國立清華大學 106 學年度碩士班考試入學試題

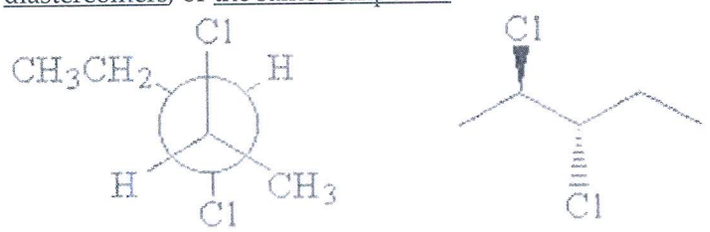
系所班組別：生醫工程與環境科學系乙組

考試科目（代碼）：有機化學 2403

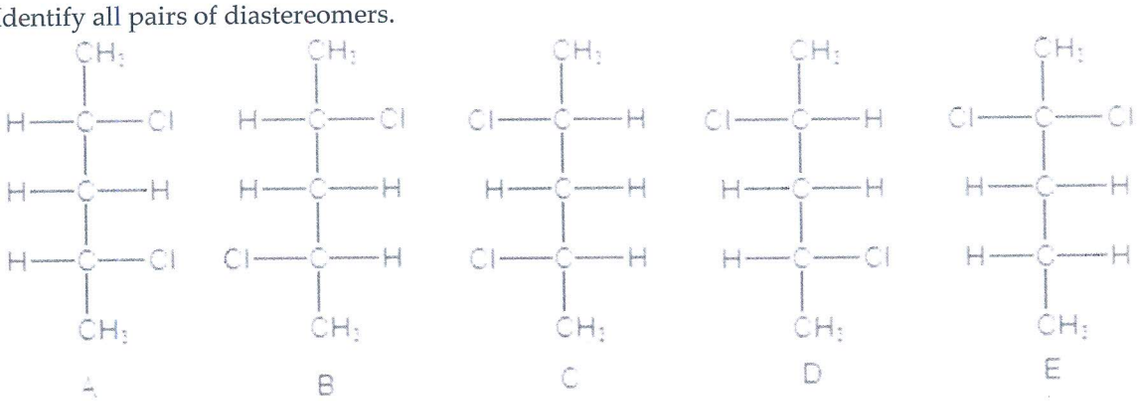
　　*請在【答案卷】作答

一. 問答題（每題 2.5 分共 100 分）

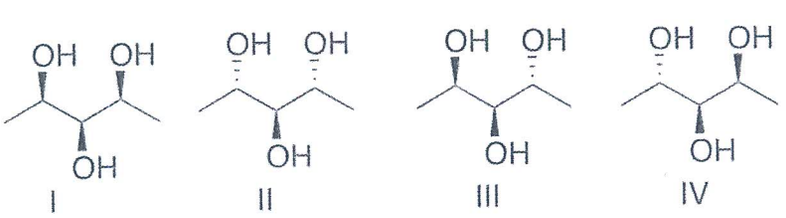
1. Which of the following terms best describes the pair of compounds shown: enantiomers, diastereomers, or the same compound?



2. Identify all pairs of diastereomers.



3. Which of the following molecules will not rotate the plane polarized light?

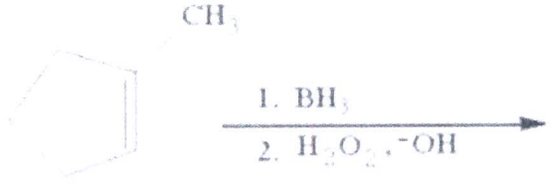


4. Consider the set of compounds, NH_3, HF, and H_2O. Rank these compounds in order of increasing acidity and discuss your rationale.
5. Draw a resonance contributor and the resonance hybrid for $HOCO_2^-$.
6. Which of the following is the electronic configuration of the element Fe?
   (A) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 4d^6$
   (B) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^6$
   (C) $1s^2\ 2s^2\ 2p^8\ 3s^2\ 3p^6\ 4s^2\ 3d^6$
   (D) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^8\ 3d^6$
   (E) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 4p^6$

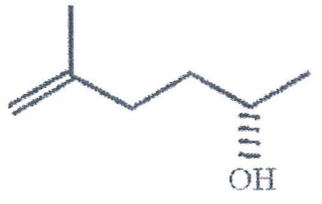
7. Draw the major organic product generated in the reaction below.

