Understandings:

- **Alkanes:** have low reactivity and undergo free radical substitution reactions.
- **Alkenes:** are more reactive than alkanes and undergo addition reactions. Bromine water can be used to distinguish between alkenes and alkanes.
- **Alcohols:** undergo nucleophilic substitution reactions with acids (also called esterification or condensation) and some undergo oxidation reactions.
- **Halogenoalkanes:** are more reactive than alkanes. They can undergo (nucleophilic) substitution reactions. A nucleophile is an electron-rich species containing a lone pair that it donates to an electron-deficient carbon.
- **Polymers:** addition polymers consist of a wide range of monomers and form the basis of the plastics industry.
- **Benzene:** does not readily undergo addition reactions but does undergo electrophilic substitution reactions.

1 Alkanes

1.1 Combustion

1. Complete Combustion

   Product: CO_2 and H_2O

2. Incomplete Combustion

   Product1: CO and H_2O

   Product2: C and H_2O

1.2 Free Radical Substitution with Halogens

1.2.1 Initiation

A halogen molecule broke into two halogen **atoms** Homolytic: Evenly distributed electrons Hetrolytic: Non-evenly distributed

1.2.2 Propogation

1. Free radicals collide with other molecules
2. New free radical species form and collide with other molecules
3. The 2nd generation of free radical (same as the first step one) collide with the same molecule
4. A **chain reaction** has formed

1.2.3 Termination

Free radicals collide with each other to form molecules.
Decrease in number of free radicals

2 Alkene

2.1 Addition Reaction

2.1.1 With Halogens

No additional requirements for the reaction to take place
With Iodine: Slow at room temperature

2.1.2 With Hydrogen

Called **Hydrogenation**
Reaction Requirements:

1. Nickel as catalyst
2. High temperature

2.1.3 With Hydrogen Halides (H-X)

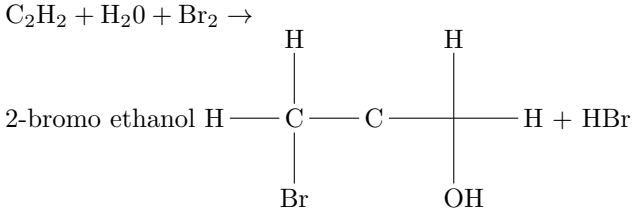
Reaction Requirements: Heat

2.1.4 With Water

1. Concentrated H_2SO_4
2. Heat

2.2 Distinguish between alkanes and alkenes

$C_2H_2 + H_20 + Br_2 \rightarrow$



- Alkene: Bromine water from orange to colorless
- Alkane: No color change

2.3 Addition Polymerisation

1. To break the alkene apart and form monomers
2. Repeat monomers to form polymers

2.3.1 Common Polymers formed by alkenes and uses

- Polyethene (from C_2H_2) to be used as plastic bags
- Polychroethene (from CH_2CHCl) to be used as electric cables
- Polypropene (from C_3H_6 to be used as car bumpers

3 Alcohols

- Writing equations for the complete combustion of alcohols
- Oxidation reactions of primary and secondary alcohols (using acidified potassium dichromate (VI) or potassium magnate (VII) as oxidizing agents.
- Esterfication

3.1 Combustion Reaction

Produce CO_2 and H_2O
See Combustion

3.2 Oxidation

3.2.1 Primary Alcohols

$C_2H_5OH \rightarrow^{+[O],heat} CH_3HO$
Primary alcohols → Aldehydes → Carboxylic acid
Reflux Distillation: end product of carboxylic acid vs. aldehydes

Color Change
From **orange** to **green**
$Cr_2O_7^{2-} + 14H^+ + 6e^- \rightarrow 2Cr^{3+} + 7H_2O$

3.2.2 Secondary alcohols

Secondary alcohols → Ketones

3.2.3 Tertiary Alcohols

Do **NOT** have oxidation reaction.

3.3 Esterfication/condensation reaction

Alcohol + Carboxylic acid → Ester

◦ The compound with the double bond oxygen is the carboxylic acid.
◦ Reaction Requirement: Concentrated sulfuric acid as the catalyst

10/esterformed.png

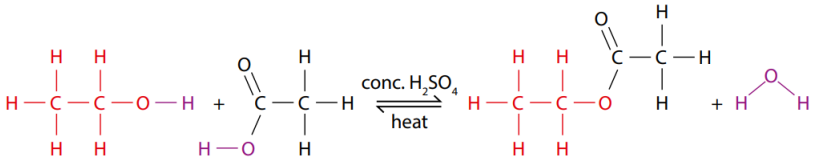


Figure 10.44 An esterification reaction.

Figure 1: Example of an esterification reaction

3.3.1 Condensation Reaction

Two molecules join together with the **elimination** of water.
Esterification could be also described as **nucleophilic substitution** (will be talked in the next section)

4 Halogenalkanes

4.1 Nucleophilic Substitution

Nucleophile: is a molecule or negatively charged ion that

- has a lone pair of electrons
- is attracted to a highly positively charged region

4.1.1 With NaOH

Requirement: Heat

4.1.2 With NH_3

Requirement: Concentrated, **sealed tube**

4.1.3 With KCN

Requirement:
1. KCN
2. Methanol
3. Heat under reflux

5 Benzene

5.1 Electrophilic Substitution

Electrophile: An electrophile is an electron-deficient species that

- is attracted to regions of relatively high electron density
- accepts a pair of electrons to form a covalent bond

Benzene has π delocalised system, thus has a region of **high electron density**

5.1.1 Nitration

Reaction Condition:

1. Concentrated Surlfuric Acid
2. Concentrated Nitric Acid