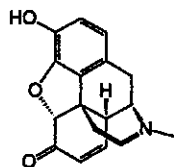


第一部分 有機化學 (共 50 分)

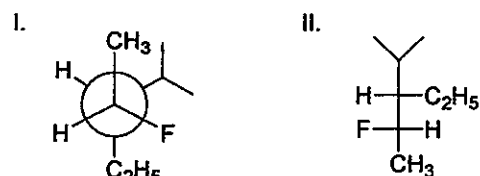
單選題：第 1-17 題 (每題 2 分，共 34 分，請依題號順序於選擇題作答區內作答)

1. What is the index of hydrogen deficiency (or degree of unsaturation) for morphinone?



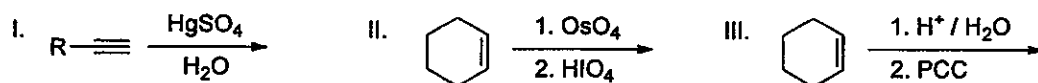
(A) 7 (B) 8 (C) 9 (D) 10

2. I and II are:



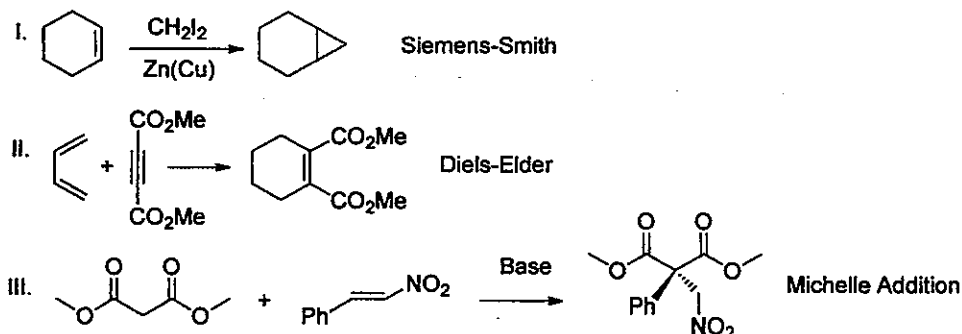
(A) constitutional isomers (B) enantiomers (C) identical (D) diastereomers

3. How many of the following reactions is/are likely to give ketone as the major product:



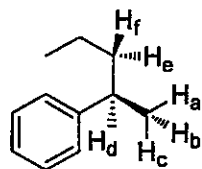
(A) 0 (B) 1 (C) 2 (D) 3

4. How many of the following reactions is/are named correctly:



(A) 0 (B) 1 (C) 2 (D) 3

5. Based on the structure of the compound below, how many of the following states is/are correct?



- I.  $H_a$  and  $H_b$  are homotopic protons.
- II.  $H_f$  and  $H_e$  are diastereotopic protons.
- III.  $H_a$  and  $H_d$  are enantiotopic protons.
- IV.  $H_f$  and  $H_d$  are enantiotopic protons.

(A) 1 (B) 2 (C) 3 (D) 4

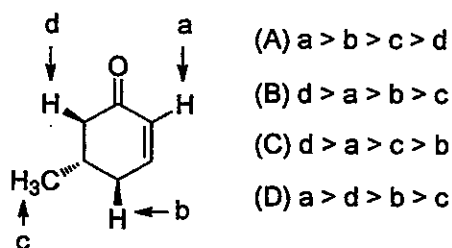
6. About  $S_N2$  reaction, how many of the following statements is/are correct?

- I. Neopentyl bromide is better substrate than methyl bromide.
- II. Anionic nucleophiles are always better than the neutral ones.
- III. Leaving group is important and tosylates are not the good ones.
- IV. DMSO (dimethyl sulfoxide) is a protic solvent preferred.

