

國立中山大學 114 學年度 碩士班考試入學招生考試試題

科目名稱：有機化學及無機化學【化學系碩士班】

— 作答注意事項 —

考試時間：100 分鐘

- 考試開始鈴響前不得翻閱試題，並不得書寫、劃記、作答。請先檢查答案卷（卡）之應考證號碼、桌角號碼、應試科目是否正確，如有不同立即請監試人員處理。
- 答案卷限用藍、黑色筆(含鉛筆)書寫、繪圖或標示，可攜帶橡皮擦、無色透明無文字墊板、尺規、修正液（帶）、手錶(未附計算器者)。每人每節限使用一份答案卷，請斟酌作答。
- 答案卡請以 2B 鉛筆劃記，不可使用修正液（帶）塗改，未使用 2B 鉛筆、劃記太輕或污損致光學閱讀機無法辨識答案者，後果由考生自負。
- 答案卷（卡）應保持清潔完整，不得折疊、破壞或塗改應考證號碼及條碼，亦不得書寫考生姓名、應考證號碼或與答案無關之任何文字或符號。
- 可否使用計算機請依試題資訊內標註為準，如「可以」使用，廠牌、功能不拘，唯不得攜帶書籍、紙張（應考證不得做計算紙書寫）、具有通訊、記憶、傳輸或收發等功能之相關電子產品或其他有礙試場安寧、考試公平之各類器材入場。
- 試題及答案卷（卡）請務必繳回，未繳回者該科成績以零分計算。
- 試題採雙面列印，考生應注意試題頁數確實作答。
- 違規者依本校招生考試試場規則及違規處理辦法處理。

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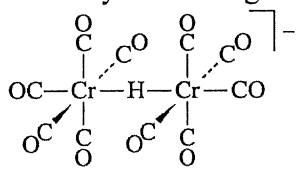
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共 10 頁 第 1 頁

一、選擇題 ($2\% \times 22 + 2.5\% \times 19 = 91.5\%$)

說明：全部單選，第 1 題至第 22 題每題 2 分，第 23 題至第 41 題每題 2.5 分，答錯不倒扣。

1. Which of the following is an inorganic compound?
(A) H_2O_2 (B) MeOH (C) CH_4 (D) HCOOH (E) Me_2O
2. Which of the following is a coinage metal?
(A) Cu (B) Ni (C) Co (D) Fe (E) none of the above
3. The E/R_H value for an electron at $n = 2$ in a Li^{2+} cation is x , where E = energy, R_H = Rydberg constant = 13.61 eV, n = principal quantum number. The nearest whole number of x is
(A) 1 (B) 2 (C) 3 (D) 4 (E) none of the above
4. The electron spin multiplicity of a ground-state carbon atom is
(A) 0 (B) 1 (C) 2 (D) 3 (E) none of the above
5. Of the following compounds, which has the largest bond angle?
(A) CO_2 (B) H_2O (C) NH_3 (D) CH_4 (E) BF_3
6. The point group of ClF_3 is
(A) C_{2v} (B) C_{3v} (C) D_{3h} (D) T_d (E) none of the above
7. In the hydride bridged dinuclear chromium complex,


the number of IR active Cr-H stretching bands is
(A) 0 (B) 1 (C) 2 (D) 3 (E) none of the above
8. The bond order of He_2^+ is
(A) 0 (B) 1 (C) 2 (D) 3 (E) none of the above
9. The electron spin multiplicity of a linear CH_2 is
(A) 0 (B) 1 (C) 2 (D) 3 (E) none of the above
10. In molecular orbital theory, how many group orbitals does BH_3 have?
(A) 1 (B) 2 (C) 3 (D) 4 (E) 5
11. In cationic BH_2^+ , which of the following orbitals at boron participates in HOMO?
(A) $1s$ (B) $2s$ (C) $2p_x$ (D) $2p_y$ (E) $2p_z$
12. The number of unpaired electrons in ground state $[\text{Fe}(\text{OH}_2)_6]^{3+}$ is
(A) 1 (B) 2 (C) 3 (D) 4 (E) 5
13. The spin-only magnetic moment of $[\text{Co}(\text{OH}_2)_6]^{2+}$ is x Bohr magneton. The nearest whole number of x is
(A) 1 (B) 2 (C) 3 (D) 4 (E) 5

