Multiple Choice Questions: 50 points

Use the following structure of lidocaine to answer problems 1-3.

1. Select the correct molecular formula for lidocaine.
   A. $C_{14}H_{22}N_2O$  B. $C_{14}H_{21}N_2O$  C. $C_{13}H_{22}N_2O$  D. $C_{13}H_{24}N_2O$  E. $C_{12}H_{25}N_2O$

2. Choose the hybrid orbitals that are used to form the indicated bond on lidocaine.
   A. $Nsp-Csp$  B. $Nsp^2-Csp^2$  C. $Nsp^3-Csp^3$  D. $Nsp^2-Csp^3$  E. $Nsp^3-Csp^2$

3. Which of the following noncovalent interactions is not present in the liquid form of lidocaine?
   A. dispersion forces  B. hydrogen bonding  C. ion-dipole
   D. dipole-dipole  E. all of the above are present

4. Choose the order that has the following compounds correctly arranged with respect to increasing boiling point.

![Chemical structures]

A 1 < 2 < 3  B 1 < 3 < 2  C 2 < 1 < 3  D 2 < 3 < 1  E 3 < 1 < 2
5. Select the structures that are not resonance structures of the same molecule.

A
\[ \text{not resonance structure} \]

B
\[ \text{not resonance structure} \]

C
\[ \text{resonance structure} \]

D
\[ \text{not resonance structure} \]

E
\[ \text{not resonance structure} \]

6. Choose the answer that is a constitutional isomer of structure 1.

A
\[ \text{constitutional isomer} \]

B
\[ \text{constitutional isomer} \]

C
\[ \text{constitutional isomer} \]

D
\[ \text{not constitutional isomer} \]

E
\[ \text{not constitutional isomer} \]

7. Choose the order that has the following compounds correctly arranged with respect to increasing acidity.

A 1 < 2 < 3

increasing acidity

B 1 < 3 < 2

increasing acidity

C 2 < 1 < 3

increasing acidity

D 2 < 3 < 1

increasing acidity

E 3 < 1 < 2

increasing acidity
8. Consider the following acid-base equilibrium reaction.

\[ \text{H}_3\text{C} = \text{CH}_3 + \text{A}^- \rightleftharpoons \text{H}_3\text{C} - \text{CH}_2 - + \text{HA} \]

Select the conjugate base, A\(^-\), that would drive the equilibrium to the right.

\[ \text{HC} = \text{C}^- : \quad \text{H}_3\text{C} - \text{OH} \quad \text{H}_3\text{C} - \text{O}^- \quad \text{Br}^- \quad \text{O} - \text{N} - \text{O}^- \]

A \quad B \quad C \quad D \quad E

9. Choose those compounds that have a trigonal planar shape.

A. i \quad B. ii \quad C. iii \quad D. i and iii \quad E. ii and iii

10. Choose the order that has the following anions correctly arranged with respect to increasing stability.

A. 1 < 2 < 3 \quad B. 1 < 3 < 2 \quad C. 2 < 1 < 3 \quad D. 2 < 3 < 1 \quad E. 3 < 1 < 2
Short Answer Questions: 50 points

11. Draw the structure of the product of the following reaction. 5 pts

\[
\begin{align*}
\text{H}_3\text{C} & \text{O} \quad \cdot \text{O} \quad \text{CH}_3 \\
+ & \quad \text{H}^+ \\
\rightarrow & \quad \text{C}_3\text{H}_7\text{O}_2^+ 
\end{align*}
\]

12. Draw the structure of the product of the following reaction. 5 pts

\[
\begin{align*}
\text{NaOD (cat.)} \\
\text{D}_2\text{O} \\
\rightarrow \\
\text{conjugate base} \\
+ \quad \text{H}^+ 
\end{align*}
\]

13. Draw three resonance structures (electronic configurations) for the conjugate base that results from ionization of the indicated hydrogen on the following structure. Circle the resonance structure that is most contributing. 10 pts

\[
\begin{align*}
\text{H} & \quad \text{CH}_2\text{CH}_2\text{CH} & \quad \text{C} & \quad \text{C} \\
\rightarrow & \quad \text{conjugate base} \\
+ & \quad \text{H}^+ 
\end{align*}
\]

14. Draw three compounds that contain the molecular formula C₄H₈O and that do not contain any sp² hybridized atoms. There are more than three compounds that fit these criteria, but only give three. 10 pts
15. Isopropanol reacts with hydrochloric acid to give 2-chloropropane. Using the curved arrow formalism, show all the bond making and bond breaking steps of this reaction. 10 pts

\[
\begin{align*}
\text{OH} & \quad + \quad \text{H—Cl} \quad \rightarrow \quad \text{Cl} \\
\bigg(\text{CH}_3\bigg) & \quad + \quad \text{H}_2\text{O}
\end{align*}
\]

16. Using the library of synthetic reactions on the cover page, propose a synthesis of the following compound from compounds containing four carbon atoms or less. 10 pts

\[
\begin{align*}
\text{compounds containing four carbons or less}
\end{align*}
\]