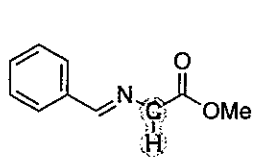
Note: Please write all answers in the organic section in ***English***.

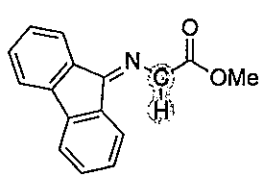
Part I: Multiple Choice (Total: 10 points) ※ 注意：請用 2B 鉛筆作答於答案卡，並先詳閱答案卡上之「畫記說明」。

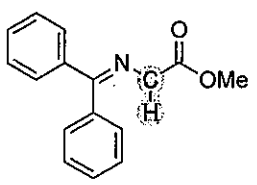
1. What is the bond angle between the two *N*,*N*-dimethyl groups of *N*,*N*-dimethylpropionamide? (2 points)

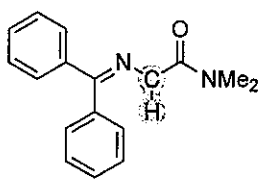
A. 90° **B.** 107° **C.** 109.5° **D.** 120° **E.** 180°

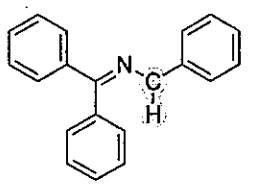
2. Which of the following compounds possess the most acidic C–H bond (as highlighted). (2 points)


A

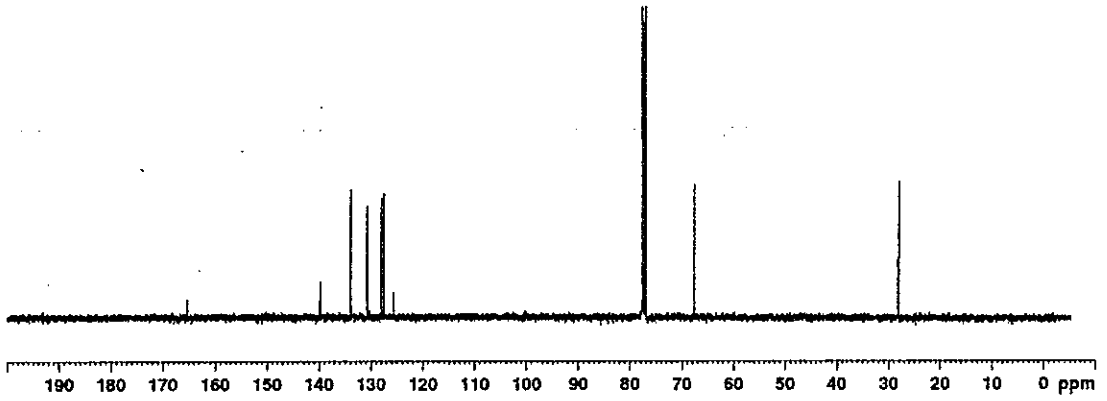

B

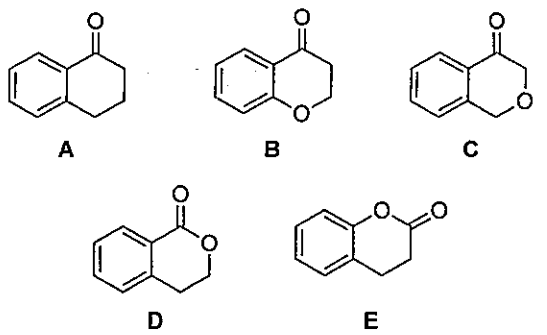

C


D

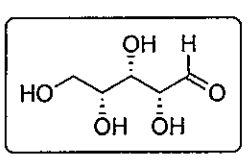

E

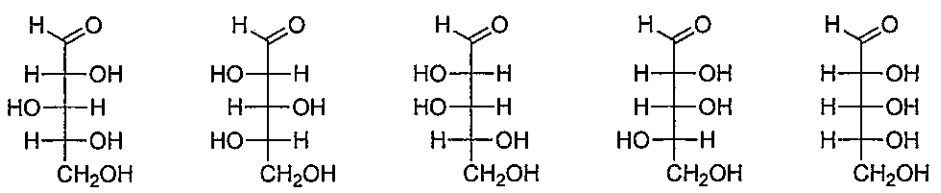
3. Determine the identity of the compound based on ^{13}C NMR shown below. (2 points)