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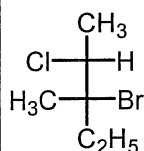
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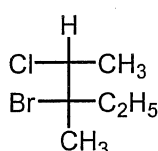
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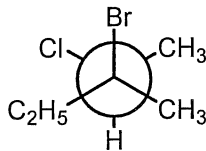
14. The d_{z^2} orbital in $\text{Ni}(\text{CO})_4$ is
(A) σ bonding (B) π bonding (C) non-bonding (D) π anti-bonding (E) σ anti-bonding
15. The number of microstates in the ground state MnO_4^{2-} is
(A) 1 (B) 2 (C) 3 (D) 4 (E) none of the above
16. The number of d-d transition bands in the UV-vis spectrum of $[\text{V}(\text{OH}_2)_6]^{4+}$ is
(A) 0 (B) 1 (C) 2 (D) 3 (E) none of the above
17. The point group of $[\text{Cu}(\text{H}_2\text{O})_6]^{2+}$ is
(A) C_{2v} (B) C_{4h} (C) D_{4d} (D) O_h (E) none of the above
18. Which of the following shows Jahn-Teller effect?
(A) $[\text{Fe}(\eta^5\text{-C}_5\text{H}_5)_2]^+$ (B) $\text{Fe}(\eta^5\text{-C}_5\text{H}_5)_2$ (C) $\text{Co}(\eta^5\text{-C}_5\text{H}_5)_2$ (D) $\text{Ni}(\eta^5\text{-C}_5\text{H}_5)_2$ (E) none of the above
19. In the tungsten complex $\text{W}(\text{CCMe}_3)(\text{CHCMe}_3)(\text{CH}_2\text{CMe}_3)(\text{dmpe})$ where $\text{dmpe} = \text{Me}_2\text{PCH}_2\text{CH}_2\text{PMe}_2$, the CHCMe_3 ligand is
(A) a pure σ donor (B) a pure π acceptor (C) a σ donor and a π donor (D) a σ donor and a π acceptor (E) none of the above
20. With covalent bond classification (CBC) method, the equivalent neutral class formula of $[\text{Fe}(\eta^5\text{-C}_5\text{H}_5)_2]^+$ is $[\text{ML}_l\text{X}_x]$, where $l =$
(A) 1 (B) 2 (C) 3 (D) 4 (E) none of the above
21. How many CO stretching bands does *fac*- $\text{Mo}(\text{CO})_3(\text{PMe}_3)_3$ have?
(A) 1 (B) 2 (C) 3 (D) 4 (E) none of the above
22. The metal-metal bond order of $\text{Zn}_2(\eta^5\text{-C}_5\text{Me}_5)_2$ is
(A) 0 (B) 1 (C) 2 (D) 3 (E) none of the above
23. Which of the following statements is CORRECT?



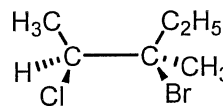
(i)



(ii)



(iii)



(iv)

- (A) (i) and (iv) are identical
- (B) (i) and (ii) are enantiomers
- (C) (i) and (iii) are enantiomers
- (D) (ii) and (iv) are diastereomers

