1. Which of the following reacts fastest with methanol by the SN1 mechanism?

\[ CH_3 \]

1) \( CH_3CH_2CH_2CH_2CH_2Br \)  
3) \( CH_3CCH_2CH_3 \)

2) \( CH_3CH_2CHCH_2CH_3 \)  
4) \( (CH_3)_3CCH_2Br \)

A) is 1  
B) is 2  
C) is 3  
D) is 4

2. What is the leaving group in the following reaction?

\[ CH_3CH_2OH + HCl \rightarrow CH_3CH_2Cl + H_2O \]

1) \( OH^- \)  
2) \( H_2O \)  
3) \( CH_3CH_2^+ \)  
4) \( Cl^- \)

A) is 1  
B) is 2  
C) is 3  
D) is 4

3. Which of the following is the rate law for the SN1 mechanism of an alkyl halide with a nucleophile?

A) \( rate = k[alkyl\ halide] \)  
B) \( rate = k[nucleophile] \)  
C) \( rate = k[alkyl\ halide][nucleophile] \)  
D) \( rate = k[alkyl\ halide]^2[nucleophile] \)
4. Which of the following bases works best to maximize the E2 product in the reaction shown below?
\[ (\text{CH}_3)_2\text{CHCH}_2\text{CH}_2\text{CH}_2\text{Br} + \text{base} \rightarrow (\text{CH}_3)_2\text{CHCH}_2\text{CH}==\text{CH}_2 \]

1) KOCH\textsubscript{2}CH\textsubscript{3}  
2) NaOCH\textsubscript{2}CH\textsubscript{3}  
3) NaOC(CH\textsubscript{3})\textsubscript{3}  
4) NaOH

A) is 1  
B) is 2  
(C) is 3  
D) is 4

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

\[ \text{Br} \quad \text{H}_3\text{C} \quad \text{CH}_3 \quad \text{NaOCH}_2\text{CH}_3 \quad \frac{\text{CH}_3\text{CH}_2\text{OH}}{} \]

1) H\textsubscript{3}C \quad \text{CH}_3 \quad 3) H\textsubscript{3}C \quad \text{H}  
2) H\textsubscript{3}C \quad \text{OCH}_2\text{CH}_3 \quad 4) H\textsubscript{3}C \quad \text{H}  

A) is 1  
B) is 2  
(C) is 3  
D) is 4
6. In the solvolysis of \( t \)-butyl chloride, a minor product is 2-methylpropene, which results from the:

\[
(\text{CH}_3)_2\text{CCl} + \text{H}_2\text{O} \rightarrow (\text{CH}_3)_2\text{COH} + (\text{CH}_3)_2\text{C} = \text{CH}_2
\]

A) E2 mechanism with OH\(^-\) acting as the base.
B) E2 mechanism with H\(_2\)O acting as the base.
C) E1 mechanism with OH\(^-\) acting as the base.
D) E1 mechanism with H\(_2\)O acting as the base.

7. Identify the mechanistic pathways, respectively, for the products in the following reaction.

\[
\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{Br} \xrightarrow{\text{CH}_3\text{ONa}} \text{CH}_3\text{CH}_2\text{CH} = \text{CH}_2 + \text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{OCH}_3
\]

A) E1, S\(_n\)1
B) E1, S\(_n\)2
C) E2, S\(_n\)1
D) E2, S\(_n\)2

8. Identify the mechanistic pathways, respectively, for the products in the following reaction.

\[
\text{Br} \xrightarrow{\text{CH}_3\text{OH}} + \text{OCH}_3
\]

A) E1, S\(_n\)1
B) E1, S\(_n\)2
C) E2, S\(_n\)1
D) E2, S\(_n\)2
9. What is the major product in the following reaction?

\[
\begin{align*}
\text{Br} & \quad \text{KOH} \\
\text{CH}_3\text{CH}_2\text{OH}
\end{align*}
\]

1) \quad 2) \quad 3) \quad 4)

A) is 1  
B) is 2  
C) is 3  
D) is 4

**Reaction 11-6**  
Consider the reaction below to answer the following questions:

\[
\begin{align*}
\text{H} & \quad \text{Ph} \\
\text{C} & \quad \text{H} \\
\text{Br} & \quad \text{H}_3\text{C} \\
& \quad \text{Ph}
\end{align*}
\]

Refer to Reaction 11-6. Write the product that results from the electron flow in the reaction, clearly indicating any stereochemistry.
In the dehydrohalogenation of 2-bromobutane, which conformation below leads directly to the formation of cis-2-butene?