8. Provide the major organic product(s) in the reaction below.

9. Draw the major organic product generated in the reaction below.



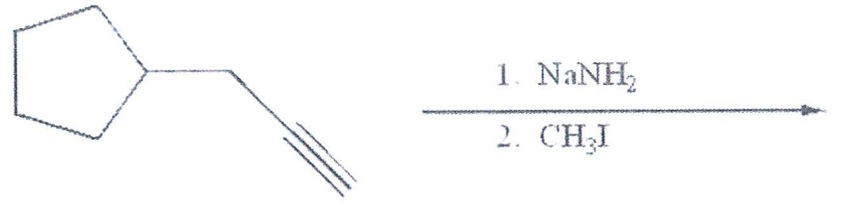
10. Give the systematic name of the compound shown below.



11. Complete the following reaction.

12. Provide the structure of the major organic product that results when 2-butyne is treated with H_2 in the presence of Lindlar's catalyst.

13. Provide the structure of the major organic product of the following reaction.



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14. Provide the major organic product of the following reaction.

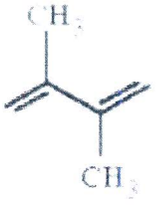
15. Is the following molecule aromatic? Explain.

16. Provide the structure of the biologically significant heterocycle purine.
17. Draw the LUMO of 1,3,5-hexatriene.
18. Why is phenol a stronger acid than cyclohexanol?

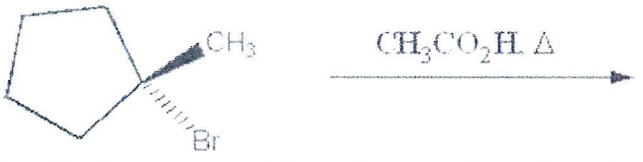
phenol

cyclohexanol

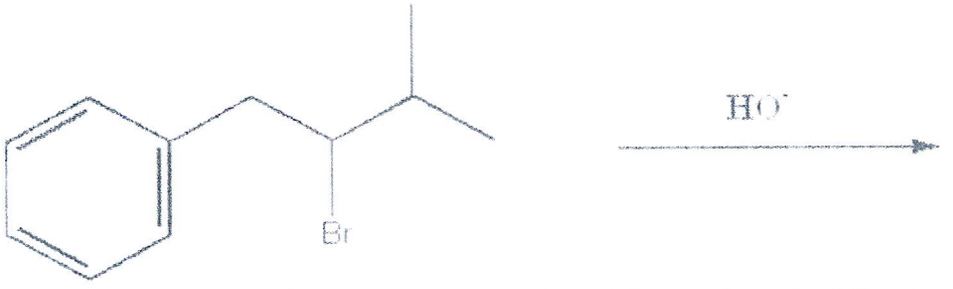
19. Draw the structure of the major product which results when the diene shown is treated with HBr at -80°C.



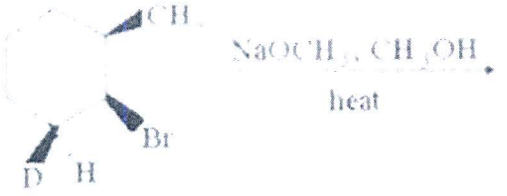
20. Rank the species below in order of increasing nucleophilicity in protic solvents: $CH_3CO_2^-$, CH_3S^- , HO^- , H_2O.
21. Provide the structure of the major organic product of the following reaction.



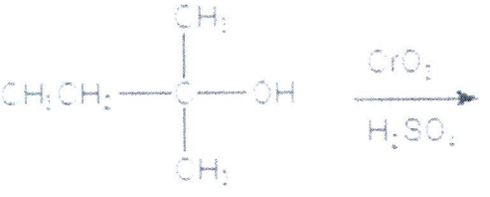
22. Provide the structure of the major organic product of the following reaction.



23. Provide the structure of the major organic product which results in the following reaction.

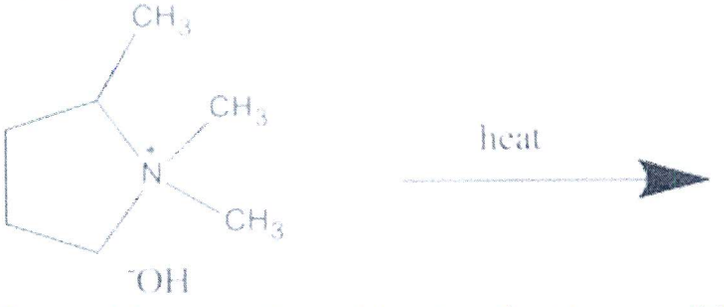


24. Give the major product for the following reaction.



25. Provide the major organic product in the reaction below.

26. Provide the major organic product of the following reaction.



27. How would one use a Grignard-based synthesis to accomplish the following transformation?
benzyl bromide ($PhCH_2Br$) to 3-phenyl-1-propanol