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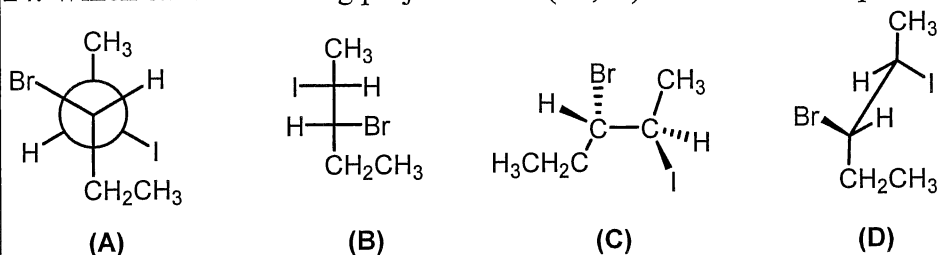
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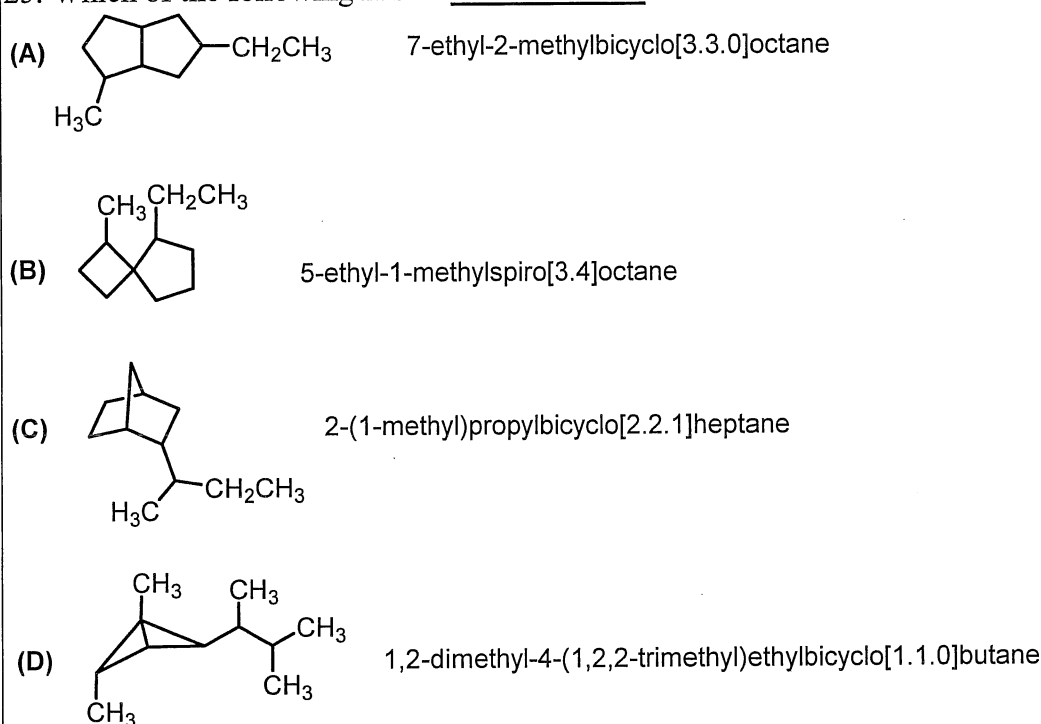
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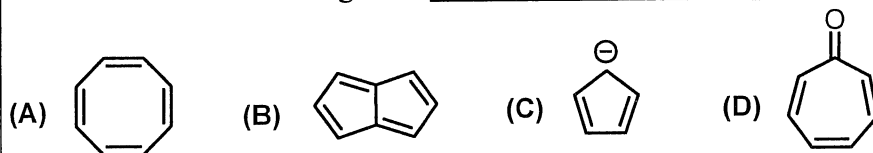
24. Which of the following projections of (2*R*,3*S*)-3-bromo-2-iodopentane is **INCORRECT**?