(A) 0 (B) 1 (C) 2 (D) 3

見背面

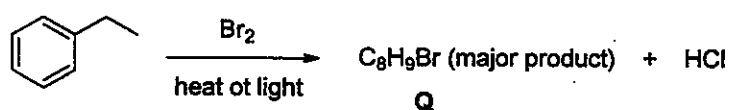
7. Rank the chemical shifts of the protons labeled as a, b, c and d in the following compound:



8. Normally, the hybridization of the carbon of a methyl radical is:

- (A)  $sp$  (B)  $sp^2$  (C)  $sp^3$  (D)  $sp^{1.5}$

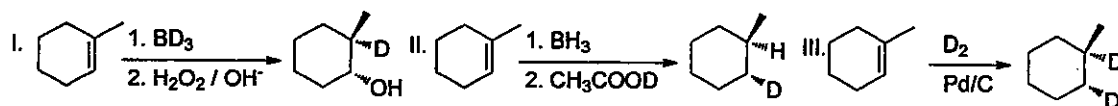
9. About the  $^1H$  NMR spectrum of Q, how many of the following statements is/are correct?



- I. There would be only 4 aromatic protons at low field.  
 II. The signal for the protons on the benzylic carbon would be a triplet.  
 III. The signal for the methyl protons would be a doublet.  
 IV. The signal for the benzylic protons would integrate for 2 hydrogens.

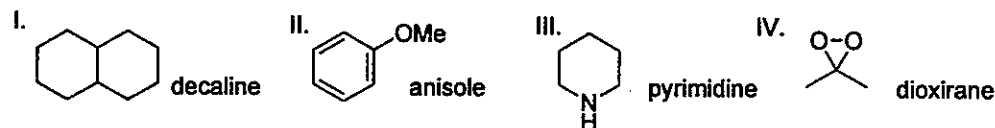
- (A) 1 (B) 2 (C) 3 (D) 4

10. How many of the following reactions is/are likely to proceed effectively?



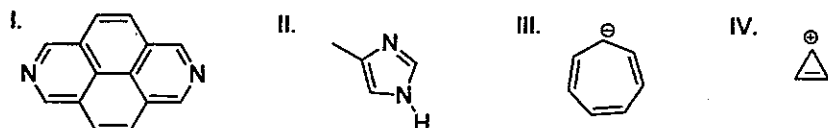
- (A) 0 (B) 1 (C) 2 (D) 3

11. How many of the following nomenclatures is/are correct?



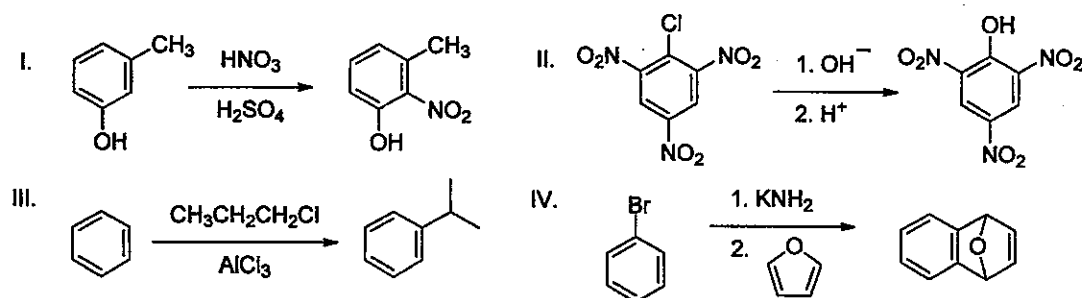
- (A) 1 (B) 2 (C) 3 (D) 4

12. How many of the following compounds is/are aromatic?



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

13. How many of the following reactions is/are likely to proceed effectively?



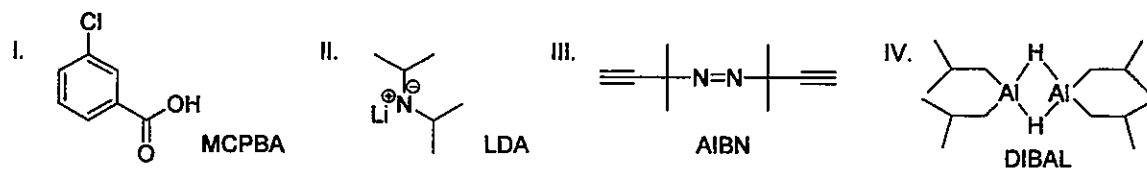
- (A) 1 (B) 2 (C) 3 (D) 4

14. How many of the following statements is/are correct?

- I. [10]Annulene is aromatic.  
 II. TBAF can be used to cleave silyl ether.

