

SPM Chemistry (Form 5) - Chapter 5: Chemicals for Consumers (Worksheet 01)

Soaps

1. Cleansing agents are chemical substances used to remove **grease** and dirt.
2. There are two types of cleansing agents:
  - a. **Soaps**
  - b. **Detergents**
3. In ancient times, soaps were made from ashes of plants which contain **sodium** carbonate and **potassium** carbonate.
4. The ashes were boiled with lime (calcium oxide) to produce caustic **potash** (potassium hydroxide). Caustic potash is then boiled with animal **fats** to produce soap.
5. In 1816, the French chemist **Michel Chevreul** 米歇尔·谢弗勒尔 (1786 – 1889) discovered that animal fats are composed of **fatty acids** and **glycerol**. This discovery contributed to the rapid development of the soap and candle industry.
6. In 1861, the Belgian chemist **Ernest Solvay** 欧内斯特·索尔维 (1838–1922) discovered the process to make soda (sodium carbonate) from common salt (sodium chloride) and calcium carbonate. This process is known as the **Solvay** Process which produces sodium carbonate which is used for making glass, soaps and detergents.
7. Soaps are sodium or potassium **salts** of long chain fatty acids with **12** to **18** carbon atoms per molecule. The general formula of soap is  **$\text{RCOO}^-\text{Na}^+$**  or  **$\text{RCOO}^-\text{K}^+$** .
8. Soap is produced by the reaction between sodium hydroxide or potassium hydroxide with animal **fats** or vegetable **oils**. This reaction is known as **saponification**. **Saponification** is the alkaline hydrolysis of esters using alkali solutions.
9. Fats and vegetable oils are large, naturally occurring **ester** molecules. When fats or oils are boiled with concentrated alkalis, such as sodium hydroxide or potassium hydroxide, **saponification** occurs and the ester molecules are broken down into **soap** and **glycerol**.
10. The soap produced can be precipitated by adding common salt to the reaction mixture. **Sodium chloride** reduces the solubility of soap in aqueous solution and causes the soap to be precipitated out.
11. The properties of soap depend on:
  - a. the type of **alkali** used for saponification,
    - o Soaps produced from sodium hydroxide are **hard** whereas soaps produced from potassium hydroxide are **soft**.
  - b. the type of **animal fats** or **vegetable oils** used.
    - o Animal fats (**tallow**) from cows and **vegetable** oils (such as palm oil or olive oil) are used for making soap.
12. When a sodium soap is dissolved in water, it will dissociate and produce **sodium** ions and **carboxylate** ions ( $\text{RCOO}^-$ ). For example, **sodium stearate** (soap) dissolves in water to form **sodium** ions and **stearate** ions.
13. The **stearate** ions take part in the removal of dirt but the **sodium** ions do not.
  - a. The stearate ion consists of **two** parts: the '**head**' and the '**tail**'. The '**head**' is **negatively**-charged and the '**tail**' is a long **hydrocarbon** chain.
  - b. The '**head**' contains the  $-\text{COO}^-$  ion which dissolves readily in water (**hydrophilic**) but does not dissolve in oil.
  - c. Conversely, the '**tail**' contains a long hydrocarbon chain which is insoluble in water (**hydrophobic**) but dissolves readily in oil.
14. Soaps made from palmitic acid are known as **sodium palmitate**.

# Bernanke Answers Chapter 5

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