25. Which of the following has an **INCORRECT** IUPAC name?



26. Which of the following is an **ANTIAROMATIC** compound?



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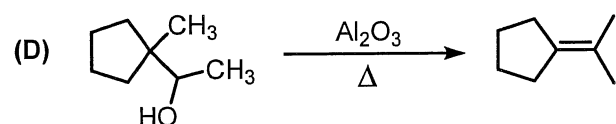
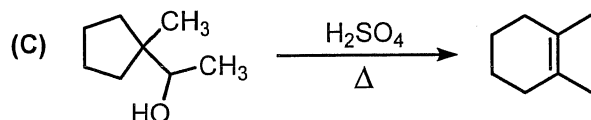
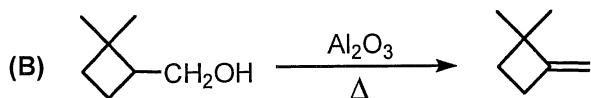
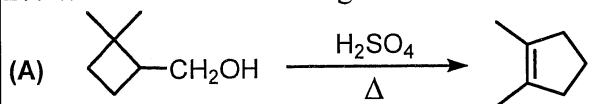
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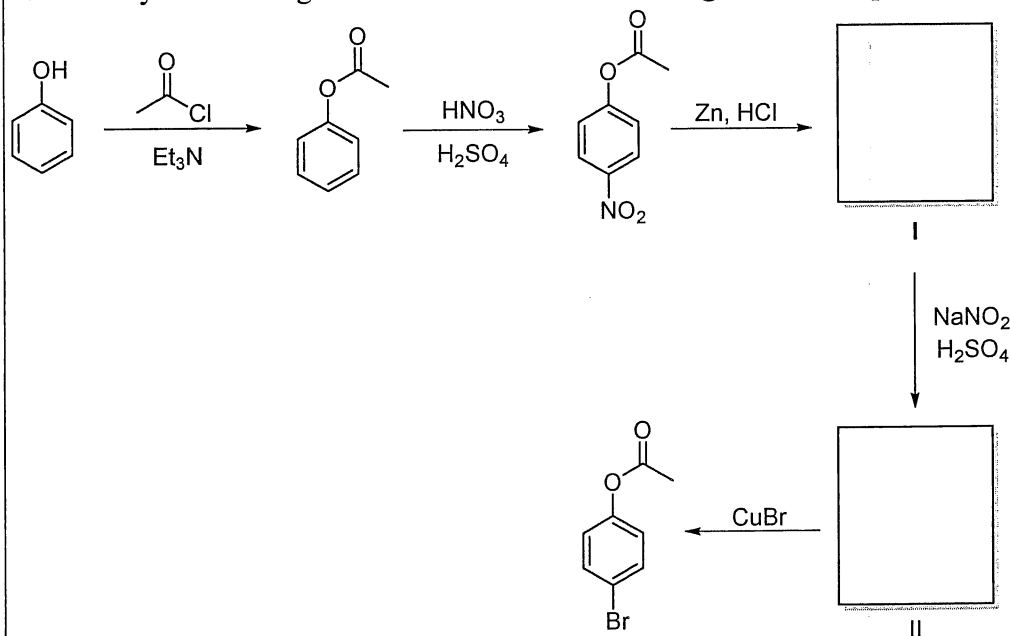
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27. Which of the following elimination reactions provides an **INCORRECT** product?