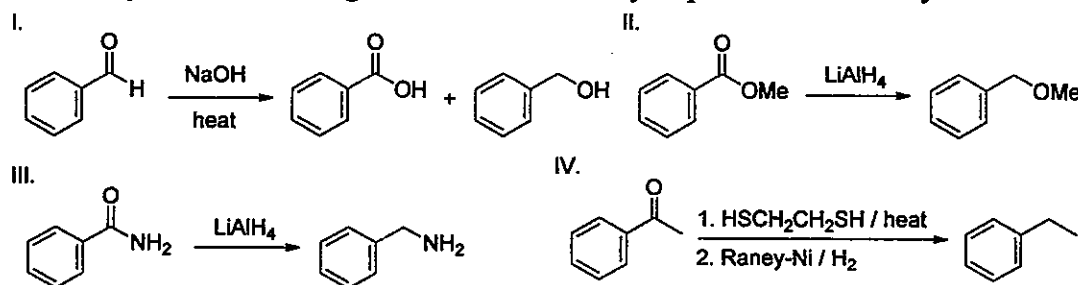
- III.  $\beta$ -carotene absorbs orange light.  
 IV. Wolff-Kishner reaction proceeds under acidic condition.  
 (A) 1 (B) 2 (C) 3 (D) 4

15. How many of the following pairs of structures and name abbreviations is/are correct?



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

16. How many of the following reactions is/are likely to proceed effectively?



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

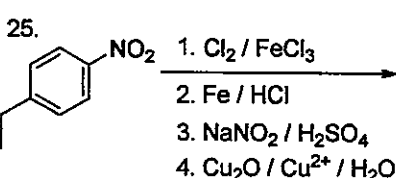
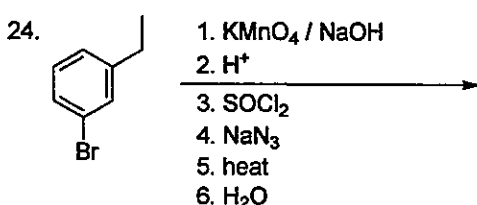
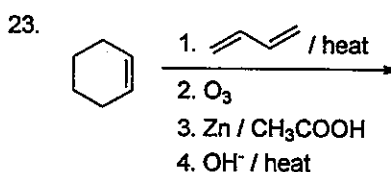
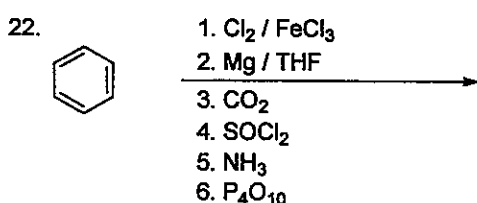
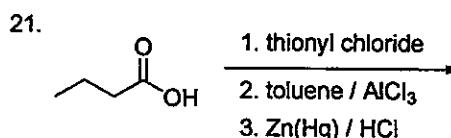
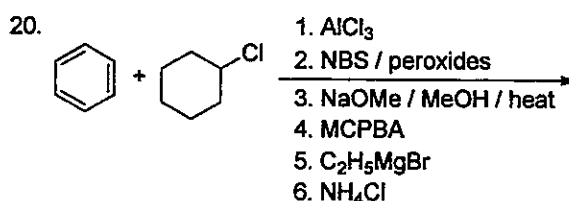
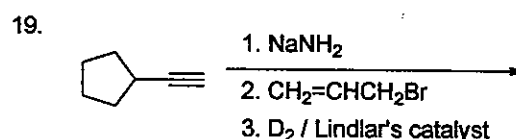
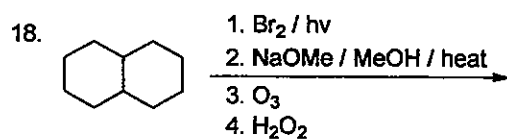
17. How many of the following statements is/are correct?

