1. Separation and Synthesis (8 points).
   a) The solids A-C are obtained as a mixture. Give a set of directions for separating these compounds by appropriate extractions from a toluene solution of the mixture. Include directions for the isolation of each after separation is completed.

   ![Chemical Structures]

   b) Draw the reactants and/or reagents required to achieve each of the following transformations in the boxes above or below the appropriate arrows.

   ![Reaction Structures]
Examples

Chem 34 Second Midterm

2. Nomenclature (8 points).

Give the complete IUPAC names for the compounds in a and b. Stereochemistries (geometries) must be specified when requested.

a) 
\[
\begin{align*}
\text{H} & \quad \text{O} \\
\text{H} & \quad \text{H} \\
\text{OH} & \\
\end{align*}
\]

(give stereochemistry)

b) 
\[
\begin{align*}
\text{CH}_3 & \quad \text{O} \\
\text{C} & \quad \text{CH}_2 \quad \text{C} \\
\text{CH}_3 & \quad \text{H} \\
\end{align*}
\]

(give geometry)

(give stereochemistry)

Draw the correct structures for the following compounds. You must include all hydrogens except those on rings where no stereochemistry is implied.

c) Allyl vinyl ether

d) o-Phenylaniline

e) N,N-diethyl-2-methyl-2-propanamine

f) Imidazole OR Lactic acid

g) Sodium ethoxide

h) Phenyl t-butyl ether

d) 2,4-Dibromophenol

e) N-Benzylcyclobutanamine

f) m-Hydroxyaniline

g) Pyruvic acid
3. Isomers (___ points). Include all hydrogens in all structures. Stereochemistry or geometry differences must be recognizable using standard conventions when used to differentiate between structures.

a) Draw the structures of **three** carboxylic acids with the molecular formula, C$_3$H$_4$Br$_2$O$_2$, which are constitutional isomers.

b) Draw the structures of **four** different **auillines** (same as aminobenzenes or benzenamines) with the molecular formula, C$_7$H$_9$N.

c) Draw the structure of **the only epoxide** with the molecular formula, C$_3$H$_6$O.

d) Draw the structures of **three** different tertiary amines of molecular formula, C$_5$H$_{13}$N.

d) How many different monochlorosubstitution products (i.e., from replacement of -H by -Cl) can be obtained (in even trace yield) from each of the aromatic reactants pictured below?

![Aromatic structures](image_url)
4. Reactions and Stuff (18 points).

Draw the main carbon containing product for reactions a-g. You must show product stereochemistry if relevant.

a) \[
\begin{array}{c}
\text{OH} \\
\text{CH-CH}_3
\end{array}
+ \text{CrO}_3
\Rightarrow
\]

b) \[
\begin{array}{c}
\text{CH}_3
\end{array}
\begin{array}{c}
\text{CH}_3
\end{array}
+ \text{HNO}_3 + \text{H}^+
\Rightarrow
\]

c) \[
\begin{array}{c}
\text{CH}_3
\end{array}
\begin{array}{c}
\text{CH}_2\text{-O}^- \text{Na}^+ + \text{CH}_3\text{-CH}_2\text{-Br}
\end{array}
\Rightarrow
\]

d) \[
\begin{array}{c}
\text{OH}
\end{array}
+ \text{SOCl}_2
\Rightarrow
\]

e) \[
\begin{array}{c}
\text{CH}_3
\end{array}
\begin{array}{c}
\text{CH}_2\text{-CH}_3
\end{array}
+ \text{CH}_3\text{-I}
\Rightarrow
\]

f) \[
\begin{array}{c}
\text{CH}_3\text{-Cl}
\end{array}
+ \begin{array}{c}
\text{C}
\end{array}
+ \text{AlCl}_3
\Rightarrow
\]

g) \[
\begin{array}{c}
\text{C}
\end{array}
+ \text{CH}_3\text{-CH-CH}_3
+ \text{AlCl}_3
\Rightarrow
\]

h) Give an important commercial use of ethylene glycol.

i) What is the name of the carboxylic acid in most kidney stones?

j) Name a compound which can be made from morphine in one step which is more addictive than morphine.
5. Products and Properties (14 points).

a) Which of the compounds A-E below is the second strongest acid? 

b) Which of the compounds A-E below is the second strongest base? 

\[
\text{(A)} \quad \text{CH}_3\text{OH} \quad \text{(B)} \quad \text{CH}_3\text{-OH} \quad \text{(C)} \quad \text{CH}_3\text{-C}^1\text{OH} \quad \text{(D)} \quad \text{NH-CH}_3 \quad \text{(E)} \quad \text{NH-CH}_3
\]

The compounds F-J below all have approximately the same molecular weight.

c) Which of the compounds F-J has the second highest boiling point? 

d) Which of the compounds F-J has the lowest boiling point? 

e) Which of the compounds F-J is the most soluble in water? 

\[
\text{(F)} \quad \text{CH}_3\text{-C-CH}_2\text{-O-CH}_3 \quad \text{(G)} \quad \text{CH}_3\text{-C-CH}_2\text{-OH} \quad \text{(H)} \quad \text{CH}_3\text{-C-NH-CH}_3 \quad \text{(I)} \quad \text{CH}_3\text{-C-CH}_2\text{-NH}_2 \quad \text{(J)} \quad \text{CH}_3\text{-CH-CH}_3\text{-O-CH}_3
\]

f) What happens to the K⁺ when KCl is added to 18-crown-6 in ether? Also, what happens to the reactivity of the Cl⁻?