28. Identify the missing intermediates for the following reaction sequence.



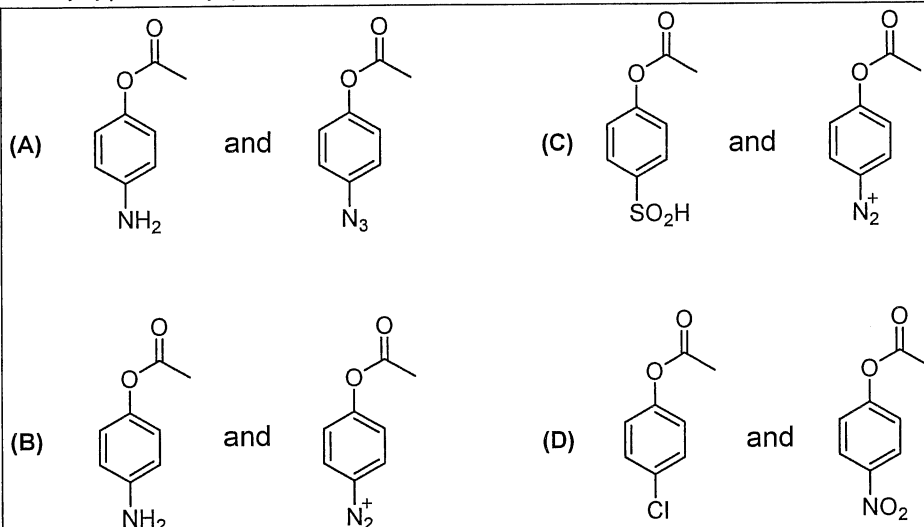
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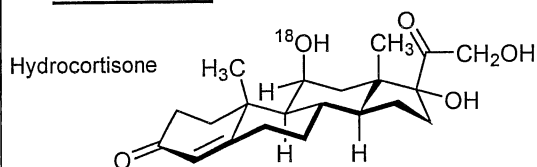
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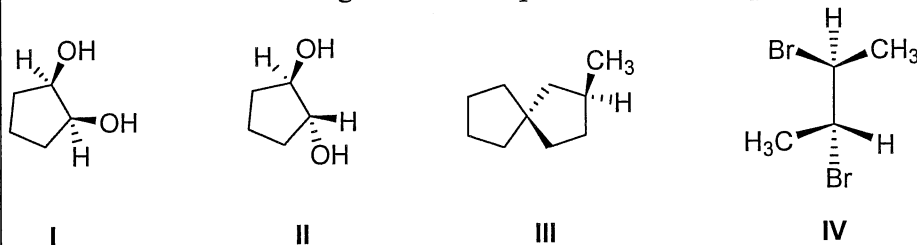


29. Hydrocortisone, a naturally occurring hormone produced in the adrenal glands, is often used to treat inflammation, severe allergies, and numerous other conditions. Which of the following statements is **CORRECT**?



- (A) The two 2° (methyl) groups are in the axial position.
 (B) The two 1° (methyl) groups are in the equatorial position.
 (C) The hydroxy with oxygen-18 is at the axial position.
 (D) The hydroxy with oxygen-18 is at the equatorial position.

