1. According to IUPAC nomenclature, which of the following is the name for the compound shown?
   (A) 3-butyl-2-(1-methylethyl)pentane  (B) 2-isopropyl-3-butylpentane  
   (C) 2-isopropyl-3-ethylheptane  (D) 4-ethyl-2,3-dimethyloctane

2. Which compound corresponds to a compound with exactly one ring or double bond?
   (A) C₅H₁₀O  (B) C₅H₁₀Cl₂O  (C) C₅H₁₁Cl  (D) C₅H₁₁ClO

3. Of the following carboxylic acids, which is the most acidic?
   (A) CH₃CO₂H  (B) HCO₂H  (C) C₆H₅CO₂H  (D) CH₃CO₂H

4. Which conformation has the highest energy for butane?
   (A) anti  (B) eclipsed  (C) gauche  (D) stagger

5. What is the possible number of stereoisomers having the structure below?
   \[ \text{OH} \quad \text{OH} \]
   \[ \text{H}_3\text{C} - \text{CH} - \text{CH}_2 - \text{CH} - \text{CH}_3 \]
   (A) four optically active  (B) two optically active and two meso
   (C) one optically active and one meso  (D) two optically active and one meso

6. Which of the following would be correct?
   \[ \text{Me} \quad \text{Me} \quad \text{Et} \quad \text{Et} \]
   \[ \text{BrH}_2\text{C} \quad \text{H} \quad \text{CH}_2\text{Br} \]
   (A) I is R form  (B) II is R form  (C) I is dextrorotatory  (D) II is levorotatory

7. Which of the following compound is hemiacetal?
   \[ \text{(A)} \quad \text{(B)} \quad \text{(C)} \quad \text{(D)} \]
   \[ \text{OH} \quad \text{OH} \quad \text{OH} \quad \text{OH} \]
   \[ \text{H} \quad \text{OH} \quad \text{OCH}_3 \quad \text{OCH}_3 \]

8. Which alkyl halides undergo Friedel-Crafts reaction with rearrangement?
   (A) ethyl chloride  (B) 1-propyl chloride  (C) 2-chlorobutane  (D) chlorocyclohexane

9. Which compound would have the lowest boiling point?
   \[ \text{I} \quad \text{II} \quad \text{III} \quad \text{IV} \]
   \[ \text{O} \quad \text{OH} \quad \text{OH} \quad \text{CH}_2\text{OH} \]
   (A) I  (B) II  (C) III  (D) IV

10. Which of the following would you expect to be aromatic?
    \[ \text{I} \quad \text{II} \quad \text{III} \quad \text{IV} \]
    \[ \text{I} \quad \text{II} \quad \text{III} \quad \text{IV} \]
    (A) I  (B) II  (C) III  (D) IV
11. Which of the following compounds would be the most stable?

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

12. Which would be the major product of the reaction shown?

\[
\begin{align*}
&\text{CH}_2\text{CH}_3 \quad \text{Hg(OAc)}_2 \cdot \text{H}_2\text{O} \cdot \text{THF} \\
&\text{NaBH}_4 \cdot \text{OH}^- \\
\end{align*}
\]

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

13. Which carbocation would be most stable?

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

14. Which of the following compounds would be most reactive toward ring bromination?

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

15. Which of the compounds you expect to give the greatest amount of meta-product when subjected to ring bromination?

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

16. Which of the following compounds would be the strongest base?

(A) I  (B) II  (C) III  (D) IV
17. Which would be the major product (s) of the following reaction?

\[ \text{CH}_3 \text{CO}_2\text{H} \xrightarrow{\text{HNO}_3, \text{H}_2\text{SO}_4} ? \]

(A) I  (B) II  (C) III  (D) I and II in roughly equal amounts

18. What is the major product of the following reaction sequence?

\[ \text{HCN} \xrightarrow{\text{H}_2\text{O}, \text{heat}} \text{HCN} \]

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

19. What is the product of the reaction below?

\[ \text{O} \xrightarrow{1. (\text{C}_6\text{H}_5)_2\text{CuLi}, 2. \text{H}_2\text{O}} ? \]

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

20. Which of the following would be the strongest acid?

\[ \text{I} \text{CO}_2\text{H} \quad \text{II} \text{Cl} \text{CO}_2\text{H} \quad \text{III} \text{Cl} \text{CO}_2\text{H} \quad \text{IV} \text{Cl} \text{CO}_2\text{H} \]

(A) I  (B) II  (C) III  (D) IV
二、非選擇題

1. Give the major products for each of the following reaction. (10 pts)
   \[
   \begin{align*}
   &\text{(1)} \quad \text{CH}_3 \quad \text{H} \quad \text{Br} \quad \text{NaI} \quad \text{acetone} \\
   &\text{(2)} \quad \text{Ph} \quad \text{H} \quad \text{EtO}^- \\
   &\text{(3)} \quad \text{Cl} \quad \text{EtO}^- \\
   &\text{(4)} \quad \text{Me}^+ \quad \text{Br} \quad \text{EtO}^- \\
   &\text{(5)} \quad \text{2-butyne} + \text{Na, NH}_3 \to
   \end{align*}
   \]

2. Provide reasonable step-by-step mechanisms for each of the following reactions. (15 pts)
   \[
   \begin{align*}
   &\text{(1)} \quad \text{OH} \quad \text{H}_2\text{SO}_4 \quad \text{- H}_2\text{O} \\
   &\text{(2)} \quad \text{Br} \quad \text{HBr} \quad \text{ROOR} \quad \text{heat} \\
   &\text{(3)} \quad \text{Br} \quad \text{NBS} \quad \text{NBS:} \quad \text{CO-Br}
   \end{align*}
   \]

3. What product would you expect from the following reactions? (10 pts)
   \[
   \begin{align*}
   &\text{(1)} \quad \text{CH}_3\text{O}\quad \text{Na, NH}_3(\text{liq}) \quad \text{EtOH} \quad \text{(Birch reduction)} \\
   &\text{(2)} \quad \text{Cl} \quad \text{NaOH} \quad \text{H}_3\text{O} \quad \text{(Farvorsky rearrangement)} \\
   &\text{(3)} \quad \text{O} \quad \text{m-CPBA} \quad \text{(Baeyer-Villiger Oxidation)} \\
   &\text{(4)} \quad \text{NH}_2 \quad \text{NaOH, Br}_2 \quad \text{(Hoffmann rearrangement)} \\
   &\text{(5)} \quad \text{O} \quad \text{CH}_3\text{CH}_2\text{CH}_2\text{Cl} \quad \text{AlCl}_3 \quad \text{(Friedel-Crafts alkylation)}
   \end{align*}
   \]

4. Using a 60-MHz spectrometer, a chemist observes the following absorption: doublet, \( J = 7 \text{ Hz} \), at \( \delta \) 4.0. (5 pts)
   (a) What would the chemical shift (\( \delta \)) be in the 300-MHz spectrum?
   (b) What would the splitting value \( J \) be in the 300-MHz spectrum?
   (c) How many hertz from be TMS peak is this absorption in the 300-MHz spectrum?