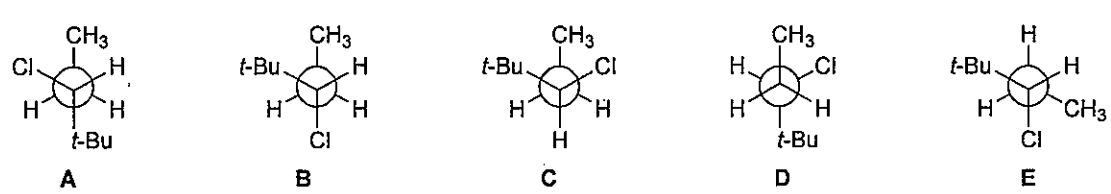

A B C D E

4. Which of the following is a valid Fischer projection for D-(+)-xylose? (2 points)


D-(+)-xylose

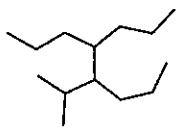

A B C D E

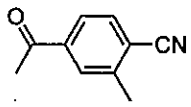
5. Which of the following Newman projections represents the lowest energy conformation of (*S*)-3-chloro-2,2-dimethylpentane? (2 points)


A B C D E

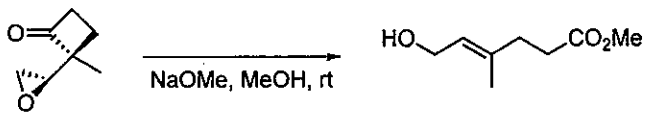
Part II: Written Questions (Total: 40 points) ※ 注意：請於試卷內之「非選擇題作答區」依序作答，並應註明作答之部份及題號。

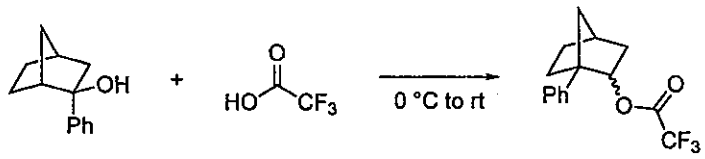
1. Name the following compounds (according to the IUPAC nomenclature in English). (5 points)

(a) 

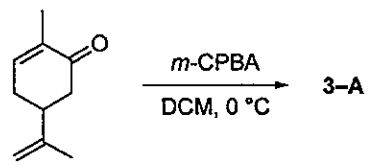
(b) 

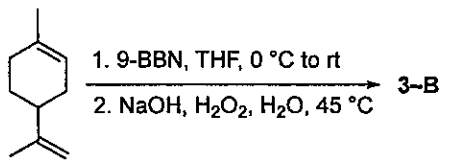
2. Write a plausible mechanism for the following reactions. (6 points)

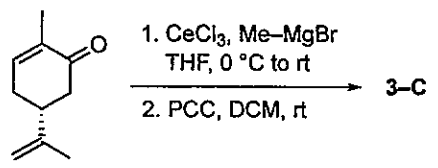
(a) 

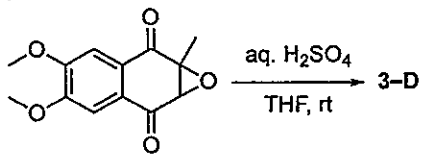
(b) 

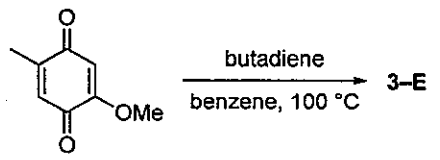
3. Predict the major products for the following reactions. (12 points)

(a) 

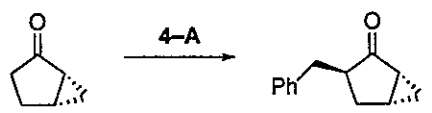
(b) 

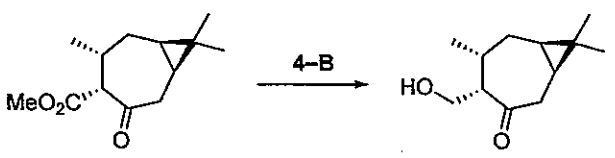
(c) 

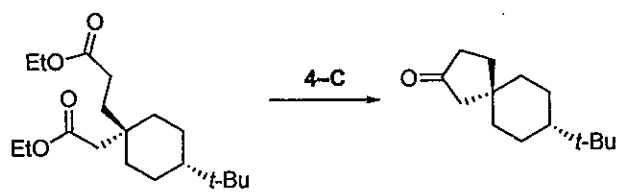
(d) 

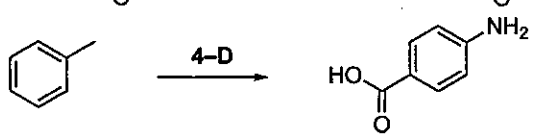
(e) 

4. Suggest suitable reagents and conditions for the following chemical transformations (no need to include the solvent unless it also acts as a reagent). Some may require more than 1 step. (12 points)

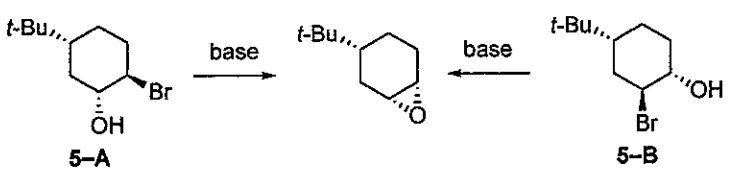
(a) 

(b) 

(c) 

(d) 

5. Answer the following questions regarding the base-mediated cyclization reactions bromohydrins **5–A** and **5–B**, as shown below. (5 points)



5–A **5–B**

(a) Draw the lowest energy conformations of **5–A** and **5–B**.
(b) Assuming that the reaction proceeds through an S_N2 reaction, which bromohydrin (**5–A** or **5–B**) reacts at a faster rate and why?

