1) Name the general class of organic compounds that each of these molecules belong to. (15pts)

2) Put a cross through a molecule which is an epoxidizing agent (2pts)

Circle the molecule with the most ring strain. (2pts)
3) Circle the strongest acid in the following sets. (12pts)

(a) \( \text{CH}_3\text{-CO}_2\text{H} \quad \text{CH}_3\text{CH}_2\text{-O-H} \quad \text{CH}_3\text{CH}_2\text{-O-O-H} \)

(b) \[
\begin{array}{c}
\text{Br} \\
\text{OH}
\end{array}
\quad 
\[
\begin{array}{c}
\text{Cl} \\
\text{OH}
\end{array}
\quad 
\[
\text{F}
\]
\[
\text{OH}
\]

(c) \( \text{CH}_3\text{OH} \quad \text{NH}_3 \quad \text{CH}_4 \)

(d) \[
\begin{array}{c}
\text{F} \\
\text{Cl}
\end{array}
\quad 
\[
\begin{array}{c}
\text{Cl}
\end{array}
\quad 
\[
\text{Cl}
\]
\[
\text{CO}_2\text{H}
\]

4) Circle the more reactive molecule with respect to nucleophilic acyl substitution. (6pts)

(a) \( \text{CH}_3\text{CH}_2\text{-OH} \quad \text{CH}_3\text{-O-C-CH}_3 \quad \text{CH}_3\text{-O-C-CF}_3 \)

(b) \[
\begin{array}{c}
\text{NH}
\end{array}
\quad 
\[
\begin{array}{c}
\text{NH}
\end{array}
\quad 
\[
\text{H}_3\text{C}-\text{C-N-CH}_3
\]

(c) \[
\begin{array}{c}
\text{H}_3\text{C-C-O-CH}_3
\end{array}
\quad 
\[
\begin{array}{c}
\text{H}_2\text{C-C-O-C-CH}_3
\end{array}
\quad 
\[
\begin{array}{c}
\text{H}_3\text{C-C-O-C-CH}_3
\end{array}
\quad 
\[
\begin{array}{c}
\text{H}_3\text{C-C-O-C-CH}_3
\end{array}
\]
5) Name the following compounds in IUPAC acceptable terms. (20pts)

\[
\begin{array}{c}
\text{NH}_2 \\
\text{F} \\
\text{O} \\
\text{O}
\end{array}
\quad
\begin{array}{c}
\text{O} \\
\text{NH}
\end{array}
\quad
\begin{array}{c}
\text{O}
\end{array}
\quad
\begin{array}{c}
\text{O}
\end{array}
\quad
\begin{array}{c}
\text{O}
\end{array}
\quad
\begin{array}{c}
\text{Br}
\end{array}
\quad
\begin{array}{c}
\text{O}
\end{array}
\]

6) Benzoic acid can be made from a wide variety of benzene derivatives. Fill in the missing starting materials. (12pts)

\[
\begin{array}{c}
\text{OH/H}_2\text{O}
\end{array}
\quad
\begin{array}{c}
\text{KMnO}_4, \text{H}_3\text{O}^+
\end{array}
\quad
\begin{array}{c}
\text{Heat}
\end{array}
\quad
\begin{array}{c}
\text{Ag}_2\text{O}
\end{array}
\quad
\begin{array}{c}
\text{1) Mg}
\end{array}
\quad
\begin{array}{c}
\text{2) CO}_2
\end{array}
\quad
\begin{array}{c}
\text{3) H}_3\text{O}^+
\end{array}
\]

\text{CO}_2\text{H}
(7) Write the mechanism for the reaction of an alcohol with an anhydride, yielding an ester. (7pts)

(8) Provide the five products. (10pts)
9) (i) Fill in all the missing products or reagents. (8pts)

(ii) Draw the mechanism for one of the above reactions in part (9i). (6pts)
****BONUS QUESTION (2 points)****

Give two reasons why esters are more reactive than amides towards nucleophilic acyl substitution.
1) Name the general class of organic compounds that each of these molecules belong to. (15pts)

- Carboxylic acid
- Ester
- Acid fluoride
- Amide
- Nitrile
- Anhydride
- Lactone
- Isoguanate
- Peroxyacid

2) Put a cross through a molecule which is an epoxidizing agent (2pts)
Circle the molecule with the most ring strain. (2pts)
3) Circle the strongest acid in the following sets. (12pts)

(a) $\text{CH}_3\text{-CO}_2\text{H}$ $\text{CH}_3\text{CH}_2\text{-O-H}$ $\text{CH}_3\text{CH}_2\text{-O-O-H}$

(b) $\text{H}_{\text{Br}}\text{Br}$ $\text{CH}_3\text{-CO}_2\text{H}$ $\text{CH}_{\text{F}}\text{-CO}_2\text{H}$

(c) $\text{CH}_3\text{OH}$ $\text{NH}_3$ $\text{CH}_4$

(d) $\text{F}_2\text{C}\text{-CO}_2\text{H}$ $\text{O}_{\text{Cl}}\text{O}$ $\text{H}_{\text{Cl}}\text{Cl}$

4) Circle the more reactive molecule with respect to nucleophilic acyl substitution. (6pts)

(a) $\text{CH}_3\text{CH}_2\text{-OH}$ $\text{CH}_3\text{-O-C-CH}_3$ $\text{CH}_3\text{-O-C-CF}_3$

(b) $\text{H}_3\text{C}\text{-N-CH}_3$ $\text{O}$ $\text{H}_3\text{C}$

(c) $\text{H}_3\text{C}\text{-O-CH}_3$ $\text{H}_3\text{C}\text{-O-C-CH}_3$ $\text{H}_3\text{C}\text{-O-C-CH}_3$
5) Name the following compounds in IUPAC acceptable terms. (20pts)

- 4-amino-5-fluoropentanoic acid
- 4-oxa-2-thietanone
- 5-hydroxypropiolic acid lactone
- Propionic acid anhydride
- 3-bromopentyl fluoride
- Ethyl propanoate

6) Benzoic acid can be made from a wide variety of benzene derivatives. Fill in the missing starting materials. (12pts)

- An aromatic carboxylic acid derivative
- K<sub>MnO</sub><sub>4</sub>, H<sub>3</sub>O<sup>+</sup>, Heat
- Ag<sub>2</sub>O

1) Mg
2) CO<sub>2</sub>
3) H<sub>2</sub>O<sup>+</sup>
(7) Write the mechanism for the reaction of an alcohol with an anhydride, yielding an ester. (7pts)

(8) Provide the five products. (10pts)
9) (i) Fill in all the missing products or reagents. (8pts)

(ii) Draw the mechanism for one of the above reactions in part (9i). (6pts)
****BONUS QUESTION (2 points)****

Give two reasons why esters are more reactive than amides towards nucleophilic acyl substitution.

- Less resonance stabilization
- Better leaving group
- Makes the $\text{C}^\text{O}$ more $\text{+ve}$