1. Name the following compounds. (15 pts)

- $\text{5-isopropyl-2,9-dimethyldecane}$
- $\text{trans-1-sec-butyl-3-butylcyclohexane}$
- $\text{7-ethyl-2-isobutyl-1-methylbicyclo[4.2.0]octane}$
2. Draw 1,7-diethyl-1,9-dimethylspiro[4.5]decane in bond line. (5 pts)

3. The following compounds are _______. (circle your answer) 9 pts

- constitutional/structural isomers
- conformational isomers
- stereoisomers
4. Answer the following questions about compound X.

   a. What is the molecular formula (mf) for compound X? (3 pts)
      \[ \text{C}_{12}\text{H}_{19}\text{N} \]
   b. Compound X has \( \boxed{10} \) sp\(^3\) atoms (2 pts)
   c. Compound X has \( \boxed{2} \) sp atoms (2 pts)

5. Fill in in the missing curved arrows (electron pushing) for the following reactions (18 pts)
   a. \[ \begin{array}{c}
   \begin{array}{c}
   \text{ } \\
   \text{S} \\
   \text{ } \\
   \text{ } \\
   \text{ } \\
   \end{array}
   \rightarrow
   \begin{array}{c}
   \begin{array}{c}
   \text{ } \\
   \text{ } \\
   \text{ } \\
   \text{ } \\
   \text{ } \\
   \end{array}
   \rightarrow
   \begin{array}{c}
   \begin{array}{c}
   \text{ } \\
   \text{ } \\
   \text{ } \\
   \text{ } \\
   \text{ } \\
   \end{array}
   \end{array}
   \end{array} \]
   b. \[ \begin{array}{c}
   \begin{array}{c}
   \text{ } \\
   \text{NC} \\
   \text{ } \\
   \text{N=NN} \\
   \text{ } \\
   \text{CN} \\
   \end{array}
   \rightarrow
   \begin{array}{c}
   \begin{array}{c}
   \text{ } \\
   \text{N} \\
   \text{ } \\
   \text{N} \\
   \text{N} \\
   \text{CN} \\
   \end{array}
   \end{array} \]
   c. \[ \begin{array}{c}
   \begin{array}{c}
   \text{ } \\
   \text{ } \\
   \text{ } \\
   \text{ } \\
   \text{ } \\
   \end{array}
   \rightarrow
   \begin{array}{c}
   \begin{array}{c}
   \text{ } \\
   \text{ } \\
   \text{ } \\
   \text{ } \\
   \text{ } \\
   \end{array}
   \end{array} \]
6. Draw, in bond line, all the structural isomers that have the molecular formula C₄H₁₂O.
(14 pts)
7. In the following reactions, decide if the organic molecule (not just a single atom) is oxidized, reduced, or is at the same oxidation state. Please circle your answer. (9 pts)

\[ \text{OH} \xrightarrow{\text{PCC}} \text{O} \]

- oxidized
- reduced
- same oxidation state

\[ \text{H} \xrightarrow{\text{HCl}} \text{Cl} \]

- oxidized
- reduced
- same oxidation state

\[ \text{Cl}_2 \xrightarrow{} \]

- oxidized
- reduced
- same oxidation state

8. Draw cis-1-tert-butyl-3-ethylcyclohexane in its least stable conformation. (4 pts)

*** Poorly drawn chairs and bad bond angles will cost points***
9. Arrange the following compounds according to their boiling points by writing **highest bp**, **middle bp**, and **lowest bp** under the structure. (3 pts)

- Middle bp
- Highest bp
- Lowest bp

10. a. Draw two additional resonance structures for the following compound. (6 pts)
    b. Decide which is the better resonance structure and explain why you picked this structure. (3 pts)

- All carbons have $8$ electron pairs.
11. a. Write Newman projections for the three staggered conformations of 3-fluorohexane, looking down the C4 - C3 bond. (6 pts)

b. Write **most stable** under the most stable conformation. (1 pt)

***Insurance Question (5 pts)***

Circle the structural isomers of C₁₂H₂₀O. All molecules have 12 carbons.  

\[ IHD = 3 \]