- I. DCC is frequently used in the amide formation reactions and its full name is dicyclohexyl chromate.  
 II.  $\text{HOOCCH}_2\text{CH}_2\text{CH}_2\text{COOH}$  is called succinic acid.  
 III. McLafferty rearrangement is more likely to be observed in the mass spectra of alkenes.  
 IV. Generally, carbon-carbon triple bond should have IR absorption around  $2150\text{ cm}^{-1}$ .

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

問答題：第 18-25 題（每題 2 分，共 16 分，請依題號順序於非選擇題作答區內作答）

Give the major product in line-angle structure of each of the following reactions:

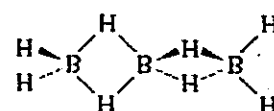
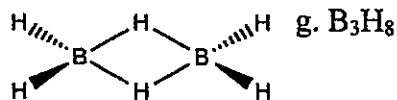


見背面

### Inorganic chemistry

1. Describe the point group of each following molecule: (10 pts)

- a. Ethylene    b.  $\text{H}_3\text{O}^+$     c.  $\text{O}_2\text{F}_2$     d. cyclohexane (chair conformation)    e.  $\text{SO}_4^{2-}$   
f. Diborane



- h. Formaldehyde ( $\text{H}_2\text{CO}$ )    i. Face-centered cubic    j. CsCl

2. Explain the possible reasons for following statements:

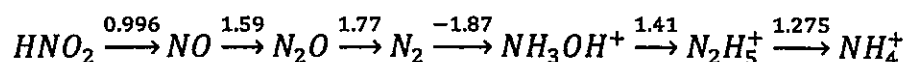
- a. Ethylene is a planar molecule, but hydrazine is not. (3 pts)  
b.  $\text{ICl}_2^-$  is linear, but  $\text{NH}_2^-$  is bent. (3 pts)  
c. To consider two compounds, mercury (II) cyanate ( $\text{Hg}(\text{OCN})_2$ ) and mercury (II) fulminate ( $\text{Hg}(\text{CNO})_2$ ), one is highly explosive, and the other is not. (4 pts)

3. To consider a known molecule of NF:

- a. Construct a molecular orbital energy-level diagram for NF, showing clearly how the atomic orbitals interact to form molecular orbitals. (6 pts)  
b. What is the most likely bond order for NF. (2 pts)  
c. What are the point groups of all molecular orbitals. (3 pts)

4. Show that spheres occupy only 74.0 % of the total volume in face-centered cubic structure in which all the atoms are identical. (5 pts)

5. To consider the following half cell emf diagram for nitrogen in acidic solution:



- a. Construct a Frost diagram for nitrogen in acid. (4 pts)  
b. The half cell emf for  $\text{N}_2\text{O} \rightarrow \text{NH}_3\text{OH}^+$ . (3 pts)

6.  $[\text{Co}(\text{H}_2\text{O})_6]^{3+}$  is a strong oxidizing agent, but  $[\text{Co}(\text{NH}_3)_6]^{3+}$  is stable in aqueous solution. Explain this observation by comparing the difference in LFSE (ligand field stabilization energy) for each oxidized/reduced complexes pair, in which the Co(III) complexes are low-spin and the Co(II) complexes are high-spin. (7 pts)

[Orbital splitting ( $\Delta_0$ ) for  $[\text{Co}(\text{H}_2\text{O})_6]^{3+}$ ] is  $16750 \text{ cm}^{-1}$ , and that for  $[\text{Co}(\text{H}_2\text{O})_6]^{2+}$  is  $8400 \text{ cm}^{-1}$ ; the value of  $\Delta_0$  for  $[\text{Co}(\text{NH}_3)_6]^{3+}$  is  $24000 \text{ cm}^{-1}$  and that for  $[\text{Co}(\text{NH}_3)_6]^{2+}$  is  $10200 \text{ cm}^{-1}$ .