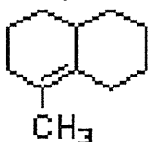


※ 考生請注意：本試題不可使用計算機。請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

一、選擇題：(單選，每題 2 分，共 40 分)

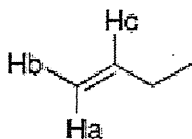
1. What would be the signs of ΔH° and ΔS° (differences in enthalpy and entropy, respectively) in the reaction of cyclohexene with H_2 to form cyclohexane? (A) $\Delta H^\circ > 0$ and $\Delta S^\circ > 0$ (B) $\Delta H^\circ > 0$ and $\Delta S^\circ < 0$ (C) $\Delta H^\circ < 0$ and $\Delta S^\circ > 0$ (D) $\Delta H^\circ < 0$ and $\Delta S^\circ < 0$ (E) $\Delta H^\circ = 0$ and $\Delta S^\circ = 0$.
2. The CCC bond angle in $(CH_3)_3C^+$ is about _____ degrees and its positively charged carbon has _____ hybridization form. (A) 109.5; sp^2 (B) 109.5; sp^3 (C) 120; sp^2 (D) 120; sp^3 (E) 180; sp .
3. What is the collision (dimerization) product of the reactive intermediate species formed when $CHBr_3$ is treated with hydroxide? (A) an alkane (B) an alkene (C) an alkyne (D) an aromatic ring (E) a carbanion.
4. How many enantiomers are there of *cis*-1,2-dimethylcyclopentane? (A) 0 (B) 1 (C) 2 (D) 3 (E) 4.
5. For S_N2 reactions using anionic nucleophiles, which of the following features of solvent is most suitable? (A) polar, protic (B) polar, aprotic (C) nonpolar, protic (D) nonpolar, aprotic.
6. Which of the following statements regarding nucleophilicity is false? (A) The iodide ion is the better nucleophile than fluoride (B) Ethoxide is the better nucleophile than *t*-butoxide (C) polarizability is favorable for nucleophilicity but not for basicity (D) CH_3SH is more nucleophilic than CH_3OH (E) none of above.
7. Which of the following compounds exhibits the best S_N2 reactivity towards $NaCN$? (A) bromoethane (B) 1-chloro-3,3-dimethylpentane (C) 1-chloro-2,2-dimethylpentane (D) 2-bromo-2-methylpentane (E) none of above.
8. In an S_N1 reaction, which of the following species displays the lowest reactivity? (A) CH_3CHICH_3 (B) CH_3Br (C) $CH_3CH_2CH_2I$ (D) $(CH_3)_3CI$ (E) $CH_3CHBrCH_3$.
9. How many carbons are coplanar in the molecule shown below? (A) 2 (B) 3 (C) 4 (D) 5 (E) 6.



10. Which of the following compounds has the highest degree of unsaturation as indicated in the molecular formula? (A) $C_{10}H_{16}$ (B) $C_{15}H_{28}O_2$ (C) $C_6H_6Cl_6$ (D) $C_8H_4N_2$ (E) C_5H_8O .
11. How many different alkenes can be drawn in structure from the molecular formula C_5H_{10} ? (A) 3 (B) 4 (C) 5 (D) 6 (E) 7.
12. Which of the following alcohols has lowest boiling point? (A) $(CH_3)_3COH$ (B) $CH_3(CH_2)_4OH$ (C) $(CH_3)_3CCH_2OH$ (D) $(CH_3)_2CHCH_2CH_2OH$.
13. Which of the following solvents is most ideal for being used in the preparation of Grignard and organolithium reagents? (A) ester (B) alcohol (C) ether (D) alkane (E) amine.
14. Which of the following sets of reagents is appropriate to carry out the chemical transformation below? (A) $KMnO_4$, $-OH$ (B) 1. $LiAlH_4$, 2. H_3O^+ (C) $NaBH_4$, CH_3OH (D) H_2 (excess), Raney Ni (E) 1. Mg/Et_2O , 2. H_3O^+ .

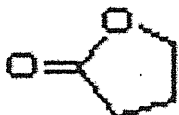


15. Absorption of radio waves can result in (A) transitions among allowed rotational motions (B) electronic transitions (C) transitions among nuclear magnetic spin states (D) ionization (E) transitions among allowed vibrational motions.
16. In IR spectroscopy, which of the following statements is false? (A) the C—O bond has a lower frequency than the C—N bond (B) the carbon-carbon triple bond stretch of an alkyne can be found 2100-2200 cm^{-1} (C) the fingerprint region locates at 600-1400 cm^{-1} (D) bond length influences the intensity of a peak (E) none of above.
17. Which of the following bonds has the highest stretching frequency in IR spectroscopy? (A) C≡N (B) C—N (C) C=O (D) O—H.
18. Which of the following m/z fragments could be found in the mass spectrum of 3-pentanone? (A) 15 (B) 43 (C) 57 (D) all of above (E) none of above.
19. If the protons of CH_2Cl_2 show up at 5.30 ppm on a 100 MHz spectrometry, where may the peak be present when measured on a 500 MHz spectrometer? (A) 8.33 ppm (B) 5.30 ppm (C) 3.18 ppm (D) 1.06 ppm (E) more information is needed for determination.
20. As indicated in the compound below, which of the following order can correctly rank the coupling constants (J, Hz) among H_a , H_b and H_c ? (A) $J_{\text{cis}} > J_{\text{trans}} > J_{\text{gem}}$ (B) $J_{\text{trans}} > J_{\text{cis}} > J_{\text{gem}}$ (C) $J_{\text{gem}} > J_{\text{cis}} > J_{\text{trans}}$ (D) $J_{\text{cis}} > J_{\text{gem}} > J_{\text{trans}}$ (E) $J_{\text{trans}} > J_{\text{gem}} > J_{\text{cis}}$.

