CHEMISTRY 30
Carboxylic acid and Esters

1. Draw a structural formula for each of the following compounds.
   a) octanoic acid
   b) benzoic acid
   c) ethanoic (acetic) acid

   ![Octanoic Acid](image)
   ![Benzoic Acid](image)
   ![Ethanoic Acid](image)

2. Write IUPAC names for the following.
   a) H-C-OH
   b) HOOC-CH₃-CH₂-CH₂-CH₃
   c) CH₃-CH₂-CH₂-CH₂-CH₂-COOH

   Methanoic acid
   Pentanoic acid
   Hexanoic acid

3. Draw condensed structural formula equations and write the IUPAC name for the ester formed.

   ![Condensed Structural Equation](image)

   Methanoic acid + Ethanol → Methyl propanoate + Water

4. Write a condensed structural formula equation to illustrate the synthesis of each of the following esters from an alcohol and an acid. Refer to table 2 and identify the odor of each ester formed.
   a) ethyl methanoate

   ![Synthesis Equation](image)

   Methanoic acid + Ethanol → Ethyl methanoate + Water

   b) ethyl benzoate

   ![Synthesis Equation](image)

   Benzoic acid + Ethanol → Ethyl benzoate + Water
5. Name each of the following esters, and the acids and alcohols from which they could be prepared.

a) \( \text{CH}_3\text{CH}_2\text{COOCH}_2\text{CH}_3 \)

**Ethyl propanoate (from propanoic acid and ethanol)**

b) \( \text{CH}_3\text{CH}_2\text{CH}_2\text{COOCH}_3 \)

**Methyl butanoate (from butanoic acid and methanol)**

c) \( \text{HCOOCH}_2\text{CH}_2\text{CH}_2\text{CH}_3 \)

**Butyl methanoate (from methanoic acid and butan-1-ol)**

d) \( \text{CH}_3\text{COOCH}_2\text{CH}_2\text{CH}_3 \)

**Propyl ethanoate (from ethanoic acid and propan-1-ol)**
6. Many organic compounds have more than one functional group in a molecule. **Circle and label** the functional groups for an alcohol, a carboxylic acid, and/or an ester.

![Functional Groups](image)

7. **Classify** each reaction and **write** a complete condensed structural formula equation for each of the following organic reactions. **Name** both the reactants and products.

   a) \( \text{C}_2\text{H}_6 + \text{Br}_2 \rightarrow \text{C}_2\text{H}_5\text{Br} + \text{HBr} \)

   ![Reaction a](image)  
   **Substitution**

   b) \( \text{C}_3\text{H}_6 + \text{Cl}_2 \rightarrow \text{C}_3\text{H}_5\text{Cl}_2 \)

   ![Reaction b](image)  
   **Addition**

   c) \( \text{C}_6\text{H}_6 + \text{I}_2 \rightarrow \text{C}_6\text{H}_5\text{I} + \text{HI} \)

   ![Reaction c](image)  
   **Substitution**
d) \[ \text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{Cl} + \text{OH}^- \rightarrow \text{CH}_3\text{CH}_2\text{CHCH}_2 + \text{H}_2\text{O} + \text{Cl}^- \]

l-chlorobutane

\[ \text{H} - \text{C} - \text{C} - \text{C} - \text{Cl} + \text{OH}^- \rightarrow \text{H} - \text{C} - \text{C} - \text{C} = \text{C} - \text{H} + \text{H}_2\text{O} + \text{Cl}^- \]

but-1-ene

water

chloride ion

\[ \text{C}_3\text{H}_7\text{COOH} + \text{CH}_3\text{OH} \rightarrow \text{C}_3\text{H}_7\text{COOCH}_3 + \text{H}_2\text{O} \]

\[ \text{H} - \text{C} - \text{C} - \text{C} - \text{O} + \text{H} - \text{C} - \text{C} - \text{O} \rightarrow \text{H} - \text{C} - \text{C} - \text{O} - \text{C} - \text{H} + \text{H}_2\text{O} \]

butanoic acid

methanol

methyl butanoate

water

\[ \text{C}_2\text{H}_5\text{OH} \rightarrow \text{C}_2\text{H}_4 + \text{H}_2\text{O} \]

\[ \text{H} - \text{C} - \text{C} - \text{OH} \rightarrow \text{H} - \text{C} - \text{C} - \text{H} + \text{H}_2\text{O} \]

either

water

elimination

g) \[ \text{C}_6\text{H}_5\text{CH}_3 + \text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2\text{O} \]

\[ \text{H} - \text{C} - \text{H} \]

oxygen

carbon dioxide

water vapor

methanol