30. Which of the following structures represent *meso* compounds?



- (A) I only
 (B) I and IV
 (C) I and II
 (D) II and III

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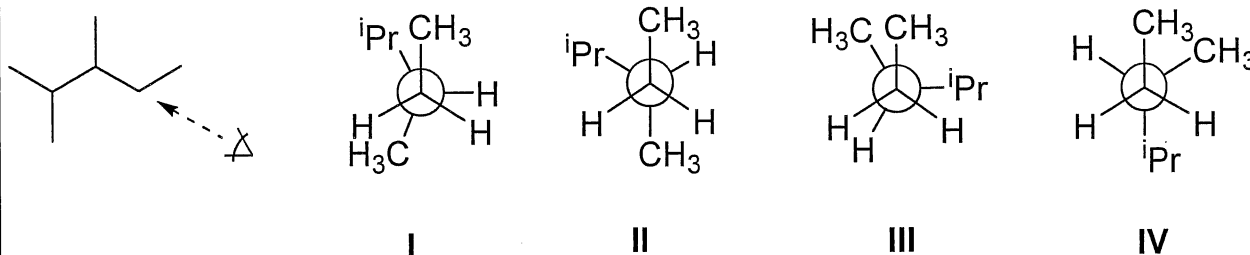
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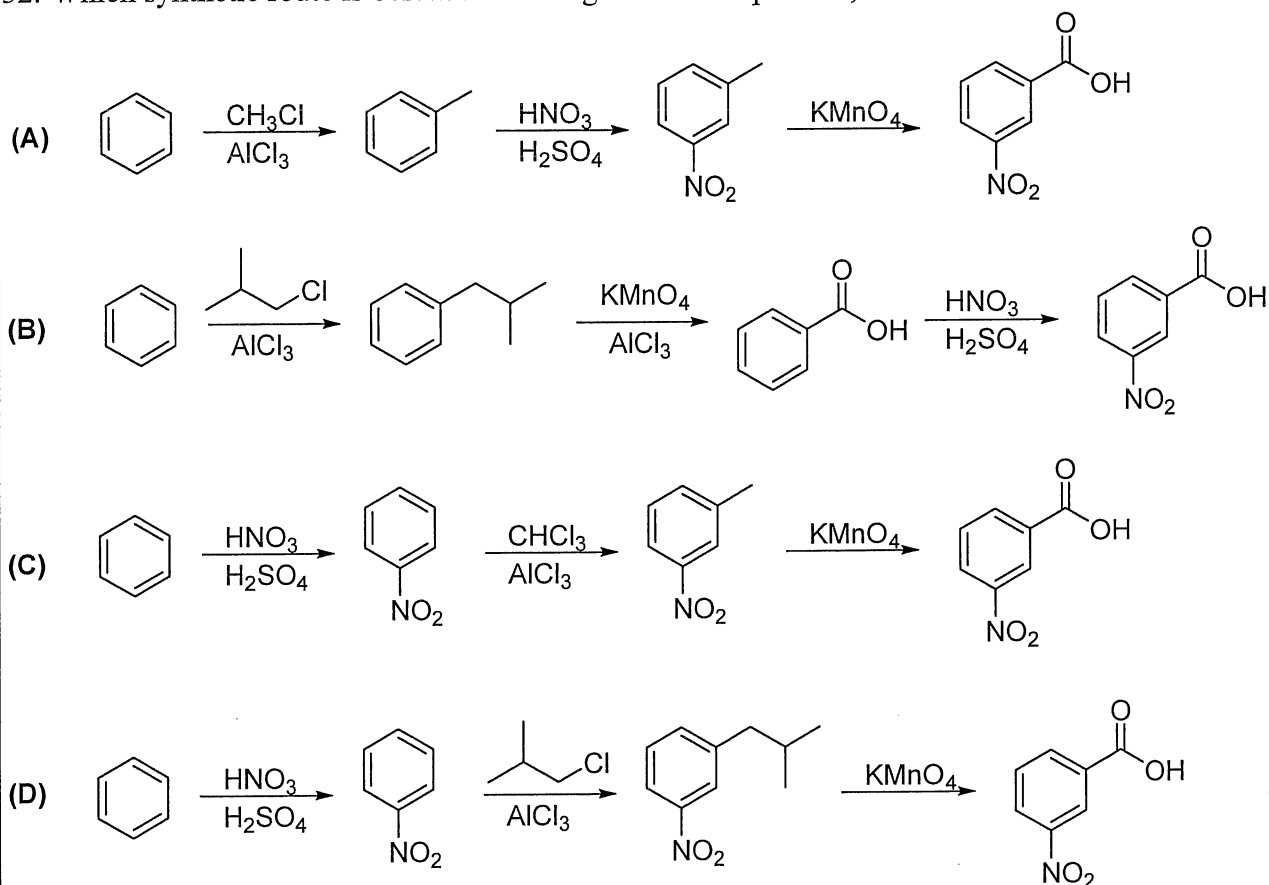
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31. Rank the following Newman projections of 2,3-dimethylpentane from **LOWEST** energy to **HIGHEST** energy.

