1. Show the **major product** that would form from each the following reactions:

(a) ![Reaction 1]

(b) ![Reaction 2]

(c) ![Reaction 3]

2. Indicate the mechanism ($S_N2$, $S_N1$, E2, or E1) that is most consistent with each of the following statements:

   (a) Tertiary alkyl halides react with nucleophiles in polar protic solvents by this mechanism.

   (b) Treatment of a primary alkyl halide with $t$-butoxide ion promotes an elimination reaction by this mechanism.

   (c) This type of elimination mechanism proceeds through initial formation of a carbocation.

   (d) This type of substitution mechanism follows first order kinetics.

   (e) Heating a secondary alkyl halide in methanol will promote a reaction through this type of mechanism.
3. Provide the reagents and conditions that would be necessary to carry out the reactions shown below with (S)-2-bromo-3-methylbutane:

\[
\begin{align*}
\text{(a)} & \quad \text{OCH}_3 \\
\text{(b)} & \quad \text{OCH}_3 \\
\text{(c)} & \quad \text{OH} \\
\text{(d)} & \quad \text{OCH}_3 \\
\text{(e)} & \quad \text{(racemic)}
\end{align*}
\]

4. Show the mechanism and major product for an E2 reaction of bromocyclohexane with methoxide ion in methanol at high temperature.
MULTIPLE CHOICE  (6 pts each)

5. Which of the following alkyl halides undergoes E1 reactions most readily (fastest)?

(a)  

(b)  

(c)  

(d)  

(e)  CH₃-I

6. How many distinct alkene products are possible when the alkyl iodide shown below undergoes E2 elimination?

(a)  1   (b)   2 (c)  3 (d)  4           (e)  5

7. What are the two most likely mechanisms for the reactions of 2-iodohexane with ethoxide ion (EtO⁻) in ethanol at room temperature?

(a)  Sₙ2 and Sₙ1  (c)  Sₙ1 and E1  
(b)  E1 and E2    (d)  Sₙ2 and E2

8. Reaction of 2-bromobutane in the presence of a strong base at high temperature proceeds via which of the following mechanism?

(a)  Sₙ1   (b)  Sₙ2  (c)  E1     (d)  E2    (e) none of these

9. Elimination through an E2 mechanism is also known as:

(a)  Zaitsev elimination   (c) Williamson ether synthesis  
(b)  β-elimination       (d) unimolecular elimination

10. Which of the following statements about elimination reactions is not true:

(a)  Elimination reactions are typically regioselective.
(b)  Elimination reactions are typically stereoselective.
(c)  Primary substrates typically undergo elimination more readily than secondary or tertiary substrates.
(d)  E2 elimination reactions typically proceed through an anti-periplanar transition state.

11. t-Butoxide is the base of choice to facilitate elimination with which type of substrate?

(a) allylic    (b) benzylic  (c) primary     (d) tertiary    (e) methyl
12. Which of the following is the strongest base?

(a) MeOH  (b) MeO⁻  (c) \( \text{COO}^- \)  (d) \( \text{COOH} \)  (e) \( \text{H}_2\text{O} \)

13. What is the major product of the following reaction?

\[ \text{Br} - \text{CH}_2 - \text{CH}_2 - \text{Br} \xrightarrow{\text{EtOH} \atop 25 \degree \text{C}} \]

(a) \( \text{CH}_2 = \text{CH} - \text{CH} - \text{CH}_2 \)  (b) \( \text{CH}_2 = \text{CH} - \text{CH} - \text{CH}_3 \)  (c) \( \text{CH}_3 \)  (d) \( \text{CH}_3 \text{O} - \text{CH} - \text{CH}_2 \)

14. Protic and aprotic solvents differ primarily in their:

(a) polarity  
(b) dielectric constants  
(c) ability to stabilize anions by hydrogen bonding  
(d) ability to stabilize cations by hydrogen bonding  
(e) ability to stabilize cations with unshared pairs of electrons

**Bonus (+5 pts): Show the product that would result from an intramolecular William ether synthesis with the substrate shown below:

\[ \text{HO} - \text{CH} - \text{CH}_2 - \text{Br} \xrightarrow{\text{NaH}} \]