Questions 1-28 (84 pts): Please mark the appropriate box on the front of the Scantron form (3 pts each).

1. Which of the following is the ground-state electron configuration of nitrogen?
   - A) $1s^2 2s^2 2p_x^2 2p_y^0 2p_z^0$
   - B) $1s^2 2s^2 2p_x^1 2p_y^1 2p_z^1$
   - C) $1s^2 2s^2 2p_x^2 2p_y^1 2p_z^1$
   - D) $1s^2 2s^2 2p_x^2 2p_y^2 2p_z^1$

2. Which of the following correctly describes bond polarity in a molecule of alcohol?
   - A) $\text{H}^+\text{C}^\delta-\text{O}^\delta^+\text{H}$
   - B) $\text{H}^\delta^-\text{C}^\delta^+\text{O}^\delta^+\text{H}$
   - C) $\text{H}^\delta^-\text{C}^\delta^-\text{O}^-\text{H}$
   - D) $\text{H}^\delta^+\text{C}^\delta^+\text{O}^\delta^-\text{H}$

3. Which of the following molecules is expected to have dipole moment $\mu$ different from 0 D?
   - A) $\text{Cl}^-\text{C}^=\text{C}^-\text{Cl}$
   - B) $\text{H}^\delta^-\text{C}^\delta^-\text{Cl}^-$
   - C) $\Delta$
   - D) $\text{Cl}^\delta^-\text{C}^\delta^+\text{Cl}^-$

4. Which of the following molecules contains a carboxylic acid functional group?
   - A) $\text{CH}_3\text{OCH}_2\text{CH}_2\text{OCH}_3$
   - B) $\text{HOCH}_2\text{CH}_2\text{OH}$
   - C) $\text{HOOCOOH}$
   - D) $\text{H}_2\text{NCH}_2\text{CH}_2\text{NH}_2$
5. Which of the following molecules contains both an alcohol functional group AND an aldehyde functional group?

A) \[
\begin{array}{c}
\text{O} \\
\text{OCH}_3 \text{CCH}_2 \text{COOH}
\end{array}
\]  
B) \[
\begin{array}{c}
\text{NH}_2 \\
\text{CH}_3 \text{CHCOOCH}_3
\end{array}
\]  
C) \[
\begin{array}{c}
\text{OH} \\
\text{CH}_3 \text{CHCOOH}
\end{array}
\]  
D) \[
\begin{array}{c}
\text{OH} \\
\text{CH}_3 \text{CHCHO}
\end{array}
\]  

6. Which of the following polyatomic ions is a correct Lewis structure with correct formal charge?

A) \[
\begin{array}{c}
\text{H} \\
\text{C} \quad \oplus
\end{array}
\]
B) \[
\begin{array}{c}
\text{H} \\
\text{C} \quad \oplus
\end{array}
\]
C) \[
\begin{array}{c}
\text{H} \\
\text{C} \quad \oplus
\end{array}
\]
D) \[
\begin{array}{c}
\text{H} \\
\text{C} \quad \oplus
\end{array}
\]

7. Which of the following structures represent the major resonance contributor of molecule in the box?

A) \[
\begin{array}{c}
\text{H}_3 \text{C} \\
\text{C} \\
\text{C} \\
\text{C} \\
\text{H}
\end{array}
\]
B) \[
\begin{array}{c}
\text{H}_3 \text{C} \\
\text{C} \\
\text{C} \\
\text{C} \\
\text{H}
\end{array}
\]
C) \[
\begin{array}{c}
\text{H}_3 \text{C} \\
\text{C} \\
\text{C} \\
\text{C} \\
\text{H}
\end{array}
\]
D) \[
\begin{array}{c}
\text{H}_3 \text{C} \\
\text{C} \\
\text{C} \\
\text{C} \\
\text{H}
\end{array}
\]

8. Which of the following structures represent resonance contributor of molecule in the box in agreement with the shown curved arrows?

A) \[
\begin{array}{c}
\text{H}_2 \text{C} \\
\text{C} \\
\text{C} \\
\text{C} \\
\text{H}
\end{array}
\]
B) \[
\begin{array}{c}
\text{H}_2 \text{C} \\
\text{C} \\
\text{C} \\
\text{C} \\
\text{H}
\end{array}
\]
C) \[
\begin{array}{c}
\text{H}_2 \text{C} \\
\text{C} \\
\text{C} \\
\text{C} \\
\text{H}
\end{array}
\]
D) \[
\begin{array}{c}
\text{H}_2 \text{C} \\
\text{C} \\
\text{C} \\
\text{C} \\
\text{H}
\end{array}
\]

