Multiple Choice Questions: 50 points

1. Select the correct number of chirality centers in heroin, the illicit drug shown below.

   - A  4
   - B  5
   - C  6
   - D  7
   - E  8
   - F  more than 8

2. Choose the correct IUPAC name for the following bicyclic compound.

   - A. 2-fluorobicyclo[2.2.1]hexane
   - B. 2-fluorobicyclo[2.1.1]hexane
   - C. 5-fluorobicyclo[2.1.1]hexane
   - D. 6-fluorobicyclo[2.1.1]hexane
   - E. 3-fluorobicyclo[2.2.0]pentane
   - F. 4-fluorobicyclo[2.1.0]pentane

3. (R)-1-bromo-2-methylbutane undergoes substitution when reacted with sodium iodide (NaI) in acetone. Choose the major product obtained from this reaction.

   - A. (R)-1-iodo-2-methylbutane
   - B. (S)-1-iodo-2-methylbutane
   - C. racemic 1-iodo-2-methylbutane
   - D. (R)-1-bromo-2-iodobutane
   - E. (S)-1-bromo-2-iodobutane
   - F. (S)-1-sodium-2-methylbutane

   2 point partial credit for choice B

4. Select the incorrect statement concerning the following reaction shown below.

   - A. Doubling the initial concentration of (S)-2-bromopentane will double the rate of the reaction.
   - B. Switching the solvent to ethanol would increase the activation energy of the reaction.
   - C. Switching the substrate to 1-bromopentane would increase the energy of the transition state.
   - D. The solvent DMSO helps solubilize NaCN and stabilize the sodium cation.
   - E. The rate of the reaction is dependent on both (S)-2-bromopentane and NaCN.
   - F. Switching the nucleophile to water would decrease the rate of the reaction.
5. Select the choice that best describes the relationship between the following two structures.

A conformers  B constitutional isomers  C diastereomers  D enantiomers

6. Select the choice that best describes the relationship between the following two structures.

A conformers  B constitutional isomers  C diastereomers  D enantiomers

7. Choose the major product of the following reaction.

\[
\text{?} \quad \text{CH}_3\text{CH}_2\text{OH} \quad \text{OCH}_2\text{CH}_3
\]

A  B  C  D  E  F
8. Choose the order that has the following bromides correctly arranged with respect to increasing reactivity toward NaN₃ in DMF.

\[
\begin{array}{ccc}
1 & 2 & 3 \\
\text{increasing reactivity} & \\
\end{array}
\]

2 point partial credit for choice A

9. Select the order that has the following conformers of 2-methylbutane correctly arranged with respect to increasing stability.

\[
\begin{array}{ccc}
1 & 2 & 3 & 4 \\
\text{increasing stability} & \\
\end{array}
\]

2 point partial credit for choice B or C
10. Select the most stable conformation of cis-1-isopropyl-4-methylcyclohexane.

![Structures A, B, C, D, E, F]

Short Answer Questions: 50 points

11. Draw the structure(s) of the major product(s) of the following reaction, indicating stereochemistry if applicable using wedges and dashes. 5 pts

![Reaction with structures and labeled products]

12. Draw the structures of the two major products (X and Y) of the following reaction sequence, indicating stereochemistry where appropriate using wedges and dashes. 7 pts

![Reaction sequence with labeled products]
13. Draw all the stereoisomers of 3,4-dichlorohexane indicating stereochemistry where appropriate, using wedges and dashes. 8 pts

![Stereoisomers of 3,4-dichlorohexane](image)

14. Using the curved arrow formalism, show all the bond making and bond breaking steps of the following reaction. 8 pts

![Curved arrow formalism](image)

15. Using the library of synthetic reactions on the cover page, propose a synthesis of the following compound from acetylene and any other compound(s) containing four carbon atoms or less. 10 pts

![Synthetic reactions](image)
16. Compounds A through E are the five isomeric bromoalkanes with the molecular formula C₄H₉Br. Based on the information given below, determine and clearly draw the structures of A, B, C, D and E, indicating stereochemistry where appropriate, using wedges and dashes. 12 pts

a. Treatment of compounds A through C with CH₃OH followed first-order kinetics and showed the following relative rates:

   A > B ≈ C

b. Treatment of compounds B through E with NaOCH₃ followed second-order kinetics and showed the following relative rates:

   D > E > B ≈ C

c. Compound B has (R) configuration.

![Structures](image-url)