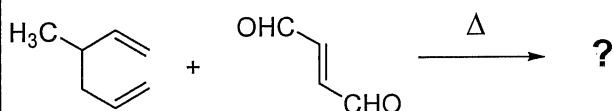


- (A) IV < II < III < I
 (B) I < III < II < IV
 (C) IV < III < II < I
 (D) I < II < III < IV

32. Which synthetic route is best for obtaining the desired product, 3-nitrobenzoic acid?



33. Give the primary product of the following reaction.



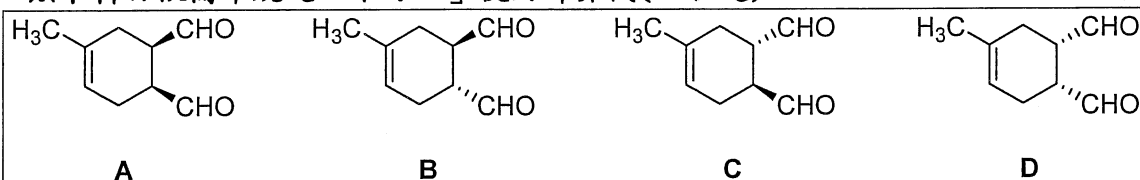
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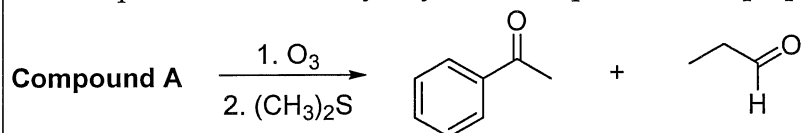
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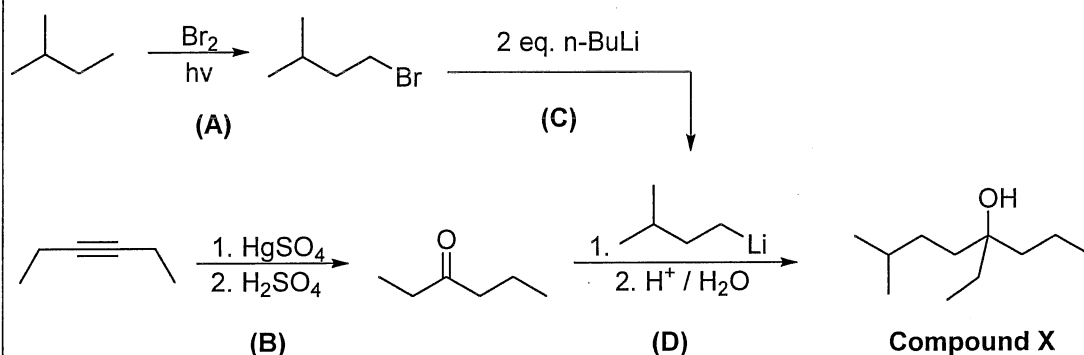


34. Compound A on ozonolysis yields acetophenone and propanal. What is the structure of compound A?

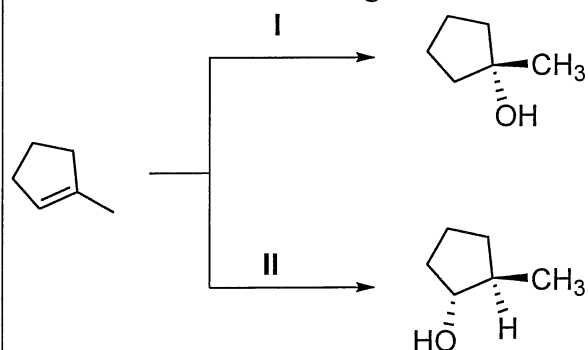


- (A) 2-phenyl-2-pentene
 (B) 1-phenyl-1-hexene
 (C) 1-phenyl-2-pentene
 (D) 2-phenyl-2-hexene

35. Below is a proposed synthesis of compound X. Which step would not work?



36. What are the correct reagents to obtain the respective alcohols?



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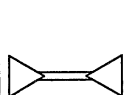
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- (A) $I = \xrightarrow[\text{H}_2\text{O}]{\text{H}_2\text{SO}_4}$, $II = \xrightarrow[\text{NaBH}_4/\text{OH}^-]{\text{Hg}(\text{OAc})_2, \text{THF-H}_2\text{O}}$
- (B) $I = \xrightarrow[\text{H}_2\text{O}_2, \text{OH}^-]{\text{BH}_3:\text{THF}}$, $II = \xrightarrow[\text{H}_2\text{O}]{\text{H}_2\text{SO}_4}$
- (C) $I = \xrightarrow[\text{H}_2\text{O}_2, \text{OH}^-]{\text{BH}_3:\text{THF}}$, $II = \xrightarrow[\text{NaBH}_4/\text{OH}^-]{\text{Hg}(\text{OAc})_2, \text{THF-H}_2\text{O}}$
- (D) $I = \xrightarrow[\text{NaBH}_4/\text{OH}^-]{\text{Hg}(\text{OAc})_2, \text{THF-H}_2\text{O}}$, $II = \xrightarrow[\text{H}_2\text{O}_2, \text{OH}^-]{\text{BH}_3:\text{THF}}$

37. The ^1H NMR spectrum of a C_6H_8 hydrocarbon displays a single sharp signal. The ^{13}C NMR spectrum has two resonance signals. Which of the following compounds would fit this evidence?



