1. (24 pts.) Write the product(s) of the following reactions showing stereochemistry in 3-D where necessary and all stereoisomers. Label the products as **optically active (O)**, **achiral (A)** or **racemic (R)**.

(a) ![Diagram](image1)

(b) ![Diagram](image2)

(c) ![Diagram](image3)

(e) ![Diagram](image5)
2. (16 pts.) Choose the alkyl halides from the list above to meet each criterion below.

(a) the compound(s) that can exist as enantiomers ______

(b) the compound(s) that can exist as diastereomers ______

(c) the compound that gives the fastest $S_N2$ reaction with sodium methoxide ______

(d) the compound that is least reactive to sodium methoxide in methanol ______

(e) the compound(s) that give only one alkene in the E2 reaction ______

(f) the compound(s) that give an E2 but no $S_N2$ reaction ______

(g) the compound(s) that undergo an $S_N1$ reaction to give rearranged product(s) ______

(h) the compound that gives the fastest $S_N1$ reaction ______
3. (20 pts.) Circle the correct structure.

(a) Circle the structures that have the $S$ configuration at the stereogenic center.

(b) Circle the **most basic** compound and put a box around the **least basic** compound.

(c) Circle the compounds that are **chiral**.

(d) Circle the the reagents which give a **nonstereospecific** reaction upon addition to a double bond.

(e) Circle the alkyl halide which will give the **highest** ratio of E2/SN2 when treated with NaOCH$_2$CH$_3$/CH$_3$CH$_2$OH.
4. (8 pts.) Draw the isomers of 1,2,3-trimethylcyclohexane, first in wedge-dash format and then in their most stable chair conformations.

5. (4 pts.) Name the following compound.

![Compound Image]

2. (10 pts.) Write the product(s) of the following reactions showing stereochemistry in 3-D including stereoisomers.

(a) \[ \text{Cyclohexene} + \text{Cl}_2 \xrightarrow{\text{H}_2\text{O}} \]  

(b) \[ \text{Cyclohexene} + \text{NaOCH}_2\text{CH}_3 \]
7. (8 pts.) Show how you would accomplish the following synthesis. Show all isolated intermediate products and reagents over the arrows. More than one step is required. Working backwards often helps.

(a)  

8. (10 pts.) Draw the mechanism of the following reaction. Show all intermediates and electron-pushing arrows.

\[
\text{Ph-CH-CH-CH-CH-CH-CH} \xrightarrow{\text{H}_2\text{SO}_4} \text{Ph-CH-CH=CH-CH-CH-CH}
\]