Note: There are 18 problems on Exam 3

Library of Synthetic Reactions.
1. Using the pKₐ table on the cover, choose the order that has the following nucleophiles correctly arranged with respect to increasing reactivity in an S_N2 reaction.

\[
\text{Br}^+ \text{CH}_2 \rightarrow \text{Nu}^- \rightarrow \text{Nu}^- \text{CH}_2 + \text{Br}^-
\]

\[\text{Nu}^- = \begin{array}{c}
\text{F}^- \quad \text{i} \\
\text{NH}_2^- \quad \text{ii} \\
\text{OH}^- \quad \text{iii}
\end{array}\]

A. increasing reactivity  B. increasing reactivity  C. increasing reactivity  D. increasing reactivity  E. increasing reactivity  F. increasing reactivity

2. Choose the order that has the following alkyl chlorides correctly arranged with respect to increasing the rate of an S_N1 reaction. (class quiz)

\[
\text{R-Cl} \rightarrow \text{C}_2\text{H}_5\text{OH} \rightarrow \text{solvolysis products}
\]

\[
\text{Cl} \quad \text{Cl} \quad \text{Cl}
\]

A. increasing reaction rate  B. increasing reaction rate  C. increasing reaction rate  D. increasing reaction rate  E. increasing reaction rate  F. increasing reaction rate
3. Choose the order that has the following compounds correctly arranged with respect to increasing $S_N2$ reactivity. (class quiz)

\[ \text{Br} \]

\[ \text{Br} \]

\[ \text{Br} \]

A. \[ \text{i} \text{ ii} \text{ iii} \]

B. \[ \text{i} \text{ iii} \text{ ii} \]

C. \[ \text{ii} \text{ iii} \text{ i} \]

D. \[ \text{iii} \text{ ii} \text{ i} \]

4. Choose the order that has the following solvents correctly arranged with respect to increasing the rate of an $S_N2$ reaction. (class quiz)

\[ \text{Br} \] + \[ \text{Na} \text{ :C=NN:} \] \[ \text{solvent} \text{ $S_N2$} \] \[ \text{Br} \] + \[ \text{Na} \text{ Br} \]

\[ \text{solvents} \]

CH$_3$CH$_2$OH

\[ \text{i} \]

\[ \text{ii} \]

\[ \text{iii} \]

A. \[ \text{i} \text{ ii} \text{ iii} \]

B. \[ \text{i} \text{ iii} \text{ ii} \]

C. \[ \text{ii} \text{ iii} \text{ i} \]

D. \[ \text{iii} \text{ ii} \text{ i} \]

E. \[ \text{iii} \text{ i} \text{ ii} \]

F. \[ \text{i} \text{ iii} \text{ ii} \]
5. For the following reaction choose the correct order of reactivity for the leaving groups shown. (pre-class quiz)

\[
\begin{align*}
\text{H} & \quad \text{H} \\
\text{C} & \quad \text{C} \\
\text{X} & \quad \text{CN} \\
\text{H} & \quad \text{H}
\end{align*}
\]

\[\begin{array}{ccc}
\text{X} & \text{i} & \text{Cl} \\
\text{i} & \text{ii} & \text{I} \\
\text{iii} & \text{O} & \text{CH}_3
\end{array}\]

Increasing reactivity:

\[\begin{array}{ccc}
\text{A} & \text{i} & \text{ii} & \text{iii} \\
\text{B} & \text{i} & \text{iii} & \text{ii} \\
\text{C} & \text{ii} & \text{i} & \text{iii} \\
\text{D} & \text{ii} & \text{iii} & \text{i} \\
\text{E} & \text{iii} & \text{ii} & \text{i} \\
\text{F} & \text{iii} & \text{i} & \text{ii}
\end{array}\]

6. Choose the correct statement about the following E2 reactions of isomeric reactants. (pre-class quiz)

(1) \[\text{Cl} \quad \text{EtO}^- \quad \text{EtOH} \rightarrow \text{Cl}\]

(2) \[\text{Cl} \quad \text{EtO}^- \quad \text{EtOH} \rightarrow \text{Cl}\]

A. Reaction (1) is faster than (2)
B. Reaction (2) is faster than (1)
C. Both reactions occur at the same rate
D. Neither of these reactions can occur as shown