A



B

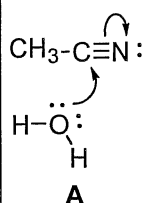
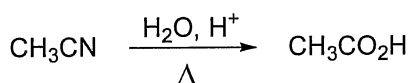


C

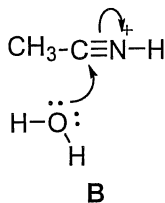


D

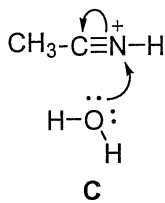
38. Which of the following best depicts the initial nucleophilic addition step in the acid-catalyzed hydrolysis of the acetonitrile shown below?



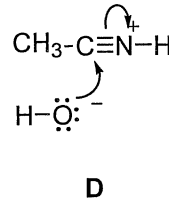
A



B



C



D

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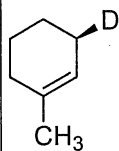
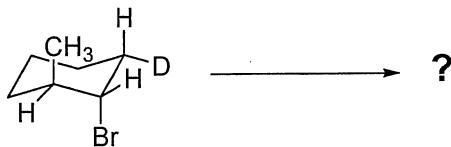
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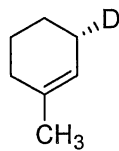
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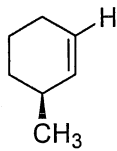
39. What is the major product of an E2 reaction of the compound shown below?



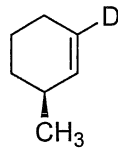
A



B

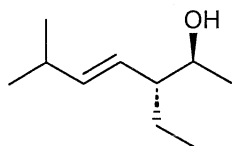


C



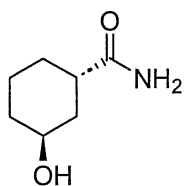
D

40. What is the correct IUPAC systematic name for the compound below?



- (A) (2*R*,3*S*,*E*)-3-ethyl-6-methylhept-4-en-2-ol
 (B) (2*S*,3*R*,*E*)-3-ethyl-6-methylhept-4-en-2-ol
 (C) (2*S*,3*R*,*E*)-3-ethyl-2-hydroxy-6-methylhept-4-en
 (D) (2*R*,3*S*,*E*)-3-ethyl-2-hydroxy-6-methylhept-4-en

41. What is the correct IUPAC systematic name for the compound below?



- (A) (1*R*,3*S*)-3-hydroxycyclohexane-1-carboxamide
 (B) (1*R*,3*R*)-3-hydroxycyclohexane-1-carboxamide
 (C) (1*S*,3*S*)-3-hydroxycyclohexane-1-carboxamide
 (D) (1*S*,3*R*)-3-hydroxycyclohexane-1-carboxamide

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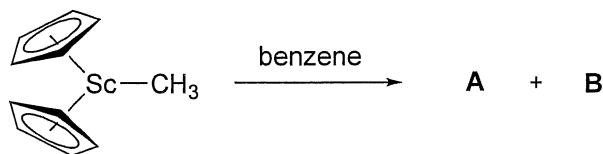
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共 10 頁 第 10 頁

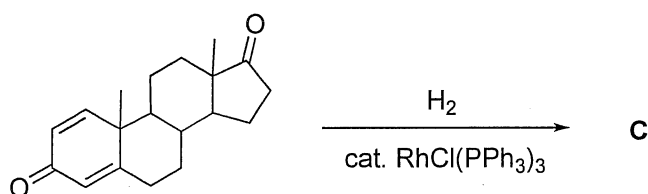
二、非選擇題 (8.5%)

1. Depict products A, B, and C, where A is an organometallic complex. (2% × 3 = 6%)

(a)



(b)



2. Give the final product for the reaction sequence shown below. (2.5%)