接次頁

無機化學(50 分)

單選題(30 分, 每題 3 分) ※注意：第 6 至 15 題選擇題考生應作答於 答案卡。

6. The electron configuration of Mn is
(A) $[Ar]4s^03d^6$, (B) $[Ar]4s^13d^5$, (C) $[Ar]4s^13d^6$, (D) $[Ar]4s^23d^5$, (E) $[Ar]4s^23d^6$.

7. Which of the following n' → n transitions in the emission spectrum of atomic hydrogen belong to the Balmer series?
(A) 5 → 4, (B) 5 → 3, (C) 4 → 3, (D) 3 → 2, (E) 4 → 1.

8. Which of the following water solution is more acidic?
(A) 1M HCl, (B) 1M HNO_3, (C) 1M H_2SO_4, (D) 1M CH_3COOH, (E) 1M NaOH.

9. Regarding "ionic liquid", which of the following is <u>incorrect</u>?
(A) it is a green solvent beneficial to the environment, (B) it is a kind of salt, (C) its melting point is generally below room temperature, (D) its structure has a significantly low symmetry, (E) it is highly stable with negligible vapor pressure.

10. There are three types of cubic unit cells, including simple cubic (SC), face-centered cubic (FCC), and body-centered cubic (BCC). Which of the following is <u>correct</u>?
(A) BCC has 4 atoms per unit cell, (B) FCC has the largest unit cell, (C) The coordination number of SC is 8, (D) FCC is alternatively called hexagonal close-packed structure, (E) In BCC, the atomic packing factor is 0.68.

11. Which of the following statements is <u>correct</u>?
(A) The conductivity of metal raises with the increase of temperature, (B) the addition of boron into the silicon forms the n-type semiconductor, (C) the decrease of temperature enhances the conductivity of semiconductors, (D) because both valence band and conduction band are full, the electrons can not move so that the insulator is not conductive, (E) because all the valence electrons of carbon form the covalent bonds, the diamond is not conductive

12. How many of the following molecules or ions contain a C_3 axis and a σ_h plane?
$[NH_4]^+$, SO_3, PCl_3, $AlCl_3$, $[PO_4]^{3-}$, $[NO_3]^-$?
(A) 4, (B) 3, (C) 2, (D) 1, (E) 0.

13. What is the formal charge of oxygen in carbon monoxide?
(A) +2, (B) +1, (C) 0, (D) -1, (E) -2.

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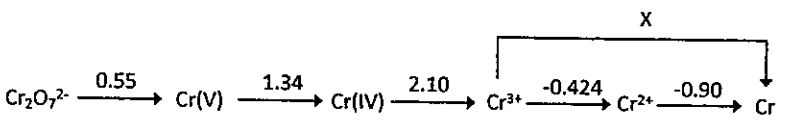
14. The following diagram summarizes the reduction potentials (ε^0) of different chromium species. Please calculate the ε^0 from Cr^{3+} to Cr (Value of X).



(A) -2.22, (B) -1.32, (C) -0.74, (D) -0.66, (E) -0.44.

15. There are two groups of solutions: group A includes the water solutions of 0.01M $AgNO_3$, 0.01M $Pb(NO_3)_2$, 0.01M $Ba(NO_3)_2$, and 0.01M $Ni(NO_3)_2$. Group B includes the water solution of 0.01M NaCl, 0.01M Na_2SO_4, and 0.01M Na_2S. If we take each solution in group A to mix with equal volume of each solution in group B, which of the following statements is correct?

(A) There are 8 solutions with precipitation, (B) there are 5 solutions with no precipitation, (C) there are 4 solutions with black precipitation, (D) there are 5 solutions with white precipitation, (E) none of the mixtures with $Ni(NO_3)_2$ has the precipitation.

非選擇題(20 分) ※ 注意：請於試卷內之「非選擇題作答區」依序作答，並應註明作答之部份及題號。

1. Fact: The S–O bonds are shorter in Sulfur dioxide (143.1 pm) than in sulfur monoxide (148.1 pm).

(A) According to the fact, please draw the most possible Lewis structure of "Sulfur dioxide" and determine the bond order of S-O bond. (2 分)

(B) Qualitatively explain why the S–O bonds are shorter in Sulfur dioxide than in sulfur monoxide. (2 分)

(C) What is the point group of "Sulfur dioxide". (2 分)

(D) Please construct the character table of the point group of "Sulfur dioxide". (4 分)

(E) How many vibration modes are IR active? (2 分)

2. (A) Determine the possible microstates for a d^2 configuration and use them to prepare a microstate table. (4 分)

(B) Reduce this table to its component free-ion terms, and identify the ground-state term. (4 分)

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試題隨卷繳回