7. Choose the major product of the following reaction. (class quiz)

\[
\text{HO} \quad \text{Br} \quad 1. \text{H} \rightarrow \\
\text{2. H}_2\text{O}
\]

\[\begin{array}{ccc}
\text{A} & \text{B} & \text{C} \\
\text{D} & \text{E} & \text{F}
\end{array}\]
8. Choose the major product of the following reaction. (pre-class quiz)

\[
\text{H} \quad \xrightarrow{1. \text{BH}_3} \quad \xrightarrow{2. \text{H}_2\text{O}_2/\text{HO}^-} \]

\[
\text{A} \quad \text{B} \quad \text{C} \quad \text{D} \quad \text{E} \quad \text{F}
\]

9. Select the major product of the following reaction. (WS9 pt2; q2)

\[
\text{CH}_3\text{OH} \quad \xrightarrow{\text{H-Br}} \quad ?
\]

\[
\text{A} \quad \text{B} \quad \text{C} \quad \text{D} \quad \text{E} \quad \text{F}
\]

10. Choose the best alkyne reactant to complete the following reaction sequence. (WS8 online quiz; q9 and WS10 online quiz; q6)

\[
? \quad \xrightarrow{\text{LDA}} \quad \xrightarrow{\text{Br}} \quad \xrightarrow{\text{H}_2} \quad \xrightarrow{\text{H-Cl}} \quad \text{Cl}
\]

\[
\text{A} \quad \text{B} \quad \text{C} \quad \text{D} \quad \text{E} \quad \text{F}
\]

**Short Answer**

11. Using the S\text{N}_2 reaction propose a synthesis of the following compound from an alcohol. (class quiz) 5 pts

\[
\text{O-CH}_3
\]
12. The solvolysis of the following compound gives a *rearranged* alkene along with other products. Give the structure of the alkene. Show all stereochemistry.

(class quiz) 5 pts

\[
\text{solvolysis} \quad \frac{\text{HCO}_2\text{H}}{H_2O} \quad \text{alkene} \quad (C_9H_{14}) \quad + \quad \text{other products}
\]

13. Give the major product of the following reaction. (pre-class quiz) 5 pts

\[
\text{CH}_3\text{O} - \text{Br} \quad \rightarrow \quad ?
\]

14. From the following data propose the correct structure for terpinoline, a natural product found in many plants. (class quiz) 5 pts

\[
\text{terpinoline} \quad \xrightarrow{\text{H}_2, \text{Pd/C}} \quad \text{terpinoline} \quad \xrightarrow{1. \text{O}_3, 2. \text{Me}_2\text{S}} \quad \text{\text{C}}\text{O} - \text{C} = \text{O} \quad + \quad \text{O}
\]

15. There are four alkenes with the molecular formula C_8H_{16} that upon hydrogenation give 2,5-dimethylhexane. Out of those four alkenes, only one gives a meso product upon reaction with osmium tetroxide. Draw the structure of that alkene. 5 pts (WS10 pt2; q3)

\[
\text{C}_8\text{H}_{16} \quad \xrightarrow{\text{H}_2, \text{Pd-C}} \quad ? \quad \xrightarrow{1. \text{OsO}_4, 2. \text{NaHSO}_3, \text{H}_2\text{O}} \quad \text{meso product}
\]

16. Draw the structure of the major product of the following reaction. 5 pts (WS9 online quiz; q7 and WS9 pt2; q1)

\[
\text{\text{C}}\text{H}_8\text{O} \quad \xrightarrow{\text{H}_2\text{SO}_4, \text{heat}} \quad ? \quad \xrightarrow{} \quad \text{C}_8\text{H}_{14}
\]

17. Using the curved arrow formalism to show the bond making and bond breaking propose a mechanism for the following reaction that accounts for the *retention* of configuration. 10 pts (class quiz)

\[
\text{H}_2\text{O} \quad + \quad \text{Cl}^- \quad \xrightarrow{} \quad \text{OH}^- \quad + \quad \text{H}^+ \quad + \quad \text{Cl}^-
\]
18. Propose a synthesis of the following compound, with the stereochemistry shown, from reactants containing four carbon atoms or less. 10 pts (WS10 pt2; q2)