The study of some exercises such as those dealing with food dyes, reduction of vanillin, polymers and plastics, etc., is enriched by the knowledge of some relatively simple concepts from organic chemistry.

In particular, there are some common, recurring molecular fragments which determine the function and name of compounds that contain these fragments.

These are listed on the following pages which summarize some of the simplest organic functional groups.

Knowledge about a small number of simple organic reactions is also helpful. We summarize these on the following pages.

**Organic Functional Groups**

( $R_1$ and $R_2$ represent organic groups with no particular functionality ). The names of the examples are mostly common (rather than systematic) names.

- **Acid**
  
  ![Acid](image)

  e.g., acetic acid

- **Alcohol**
  
  ![Alcohol](image)

  e.g., methyl alcohol

- **Ester**
  
  ![Ester](image)

  e.g., ethyl acetate

- **Acid Chloride**
  
  ![Acid Chloride](image)

  e.g., acetyl chloride
Some basic organic structures will recur in many of the substances used in the exercises.

**Ethylene** (left) whose mono-substituted derivatives are often called vinyl compounds, e.g., vinyl chloride (right)

**Benzene**, represented by \( \text{苯} \) or \( \text{苯} \)
Organic Reactions

Organic acids can react with inorganic bases such as sodium hydroxide to produce salts, just like their inorganic counterparts.

\[
\text{OH}^- + \text{R--COOH} \rightarrow \text{R-COO}^- + \text{H}_2\text{O}
\]

**acid** **acid anion**

e.g.,

\[
\text{OH}^- + \text{CH}_3\text{--COOH} \rightarrow \text{CH}_3\text{--COO}^- + \text{H}_2\text{O}
\]

**acetic acid** **acetate**

A second organic analog of a neutralization reaction is the reaction of an organic **acid** with an organic **alcohol**. The result is the formation of an ester.

\[
\text{ROH} + \text{R'COOH} \rightarrow \text{R-O-CO-R'} + \text{H}_2\text{O}
\]

**alcohol** **acid** **ester**

e.g.,

\[
\text{CH}_3\text{OH} + \text{C}==\text{O}\text{H} \rightarrow \text{C}==\text{O}\text{H} \text{H}_3\text{C}-\text{O} + \text{H}_2\text{O}
\]

**METHANOL** **BENZOIC ACID** **METHYL BENZOATE**

Another type of reaction is that between an **amine** (an ammonia molecule in which one or more of the hydrogen atoms is replaced by an organic group), with an **acid chloride**.

The reaction produces an **amide**. Viz.

\[
\text{H}_3\text{C}==\text{COCl} + \text{NH}_3\text{CH}_3 \rightarrow \text{H}_3\text{C}==\text{C}==\text{ON(CH}_3\text{)} + \text{HCl}
\]

**Acetyl Chloride** **Methyl Amine** **N-Methyl Acetamide** **Hydrochloric Acid**
Note particularly the arrangement of atoms – an amide linkage

Also, note the elimination of a molecule of HCl in the above example.

**Oxidation and Reduction**

Oxidation and reduction reactions also have meaning in organic chemistry. In unsaturated compounds, they can often be identified by examining whether the reaction results in hydrogen atoms being added or removed across a multiple bond.

E.g.,

\[
\begin{array}{c}
\text{H} \\
\text{C} \quad \text{C} \\
\text{H} \\
\end{array} + \quad \text{H}_2 \rightarrow \quad \begin{array}{c}
\text{H} \\
\text{H} \\
\text{H} \\
\text{H} \\
\text{H} \\
\text{H} \\
\end{array}
\]

represents the *reduction* of ethylene to ethane.

\[
\begin{array}{c}
\text{H} \\
\text{C} \quad \text{C} \quad \text{O} \\
\text{H} \\
\end{array} + \quad \text{H}_2 \rightarrow \quad \begin{array}{c}
\text{H} \\
\text{H} \\
\text{H} \\
\text{H} \\
\text{H} \\
\text{O} \\
\end{array}
\]

Is the *reduction* of acetaldehyde to ethanol.

The addition of hydrogen can be accomplished by catalytic addition of hydrogen gas or by other reagents such as metal hydrides, e.g., sodium borohydride NaBH₄.