1. (30) Using curved arrows and showing the structure of the intermediates, write mechanisms that account for the products in the following reactions (15 pts each):

(a) 

(b)
2. (29) Draw three-dimensional structures of major organic products for the reaction of (R)-3-methylcyclopentene with Br₂ in CCl₄ (10 pts). Assign R, S configurations for all chiral centers in each of the products. (8 pts). Using curved arrows, write a mechanism that explains stereochemistry of the reaction (11 pts).

3. (36) Complete the following equations by drawing three-dimensional structures with correct stereochemistry of the major organic products expected in each case (6 pts each).
4. (35) Complete the following equations by drawing structures of the major product(s) expected in each reaction (5 pts each).

\[
\text{H}_3\text{C} \equiv \text{C} \equiv \text{CNa} + \text{C}_{6}\text{H}_{5}\text{CH}_2\text{Br} \rightarrow \text{CH}_3 \equiv \text{C} \equiv \text{C} \equiv \text{CH}_2 \text{Ph}
\]

\[
\text{C}_5 \text{H}_7 \equiv \text{C} + \text{H}_2\text{O} \xrightarrow{\text{H}_2\text{SO}_4 / \text{HgSO}_4} \text{C}_5 \text{H}_8 \text{CH}_3
\]

\[
\text{C}_5 \text{H}_{10} \text{CH}_2 \text{OH} \xrightarrow{\text{TsCl / pyridine}} \text{C}_5 \text{H}_8 \text{CH}_2 \text{OTs}
\]

\[
\text{HOCH}_2\text{CH}_2\text{Cl} \xrightarrow{\text{CH}_3\text{SNa / CH}_3\text{OH}} \text{HOCH}_2\text{CH}_2\text{SCH}_3
\]

\[
\text{C}_5 \text{H}_7 \text{CH}_3 \xrightarrow{\text{BH}_3} \xrightarrow{\text{H}_2\text{O}_2 / \text{NaOH}} \text{C}_5 \text{H}_8 \text{OH}
\]

\[
\text{C}_{10}\text{H}_8 \text{CH}_2\text{OH} \xrightarrow{\text{PBr}_3} \text{C}_{10}\text{H}_7 \text{CH}_2 \text{Br}
\]

\[
\text{C}_5 \text{H}_9 \text{CH}_2\text{OH} \xrightarrow{\text{PCC}} \text{C}_5 \text{H}_8 \text{C} = \text{O}
\]
5. (30) Give the **reagents on the arrow** that can be used to convert the reactant to the indicated product in high yield (5 pts each).

\[
\begin{align*}
\text{CH}_2\text{Br} & \quad \text{HC} = \text{CNa} & \quad \text{H}_2\text{O}, \text{H}_2\text{SO}_4 \quad \text{H}_2\text{SO}_4 \quad \text{O} \\
\text{H}_3\text{C} - \text{CH} - \text{CH}_3 & \quad \text{SOCl}_2 & \quad \text{NaSCl}_3 \quad \text{H}_3\text{C} - \text{CH} - \text{CH}_3 \quad \text{SCH}_3 \\
\text{Ph-CH=CH}_2 & \quad \text{HCl} & \quad \text{N}(\text{CH}_3)_3 \quad \text{Ph-CH-N}^+\text{(CH}_3)_2 \text{Cl}^- \\
\text{CH}_3\text{CH}_2\text{CH}_2\text{Br} & \quad \text{HC} = \text{CNa} & \quad \text{CH}_3\text{CH}_2\text{CH}_2\text{C} = \text{CH} \\
\text{CH}_2\text{OH} & \quad \text{CrO}_3, \text{H}_2\text{SO}_4 & \quad \text{OH} \\
\end{align*}
\]

6. (40, 5 pts each) For each of the following questions (a)-(h) **circle** the item that is the correct answer.

(a) Which of the following compounds is the **most reactive in S_N2 reactions**?

- iodocyclohexane
- 1-iodo-2-methylhexane
- 1-iodo-1-methylcyclohexane
- 2-iodohexane
- 1-iodo-4-methylhexane
- 1-iodo-4-methylcyclohexane
(b) Which one of the following species is the most stable carbocation?

\[
\begin{align*}
H_3C-CH_2^+ & \quad \text{Ph}^+ & \quad H_3C^+ \\
\end{align*}
\]

(c) Which of the following substituents is the best leaving group?

\[
\begin{align*}
\text{−OTs} & \quad \text{−Cl} & \quad \text{−CH}_3 & \quad \text{−Ph} & \quad \text{−OH} & \quad \text{−F} & \quad \text{−NH}_2
\end{align*}
\]

(d) Which one of the following anions is the strongest base?

\[
\begin{align*}
\text{CH}_3\text{NH}_2 & \quad \text{C}_2\text{H}_5\text{O}^- & \quad \text{CH}_3\text{CH}_2^- & \quad \text{H}_2\text{O} & \quad \text{NH}_2^- & \quad \text{Br}^- & \quad \text{I}^-
\end{align*}
\]

(e) Which one of the following compounds has four stereoisomers?

2-bromobutane \text{ 3,4-dichlorohexane} \text{ methylcyclopentane} \text{ 1,1-dimethylcyclobutane} \\
1,4-dichlorocyclohexane \text{ 2,3-dibromopentane} \text{ 1,2-dibromocyclohexane}

(f) Which one of the following compounds will have the highest boiling point?

\[
\begin{align*}
\text{H}_3\text{C-CH(OH)} & \quad \text{CH}_3\text{O-C-H} & \quad \text{CH}_3\text{F} & \quad \text{C}_2\text{H}_6 & \quad \text{CH}_3\text{OCH}_3
\end{align*}
\]

(g) Which one of the following compounds has the most acidic C−H bonds??

2-butyne \text{ 3-methyl-1-butene} \text{ 1-butene-3-yne} \text{ methane} \\
2,3-dimethyl-2-pentene \text{ propene} \text{ ethylene} \text{ cyclohexene}

(h) Which of the following compounds is the most stable alkene?

\[
\begin{align*}
\text{2-methyl-2-butene} & \quad \text{3-methyl-1-butene} & \quad \text{2-methyl-1-butene} \\
\text{2,3-dimethyl-2-pentene} & \quad \text{propene} & \quad \text{ethylene} & \quad \text{cyclohexene}
\end{align*}
\]