9. Which of the line-angle formulas corresponds to the condensed structural formula shown in the box?

A) \[
\begin{array}{c}
\text{(CH}_3\text{)}_2 \text{CHCH}_2 \text{CH(CH}_3\text{)}_2
\end{array}
\]
B) \[
\begin{array}{c}
\text{(CH}_3\text{)}_2 \text{CHCH}_2 \text{CH(CH}_3\text{)}_2
\end{array}
\]
C) \[
\begin{array}{c}
\text{(CH}_3\text{)}_2 \text{CHCH}_2 \text{CH(CH}_3\text{)}_2
\end{array}
\]
D) \[
\begin{array}{c}
\text{(CH}_3\text{)}_2 \text{CHCH}_2 \text{CH(CH}_3\text{)}_2
\end{array}
\]
10. What is the IUPAC name for the compound shown in the box?

A) cis-1-ethyl-4-methylcyclohexane  B) trans-1-ethyl-4-methylcyclohexane
C) cis-1-methyl-4-propylcyclohexane  D) trans-1-methyl-4-propylcyclohexane

11. What is the IUPAC name for the compound shown in the box?

A) (2S,3S)-2-bromo-3-chlorobutane  B) (2S,3R)-2-bromo-3-chlorobutane
C) (2R,3S)-2-bromo-3-chlorobutane  D) (2R,3R)-2-bromo-3-chlorobutane

12. Which is the structure of (R)-1,1,3-trimethylcyclopentane?

A)  
B)  
C)  
D)  

13. Which of the following is the chair representation of the compound shown in the box?

A)  
B)  
C)  
D)  

14. Which of following Newman projections represent a meso compound?

A)  
B)  
C)  
D)  

\[ \text{CH}_3 \]
15. What is the configuration (R or S) at the carbon atoms 2 and 3 of the molecule shown in the box?

\[
\begin{align*}
\text{CHO} & \quad \text{A) 2R,3R} & \text{B) 2S,3R} \\
\text{HO} & \quad \text{C) 2R,3S} & \text{D) 2S,3S} \\
\text{H} & \quad \text{CH}_2\text{OH} \\
\text{H} & \end{align*}
\]

16. Which of the following is expected to be least stable?

A) \[
\begin{align*}
\text{CH}_3 & \\
& \end{align*}
\]
B) \[
\begin{align*}
\text{H}_3\text{C} & \quad \text{C(CH}_3)_3 \\
& \end{align*}
\]
C) \[
\begin{align*}
\text{CH}_3 & \quad \text{C(CH}_3)_3 \\
& \end{align*}
\]
D) \[
\begin{align*}
\text{H}_3\text{C} & \quad \text{C(CH}_3)_3 \\
& \end{align*}
\]

17. Consider the following orders of priority (highest to lowest). Which order is incorrect?

A) OH > CH₂OH > CHO > CH₃  
B) OH > CH=CH₂ > CH₂CH₃ > H  
C) OH > CH₂CH₃ > CH₃ > H  
D) NH₂ > CH₂SH > CH₂OH > CH₃

18. Consider the structures shown in the box. Which of the following pairs of these structures are diastereomers?

\[
\begin{align*}
\text{I)} & \quad \text{II)} & \quad \text{III)} & \quad \text{IV)} & \quad \text{V)} \\
\text{CH}_3 & \quad \text{CH}_3 & \quad \text{CH}_3 & \quad \text{H}_3\text{C} & \quad \text{H}_3\text{C} \\
& & & & \\
\text{COOH} & \quad \text{COOH} & \quad \text{COOH} & \quad \text{COOH} & \quad \text{COOH} \\
& & & & \\
\text{CH}_3 & \quad \text{CH}_3 & \quad \text{CH}_3 & \quad \text{H}_3\text{C} & \quad \text{H}_3\text{C} \\
& & & & \\
& & & & \\
\end{align*}
\]

A) I and II  
B) I and III  
C) I and IV  
D) I and V

19. Which of the following molecules contains two chiral centers?

A) \[
\begin{align*}
\text{H} & \quad \text{OH} & \quad \text{H} \\
\text{H} & \quad \text{H} & \quad \text{CH}=\text{CH}_2 \\
& & \end{align*}
\]
B) \[
\begin{align*}
\text{H} & \quad \text{H} & \quad \text{H}_3\text{C} \\
\text{H} & \quad \text{H} & \quad \text{CH}_2\text{COOH} \\
& & \end{align*}
\]
C) \[
\begin{align*}
\text{H} & \quad \text{H} & \quad \text{H}_3\text{C} \\
\text{H} & \quad \text{H} & \quad \text{HOOC} \\
& & \end{align*}
\]
D) \[
\begin{align*}
\text{H} & \quad \text{H} & \quad \text{H}_3\text{C} \\
& & \end{align*}
\]
20. Which one of the following molecules is a meso compound?