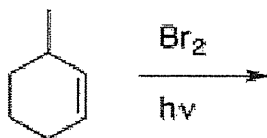


二、簡答題：(每題 3 分，共 60 分)

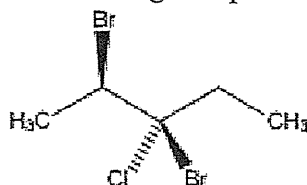
1. What is the major consequence when the following compound is treated with NaBH_4 , followed by H_3O^+ ?



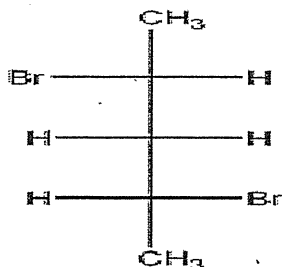
2. Draw the structures of the products of the following light-promoted reaction in the presence of a small amount of bromine.



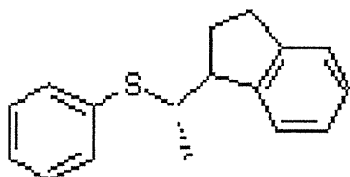
3. Name the following compound with correct stereochemistry indicated.



4. The following compound is shown in Fischer projection. Name the compound with correct stereochemistry indicated.

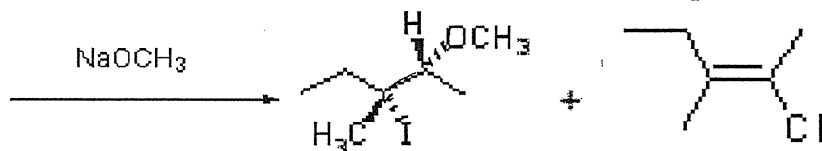


5. The compounds A and B react to give the following product and sodium bromide by an S_N2 reaction mechanism. Draw the chemical structures of A and B



6. 1-Bromo-2, 2-dimethylcyclopentane can undergo rearrangement to give fully alkyl-substituted alkene when heated in ethanol. Draw the structure of the final rearrangement product.

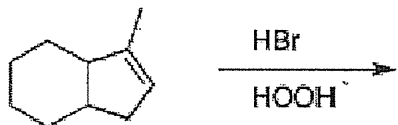
7. The compound A reacts with NaOCH_3 to give the following two products as the major substitution product and the major elimination product. Predict the structure of compound A.



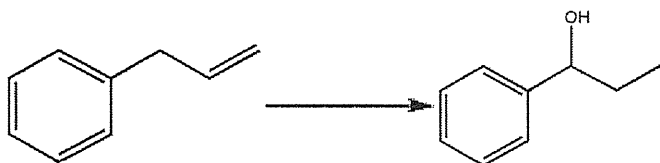
8. Name the major product obtained when *cis*-1-bromo-2-methylcyclohexane is treated with *tert*-butoxide/*tert*-butyl alcohol?

9. Give the IUPAC name for the alkene isomer of formula C_5H_{10} which can give the largest molar heat of hydrogenation.

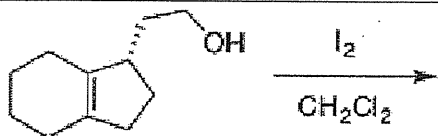
10. Draw the major alkyl halide product generated from the following reaction.



11. Provide a one-step reaction condition with appropriate reagents to accomplish the following chemical transformation.



12. Provide the product generated in the reaction below.

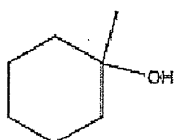


13. Draw the structures of the products when bromo-cyclohexane is treated with the following reaction sequence: (1) $NaOCH_3$, CH_3OH (2) MCPBA or CH_3CO_3H (3) H_3O^+ or hydroxide.

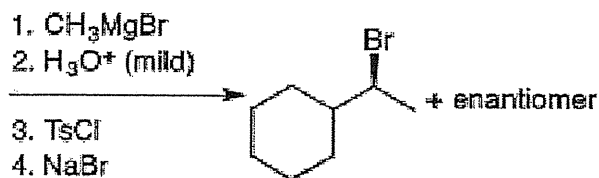
14. Draw the product generated from the reaction of the following starting material with a 2-step treatment of reagents, (1) Br_2 / CH_3OH and (2) $(CH_3)_2CuLi$.



15. Predict and draw the product generated when the following starting material is treated with a sequence of reagents: (1) H_2SO_4, Δ (2) $BH_3 \cdot THF$ (3) $H_2O_2, NaOH$ (4) pyridinium chlorochromate.



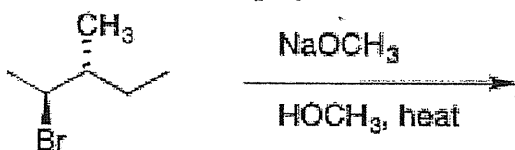
16. Draw the structure of the starting material applied to the following 4-step sequence of reaction to give a mixture of enantiomers as shown below.



17. Draw the structure of the compound with molecular formula $C_5H_{10}O$ which gives the following spectral data: 1H NMR, δ 1.2 (6H, doublet), 2.1 (3H, singlet), 2.8 (1H, septet) (ppm); IR, 2980, 1710 cm^{-1} ; MS, m/z 71, 43.

18. A compound has a molecular formula of C_7H_{16} and displays 3 peaks in both ^{13}C and 1H NMR spectra, where a doublet, a triplet and a multiplet are observed in 1H NMR. Draw the structure of this compound.

19. Draw the structure of the product obtained from the following reaction. Also, explain the reason for its formation using a Newman projection as a model.



20. What would be the major product of the following reaction? Draw the chemical structure of the product and also provide the detailed, stepwise reaction mechanism indicated with electron flows for its formation.

