0	-2	0	0	-2	0	2	0	0	(x, y)

$O_h$ ( $m3m$ )	E	$8C_3$	$6C_2$	$6C_4$	$3C_2$ ( $=C_4^2$ )	i	$6S_4$	$8S_6$	$3\sigma_h$	$6\sigma_d$	
$A_{1g}$	1	1	1	1	1	1	1	1	1	1	$x^2+y^2+z^2$
$A_{2g}$	1	1	-1	-1	1	1	-1	-1	1	-1	
$E_g$	2	-1	0	0	2	2	0	-1	2	0	$(2z^2-x^2-y^2, \sqrt{3}(x^2-y^2))$
$T_{1g}$	3	0	-1	1	-1	3	1	0	-1	-1	$(R_x, R_y, R_z)$
$T_{2g}$	3	0	1	-1	-1	3	-1	0	-1	1	
$A_{1u}$	1	1	1	1	1	-1	-1	-1	-1	-1	(xy, xz, yz)
$A_{2u}$	1	1	-1	-1	1	-1	1	-1	-1	1	
$E_u$	2	-1	0	0	2	-2	0	1	-2	0	
$T_{1u}$	3	0	-1	1	-1	-3	-1	0	1	1	(x, y, z)
$T_{2u}$	3	0	1	-1	-1	-3	1	0	1	-1	

試題隨卷繳回