A) \[
\begin{array}{c}
\text{CH}_3 \\
\end{array}
\]
B) \[
\begin{array}{c}
\text{CH}_2\text{CH}_3 \\
\end{array}
\]
C) \[
\begin{array}{c}
\text{CH}_3 \\
\end{array}
\]
D) \[
\begin{array}{c}
\text{CH}_2 \text{CH}_3 \\
\end{array}
\]

21. Which one of the following compounds has the strongest intermolecular forces of attraction?

A) \[
\begin{array}{c}
\text{CH}_3\text{CH}_2\text{F} \\
\end{array}
\]
B) \[
\begin{array}{c}
\text{CH}_3\text{CH}_2\text{OCH}_3 \\
\end{array}
\]
C) \[
\begin{array}{c}
\text{HB(CH}_3)_2 \\
\end{array}
\]
D) \[
\begin{array}{c}
\text{CH}_3 \text{OH} \\
\end{array}
\]

22. Which one of the following molecules is chiral?

A) \[
\begin{array}{c}
\text{Cl} \\
\end{array}
\]
B) \[
\begin{array}{c}
\text{CH}_3 \\
\end{array}
\]
C) \[
\begin{array}{c}
\text{CH}_3 \\
\end{array}
\]
D) \[
\begin{array}{c}
\text{CH}_3 \\
\end{array}
\]

23. Which of the following depicts a primary (\(1^\circ\)) alcohol?

A) \[
\begin{array}{c}
\text{HO} \\
\end{array}
\]
B) \[
\begin{array}{c}
\text{H}_3\text{C} \\
\end{array}
\]
C) \[
\begin{array}{c}
\text{H}_3\text{C} \\
\end{array}
\]
D) \[
\begin{array}{c}
\text{H}_3\text{C} \\
\end{array}
\]

24. Which of the molecules shown below contains a tert-butyl group?

A) \[
\begin{array}{c}
\text{CH}_3 \\
\end{array}
\]
B) \[
\begin{array}{c}
\text{CH}_3 \\
\end{array}
\]
C) \[
\begin{array}{c}
\text{CH}_3 \\
\end{array}
\]
D) \[
\begin{array}{c}
\text{CH}_3 \\
\end{array}
\]

25. Which of the statements below is NOT true about stereoisomers?

A. They have the same molecular formula
B. They have the same orientation of atoms in space
C. They have the same molecular weight
D. They have the same connectivity of atoms

26. How many aldehydes have a molecular formula of \(\text{C}_4\text{H}_8\text{O}\)?

A) 1  B) 2  C) 3  D) 4
27. Which sets of **curved arrows** correctly describes the flow of electrons in the resonance contributors?

A) \[ \text{H} - \text{C} = \text{O}^\ominus \quad \rightarrow \quad \text{H} - \text{C} = \text{O}^\ominus \]

B) \[ \text{H} - \text{C} = \text{O}^\ominus \quad \rightarrow \quad \text{H} - \text{C} = \text{O}^\ominus \]

C) \[ \text{H} - \text{C} = \text{O}^\ominus \quad \rightarrow \quad \text{H} - \text{C} = \text{O}^\ominus \]

D) \[ \text{H} - \text{C} = \text{O}^\ominus \quad \rightarrow \quad \text{H} - \text{C} = \text{O}^\ominus \]

28. Which of the following compounds has the **shortest carbon-hydrogen** bond?

A) \[ \text{C} = \text{C} - \text{CH}_3 \]

B) \[ \text{CH}_3 \]

C) \[ \text{C} = \text{C} - \text{CH}_2 \]

D) \[ \text{C} = \text{C} - \text{CH} \]

**Question 29 (16 pts): Please mark your answers in the appropriate box on the back of the Scantron form (2 pts each)**

29. Consider the molecule shown below and answers the following questions. Indicate your answers by marking the appropriate number in the boxes on the back of the Scantron form.

[Diagram of a molecule with various atoms and bonds]

- **Box 51:** Number of \( \sigma \) bonds formed by overlap of \( sp^2 \) and \( sp^3 \) orbitals
- **Box 52:** Number of \( \sigma \) bonds formed by overlap of \( sp \) and \( sp \) orbitals
- **Box 53:** Number of \( \sigma \) bonds formed by overlap of \( sp^3 \) and \( sp \) orbitals
- **Box 54:** Number of \( \sigma \) bonds formed by overlap of \( s \) and \( sp^3 \) orbitals
- **Box 55:** Number of \( \sigma \) bonds formed by overlap of \( sp^2 \) and \( sp^2 \) orbitals
- **Box 56:** Total number of \( \sigma \) bonds
- **Box 57:** Total number of \( \pi \) bonds
- **Box 58:** Total number of non-bonding electrons in this molecule