g) Circle the name of the vitamin in the following series which is most acidic.

\[
A \quad B_1 \quad B_2 \quad C \quad D \quad E
\]

h) What does "phenol coefficient" measure?

a) Show by drawing the appropriate carbon skeleton to the right of the pictured structure that the sesquiterpene depicted below is derived in nature from a 15-carbon precursor containing three isoprenoid units. Mark the two head to tail junctions between these three units.

\[ \text{Structure Image} \]

b) In the FeBr\(_3\) catalyzed bromination of A to give B, the first key intermediate is Br\(^+\). Draw the three structures of the resonance hybrid which is the next intermediate.

\[ \begin{array}{c}
\text{CH}_3 \\
\text{CH}_3 \\
\hline
\text{C} \\
\text{Br} \\
\text{CH}_3 \\
\text{CH}_3 \\
\end{array} \]

---

c) In the base catalyzed polymerization of ethylene oxide, the first intermediate is D. What is the next intermediate?

\[ \begin{array}{c}
\text{H}_2\text{C} \\
\text{CH}_2 \\
\hline
\text{OH} \\
\text{catalyst} \\
\hline
[\text{HO-CH}_2\text{-CH}_2\text{-O}^-] \\
\hline
\text{D} \\
\end{array} \]

d) The mechanism of the oxidation of cyclopentanol to cyclopentanone with CrO\(_3\) is pictured below. Which of the two steps of this reaction determines the reaction rate?

\[ \begin{array}{c}
\text{OH} \\
\text{CrO}_3 \\
\hline
\text{OH-Cr-OH} \\
\hline
\text{O} \\
\text{C} \\
\hline
\text{O} \\
\text{C} \\
\hline
\end{array} \]
4. Reactions and Stuff (18 points).

Draw the main carbon containing product for reactions a-g. You must show product stereochemistry if relevant.

a) \[
\text{C-OH} + \text{NaOH} \rightarrow
\]

b) \[
\text{C-H} + \text{NaBH}_4 \rightarrow
\]

c) \[
\text{CH}_3 - \text{NO}_2 + \text{Fe} \xrightarrow{\text{HCl}}
\]

d) \[
\text{ } + \text{H}_2\text{SO}_4 \rightarrow
\]

e) \[
\text{CH}_3\text{-NH}_2 + \text{CH}_3\text{-CH}_2\text{-Br} \rightarrow
\]

f) \[
\text{SO}_3\text{H} + \text{NaOH} \xrightarrow{250 \ ^\circ \text{C}} \text{melt together}
\]

g) \[
\text{CH}_2\text{-CH}_2\text{-OH} + \text{PCC} \rightarrow
\]

h) Give a common use for:

Acetylsalicylic acid and codeine _______________________

i) An overworked muscle tissue deprived of enough oxygen converts pyruvic acid to lactic acid in order to keep functioning. Is this process a hydration, a dehydration, an oxidation, a reduction, a hydrolysis, or a condensation?

j) Give a common use of sodium benzoate, sodium propanoate, butylated hydroxytoluene (BHT), ascorbic acid, and citric acid.
5. Products and Properties (___ points).

a) Which of the compounds A-E below is the strongest acid? 

b) Which of the compounds A-E below is the strongest base?

\[ \text{CH}_3\text{OH} \quad \text{CH}_3\text{NCH}_3 \quad \text{CH}_3\text{Cl} \quad \text{HOCH}_2\text{OH} \quad \text{NO}_2\text{CCH}_3 \]

(A) (B) (C) (D) (E)

The compounds F-J below all have approximately the same molecular weight.

c) Which of the compounds F-J has the highest boiling point? 

d) Which of the compounds F-J has the lowest boiling point? 

e) Which of the compounds F-J is the most soluble in water?

\[ \text{C-OH} \quad \text{CH}_2\text{OH} \quad \text{CH}_2\text{NHH}_2 \quad \text{NCH}_3 \quad \text{NH-CH}_3 \]

(F) (G) (H) (I) (J)

f) What is an alkaloid?

g) What important alcohol is formed and isolated by the destructive distillation of wood?

h) What is the functional group in the compounds which are part of the odor of skunk?

alcohol amine carboxylic acid phenol thiol ether

g) What is the percent of ethanol by volume in "Wild Turkey Kentucky Straight Bourbon Whiskey"? The bottle is labelled 86 proof. What is meant by "denatured alcohol."

   a) Show by drawing the appropriate carbon skeleton to the right of the pictured structure that the sesquiterpene depicted below is derived in nature from a 15-carbon precursor containing three isoprenoid units. Mark the two head to tail junctions between these three units.

   ![Chemical structure image]

   b) In the FeCl₃ catalyzed reaction of A with Cl₂ to give B, the first intermediate is Cl⁺. Draw the three resonance structures of the resonance hybrid which is the next intermediate.

   ![Chemical reaction image]

   c) In the nucleophile (:Nu) induced polymerization of propylene oxide, the first intermediate is D. What is the second intermediate in this reaction?

   ![Chemical reaction image]

   d) In the reduction of X to give Y with NaBH₄, the first intermediate is the formal equivalent of "H⁻". What is the next intermediate in this reaction?

   ![Chemical reaction image]