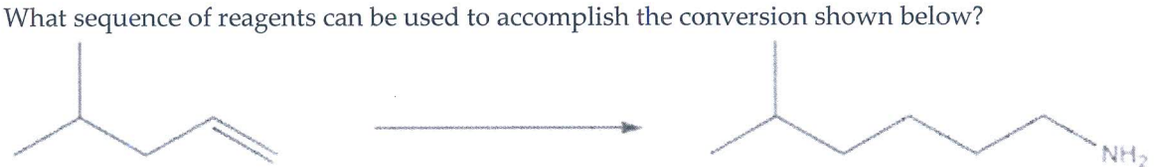
28. Given the bond dissociation energies below (in kcal/mol), calculate the overall ΔH° for the following reaction:

$(CH_3)_3CH + Br_2 \rightarrow (CH_3)_3CBr + HBr$

$(CH_3)_3C$-H	91
$(CH_3)_3C$-Br	65
Br-Br	46
H-Br	88
CH_3-Br	70

29. When 1,1,3,3-tetramethylcyclobutane is brominated at 125°C, the relative reactivity of the 1°: 2° :3° hydrogens is approximately 1: 82: 1600. Estimate the amount of each monobromination product.

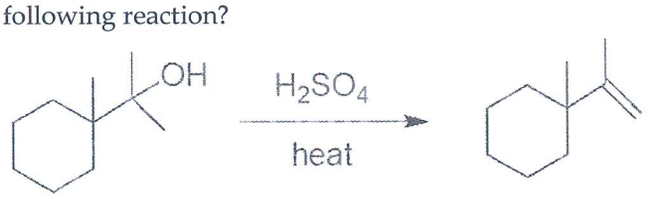
30. What sequence of reagents can be used to accomplish the conversion shown below?



31. The mass spectrum of an unknown compound has a molecular ion peak with a relative abundance of 43.27% and an M + 1 peak with a relative abundance of 3.81%. How many carbon atoms are in the compound?

32. Which has a lower characteristic stretching frequency, the C–H or C–D bond? Explain briefly.

33. How can NMR spectroscopy be used to determine the formation of the product in the following reaction?



34. Provide the structure that is consistent with the data below.

$C_5H_{10}O_2$

IR (cm^{-1}): 3300–2800 (v. broad), 2950, 1710

^1H NMR (δ): 12.0 (broad s, 1H), 0.9 (s, 9H)

^{13}C NMR (δ): 220 (s), 45 (s), 12 (q)

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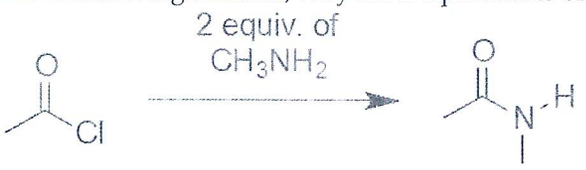
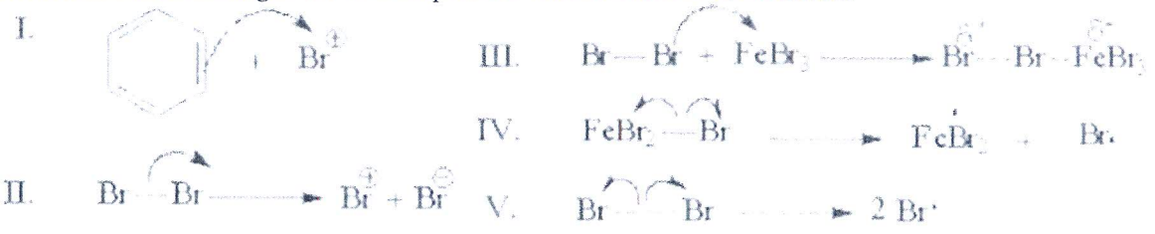
35. In the following reaction, why are 2 equivalents of the amine needed?



36. An unknown compound, $C_5H_{10}O_2$, gave the following proton NMR data:
    a) doublet, at 1.23 ppm (6H)
    b) singlet, at 2.10 ppm (3H)
    c) septet, at 4.98 ppm (1H)
    Propose a structure for the compound.

37. What reagent can be used to convert benzophenone into triphenylmethanol?

38. Which of the following is the first step in the mechanism of bromination?



39. How would you convert benzene to 1,3,5-tribromobenzene?

40. Propose a synthesis of the following compound from benzene.