1)  

2)  

3)  

4)  

(A) is 1
(B) is 2
(C) is 3
(D) is 4

12. What is the major product of the reaction of (R)-3-chloro-3-methylhexane with water, H₂O?

- racemic 3-methyl-3-hexanol
- (S) 3-methyl-3-hexanol
- (R) 3-methyl-3-hexanol
- (S) 3-methyl-3-hexene

13. What is the correct order of decreasing reactivity of the following compounds towards hydrolysis (reaction with water)? (Faster reaction >; slower reaction)

- 4 >; 1 >; 2 >; 3
- 3 >; 2 >; 4 >; 1
- 1 >; 4 >; 2 >; 3
- 1 >; 2 >; 4 >; 3
14. The rate law for the following reaction is:

\[ \text{CH}_3\text{CH}_2\text{CH}_2\text{Cl} + \text{NaCN} \xrightarrow{\text{DMSO}} \]

A) \( \text{rate} = k[\text{CH}_3\text{CH}_2\text{CH}_2\text{Cl}] \)

B) \( \text{rate} = k[\text{CH}_3\text{CH}_2\text{CH}_2\text{Cl}][\text{NaCN}] \)

C) \( \text{rate} = k[\text{CH}_3\text{CH}_2\text{CH}_2\text{Cl}][\text{NaCN}]^2 \)

D) \( \text{rate} = k[\text{CH}_3\text{CH}_2\text{CH}_2\text{Cl}]^2[\text{NaCN}] \)

15. Identify the major product(s) in the reaction of (R)-2-bromopentane with sodium cyanide in DMSO?

A) (R)-2-cyanopentane

B) (S)-2-cyanopentane

C) racemic mixture of 2-cyanopentane

D) \textit{trans}-2-pentene

16. In which of the solvents below would the reaction shown take place at the fastest rate?

\[ \text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{Br} + \text{NaCN} \xrightarrow{} \text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CN} + \text{NaBr} \]

A) ethanol

B) acetic acid

C) dimethyl sulfoxide

D) water

17. Which of the following alkyl halides undergoes the fastest S_{N}2 reaction with sodium cyanide, NaCN?

A) bromomethane

B) tert-butyl bromide

C) 2-bromopropane

D) bromoethane
18. Which of the following reacts fastest with methanol by the $S_{N1}$ mechanism?

1) $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{Br}$  
2) $\text{CH}_3\text{CH}_2\text{CHCH}_2\text{CH}_3 \quad \text{Br}$  
3) $\text{CH}_3\text{CCH}_2\text{CH}_3$  
4) $(\text{CH}_3)_3\text{CCH}_2\text{Br}$

A) is 1  
B) is 2  
C) is 3  
D) is 4

---

19. Ignore double-bond stereochemistry and give the structures of all possible products of the elimination reaction of:

\[
\begin{align*}
\text{CH}_3 & \quad \text{CH}_3 \\
\text{CH}_3 & \quad \text{CH}-\text{CH}_2 \quad \text{C} - \text{CH}-\text{CH}_3 \quad \text{CH}_3 \\
\text{CH}_3 \quad \text{CH} - \text{CH}_3 & \quad \text{CH} - \text{CH} - \text{CH}_2 & \quad \text{C} - \text{CH} - \text{CH}_3 \\
\text{CH}_3 \quad \text{CH} - \text{CH}_3 & \quad \text{CH} - \text{CH} - \text{CH}_2 & \quad \text{C} - \text{CH} - \text{CH}_3 \\
\text{CH}_3 \quad \text{CH} - \text{CH}_3 & \quad \text{CH} - \text{CH} - \text{CH}_2 & \quad \text{C} - \text{CH} - \text{CH}_3 \\
\text{CH}_3 \quad \text{CH} - \text{CH}_3 & \quad \text{CH} - \text{CH} - \text{CH}_2 & \quad \text{C} - \text{CH} - \text{CH}_3
\end{align*}
\]
Write a reaction to produce the following structure:

![Chemical Structure](image)

Ethers can often be prepared by $S_N2$ reaction of alkoxide ions, $RO^-$, with alkyl halides. Suppose you wanted to prepare cyclohexyl methyl ether. Which of the two possible routes shown below would you choose? Explain.

Option 1:

\[ \text{Cyclohexyl-OH} + \text{CH}_3\text{I} \rightarrow \text{Cyclohexyl-OCH}_3 \]

Option 2:

\[ \text{CH}_3\text{O}^- + \text{Cyclohexyl-I} \rightarrow \text{Cyclohexyl-OCH}_3 + \text{I}^- \]

Also, elimination.
22.) The $sp^2$ reaction can occur intramolecularly (within the same molecule). What product would you expect from treatment of 4-bromo-1-butanol with base?

\[
\begin{array}{c}
\text{CH}_2\text{CH(CH}_3\text{CH}_2\text{OH} \\
\text{O} \\
\end{array}
\]

23.) Which is more nucleophilic?

a) $\text{H}_2\text{O}$ or $\text{OH}^-$

b) $\text{Cl}^-$ or $\text{I}^-$

24.) Which of the following involves a carbocation intermediate?

$\text{SN}_1$  $\text{SN}_2$  $\text{E}_1$  $\text{E}_2$
WRITE THE THREE STEPS INVOLVED IN THE MECHANISM OF THIS REACTION.