1) Name the general class of organic compounds that each of these molecules belong to, and circle the molecule with the weakest π bond. (17pts)

2) Put a cross through the molecule whose name means "without water". (2pts)
3) Circle the stronger acid in the following sets. (12pts)

(a) CH₃CH₂-OH  CH₃CH₂-O-OH  CH₃-CO₂H

(b) Cl

(c) NC-Ph-CO₂H  Ph-CO₂H  CH₃-Ph-CO₂H

(d) O

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

(a) CH₃CH₂-NH₂  CH₃-NH-C-CH₃

(b) O

(c) H₃C-C-N-CH₃  H₃C-C-O-C-CH₃
5) Name the following compounds in IUPAC acceptable terms. (20pts)

6) Benzoic acid can be made from a wide variety of benzene derivatives. Fill in the missing reagents. (12pts)
(7) **EITHER** write the mechanism for the hydrolysis of an amide into a carboxylic acid. (7pts)

**OR**
Provide in the products. (7pts)
(8) **Either** give the reagents for all of the following transformations (10pts). **OR** Write the mechanism for any two of the steps shown below (10pts)

Nitrobenzene → \( \text{HN-} \) → \( \text{HN-} \) → \( \text{HN-} \) → \( \text{NH}_2 \)

\( \text{SO}_2\text{Cl} \)

\( \text{NH}_2 \)

\( \text{O=S=O} \)

\( \text{NH}_2 \)
9) Penicillin and many other modern anti-biotics contain a 4 membered ring lactam functionality as their active site.

\[
\begin{array}{c}
\text{PhOCH}_2 \\
\text{\text{C-NH}} \\
\text{\text{\text{C-}} \text{\text{O}} \text{ \text{N}} \text{ \text{C}} \text{ \text{C}} \text{ \text{H}} \text{ \text{H}} \text{ \text{C}} \text{ \text{O}} \text{ \text{C}} \text{ \text{H}} \text{ \text{H}} \text{ \text{H}} \text{ \text{H}}}
\end{array}
\]

penicillin V

Draw an arrow to: (a) an AMIDE functional group
(b) the AROMATIC part of the molecule
(c) the ETHER linkage

How many sp\(^2\) hybridized carbons are in this molecule?

Draw the mechanism and product of the reaction of penicillin V with warm alkaline water. (8+4+2 pts).
*Bonus question* (up to 4pts)
Propose a synthesis of 2-phenylethylamine from toluene.
1) Name the general class of organic compounds that each of these molecules belong to, and circle the molecule with the weakest π bond. (17pts)

2) Put a cross through the molecule whose name means “without water”. (2pts)
3) Circle the stronger acid in the following sets. (12pts)

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

(b) \( \text{Cl} \quad \text{Cl} \quad \text{Cl} \)

(c) \( \text{NC} \quad \text{O} \quad \text{CH}_3 \)

(d) \( \text{O} \quad \text{O} \quad \text{O} \)

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

(a) \( \text{CH}_3\text{CH}_2\cdot\text{NH}_2 \)

(b) \( \text{O} \)

(c) \( \text{H}_3\text{C} \cdot \text{C} \cdot \text{N} \cdot \text{CH}_3 \)

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

- Ethyl Ethanoate
- Butanoic Acid
- Pentanoic Acid
- Propanoic Acid
- 3-Amino-4-chloropentanoic Acid
- 4-Hydroxybutanoic Acid
- Maleic Acid Lactone
- Maleic Acid
- Maleic Acid Lactone
- Maleic Acid
- Maleic Acid Lactone

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

- \( \text{CH}_2\text{CH}_3 \) + \( \text{KMnO}_4 \) or \( \text{H}_2\text{SO}_4 \) or \( \text{HNO}_3 \) → \( \text{CO}_2\text{H} \)
- \( \text{CH}_2\text{CH}_3 \) + \( \text{As}_2\text{O}_5 \) → \( \text{CO}_2\text{H} \)
- \( \text{CH}_2\text{CH}_3 \) + \( \text{H}_2\text{SO}_4 \) or \( \text{HNO}_3 \) or \( \text{H}_2\text{SO}_4 \) → \( \text{CO}_2\text{H} \)
- \( \text{CH}_2\text{CH}_3 \) + \( \text{H}_2\text{SO}_4 \) or \( \text{HNO}_3 \) or \( \text{H}_2\text{SO}_4 \) → \( \text{CO}_2\text{H} \)
(7) **EITHER** write the mechanism for the hydrolysis of an amide into a carboxylic acid. (7pts)

![Chemical reaction diagram](image)

Acid version see (8)

**OR**

Provide in the products. (7pts)

![Chemical structures and reactions](image)
(8) **Either** give the reagents for all of the following transformations (10pts). **OR** Write the mechanism for any two of the steps shown below (10pts).
9) Penicillin and many other modern anti-biotics contain a 4 membered ring lactam functionality as their active site.

Draw an arrow to: (a) an AMIDE functional group
(b) the AROMATIC part of the molecule
(c) the ETHER linkage

How many sp^2 hybridized carbons are in this molecule? \(6 + 1 + 1 + 1 = 9\)

Draw the mechanism and product of the reaction of penicillin V with warm alkaline water. (8+4+2 pts).
*Bonus question* (up to 4pts)
Propose a synthesis of 2-phenylethylamine from toluene.

![Chemical reaction diagram]

1. Toluene is treated with Br₂ and light to form a dibromide.
2. The dibromide is converted to a cyanide derivative with NaCN.
3. The cyanide derivative is then reduced to 2-phenylethylamine using LiAlH₄ and H₂O⁺.