1. Provide the IUPAC names for the following structures: (24 pts)

(a)

2-cyclohexen-1-ol

(b)

4-bromo-3-ethyl-2,2,5,5-tetramethylheptane

(c)

1-(2-propoxy)pentane

1-isopropoxypentane

(d)

(2S,3S)-2,3-butandiol

2. Circle the correct answer to the following questions. (10 pts)

(a) Which of the following compounds would be the most water soluble?

- OH

(b) Which of the following alkanes would have the lowest boiling point?

- -
3. Provide structures for the following compounds: (24 pts)

(a) 1,3-cyclopentadiene

(b) 6-chloro-3-heptyne

(c) 3-methoxypentane

(d) (Z)-5-bromo-3-ethyl-2-pentene
4. Assign the following molecules from most acidic to least acidic. (draw the compound in the correct spot). (25 pts)
(a)

\[ \text{Most acidic} \quad A \quad B \quad C \quad \text{Least acidic} \]

(b) Provide one major reason why A is more acidic than B (use structures and words).

The conjugate base of \( A \) is stabilized by resonance (more stable conjugate base \( \Rightarrow \) more acidic acid)

(c) Provide one major reason why B is more acidic than C (use structures and words).

Electronegativity: \( O \) which takes on the negative charge (one pair of e\(^{-}\)'s) when deprotonated is more electronegative than the conjugate base more stable negative in that case

5. Provide the 2 pK\( \alpha \) values below, and circle the side of the equilibrium that would be favored based on these values. (15 pts.)

\[ \text{CH}_4 + \text{NH}_3 \xrightleftharpoons{\text{55}} \text{CH}_3^- + \text{^+NH}_4^- \]

\[ \text{pK} \alpha \]

\[ \text{9} \]

\[ \text{pK} \alpha \]
6. Draw an accurate representation of ethene showing all atomic orbitals. (12 pts)

[Diagrams of ethene molecule with orbitals labeled]

7. Indicate the hybridization of all non-H atoms for the following molecules. (14 pts)

(a) [Diagram with sp^2 and sp^3 orbitals labeled]
(b) [Diagram of an oxygen atom with sp^2 and sp^3 orbitals labeled]

8. Draw the lowest energy chair conformation for methylcyclohexane showing all hydrogens. (15 pts)
9. Use Newman projections to draw the lowest and highest energy conformations for 2,3-dimethylbutane looking down the C2 – C3 bond. (16 pts)

Lowest energy

Highest Energy

10. Assign the R or S designation to each of the following stereocenters. (20 pts)

(a)

(b)

(c)
11. Indicate whether the pairs of compounds below are enantiomers (E), diastereomers (D), or identical (I). (20 pts.)

(a) 

\[ \begin{align*} 
\text{Identical} 
\end{align*} \]

(b) 

\[ \begin{align*} 
\text{Enantiomers} 
\end{align*} \]

(c) 

\[ \begin{align*} 
\text{Identical} 
\end{align*} \]

(d) 

\[ \begin{align*} 
\text{Diastereomers} 
\end{align*} \]

12. Upon isolation of the R-isomer of alanosine from the fermentation of \textit{Streptomyces alanosinicus}, the optical activity of the isolated compound was found to be 76%. What % of the compound is actually in the R form and what % is in the S form? (10 pts)

\[ \begin{align*} 
R &= \frac{88}{2} \% \\
S &= \frac{12}{2} \% \\
100 - 76 &= 24 \\
\frac{24}{2} &= 12 \\
\frac{76}{88} &= 88 \% \ R \\
\frac{12}{88} &= 14 \% \ S \\
76\% \ R, \ 24\% \ \text{50:50 mix of } R \ \text{and } S, \ \text{(Robinson model)} \\
\text{in } \theta_3 \ 24\% 
\end{align*} \]
13. Show the 2 different pairs of reagents that could be used to synthesize the molecule below by the Williamson Ether synthesis. Circle the pair that would be most likely to provide the desired ether product. (15 pts)

14. Please provide the product(s) for the following reactions, AND circle the mechanism type(s) that the reaction proceeds through, AND provide 2 reasons to support your choice (be brief). (20 pts)

Reason #1:  
\[ \text{Sn}2 \text{ is a strong nucleophile and weak base} \]
\[ \text{(favor Sn2) } \frac{k}{ \text{H}_2 \text{S} } \approx 7 \]

Reason #2:  
\[ \text{DMSO is a polar aprotic solvent} \]
\[ \text{(favor Sn2)} \]
15. Please provide the starting material, reagents or products needed to complete the following reactions. (35 pts)

(a)

```
\begin{center}
\begin{tikzpicture}
  \node [draw, shape=rectangle] (n1) at (0,0) {Br};
  \node [draw, shape=rectangle] (n2) at (1,0) {$\text{+} + \overset{\text{\angle}}{\text{\kappa}}$}
  \node [draw, shape=rectangle] (n3) at (2,0) {CH$_2$=CH$_2$};
  \foreach \s in {1,2,3}
  \draw [->] (\s) -- (\s + 1);
\end{tikzpicture}
\end{center}
```

(b)

```
\begin{center}
\begin{tikzpicture}
  \node [draw, shape=rectangle] (n1) at (0,0) {C$_5$H$_8$};
  \node [draw, shape=rectangle] (n2) at (1,0) {Br$_2$};
  \node [draw, shape=rectangle] (n3) at (2,0) {C$_5$H$_7$-CH$_2$ \textit{heat or light!}}
  \foreach \s in {1,2,3}
  \draw [->] (\s) -- (\s + 1);
\end{tikzpicture}
\end{center}
```

(c)

```
\begin{center}
\begin{tikzpicture}
  \node [draw, shape=rectangle] (n1) at (0,0) {CH$_3$CH$_2$OH};
  \node [draw, shape=rectangle] (n2) at (1,0) {H$_2$CrO$_4$};
  \node [draw, shape=rectangle] (n3) at (2,0) {CH$_3$CH$_2$COOH}
  \foreach \s in {1,2,3}
  \draw [->] (\s) -- (\s + 1);
\end{tikzpicture}
\end{center}
```

(d)

```
\begin{center}
\begin{tikzpicture}
  \node [draw, shape=rectangle] (n1) at (0,0) {=C=CH$_2$};
  \node [draw, shape=rectangle] (n2) at (1,0) {H$_2$ \textit{Lindlar's Catalyst}}
  \node [draw, shape=rectangle] (n3) at (2,0) {CH$_2$=CH$_2$}
  \foreach \s in {1,2,3}
  \draw [->] (\s) -- (\s + 1);
\end{tikzpicture}
\end{center}
```

(e)

```
\begin{center}
\begin{tikzpicture}
  \node [draw, shape=rectangle] (n1) at (0,0) {CH$_2$=CHCH=CH$_2$};
  \node [draw, shape=rectangle] (n2) at (1,0) {1) BH$_3$};
  \node [draw, shape=rectangle] (n3) at (2,0) {CH$_2$CH$_2$OH}
  \node [draw, shape=rectangle] (n4) at (3,0) {2) NaOH, H$_2$O$_2$}
  \foreach \s in {1,2,3,4}
  \draw [->] (\s) -- (\s + 1);
\end{tikzpicture}
\end{center}
```
16. Provide a mechanism for the formation of A and B below. Which compound should predominate and why? (25 pts)

Extra Credit (20 pts)

Draw 4 of the constitutional isomers for the molecular formula C₄H₈.

1
2
3
4
(stereo isomers)