

MINISTRY OF EDUCATION
SECONDARY ENGAGEMENT PROGRAMME
GRADE 11
CHEMISTRY

Week 1 - Lesson 1

Topic: Organic Chemistry

Sub-topic: Introduction to Organic Chemistry

Objective: Given information, students will be able to:

- identify natural gas and petroleum as natural sources of hydrocarbons
- list the main uses of at least three fractions obtained from the fractional distillation of petroleum
- describe cracking of petroleum fractions

Content: **Introduction to Organic Chemistry**

In simple terms, Organic Chemistry is the study of Carbon-containing compounds. A carbon atom has 4 valence electrons (electrons in its outer shell), and can therefore form four covalent bonds (either with other carbon atoms, or atoms from other elements). These bonds are represented by lines. Take a look at the diagram below (*Figure 1*). In this diagram, the Carbon atom has bonded covalently with four Hydrogen atoms.

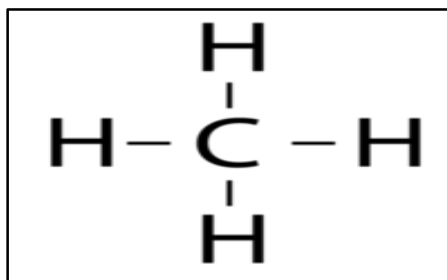


Figure 1: Carbon atoms can form a total of four covalent bonds.

Hydrocarbon Compounds

When only **Carbon** and **Hydrogen** atoms are bonded, the resulting compound is called a **Hydrocarbon**. The above example is a Hydrocarbon. Hydrocarbon compounds are found naturally in:

- **Natural Gas**

Natural Gas is found underground and is used as fuel for electricity generation, heating and cooking.

- **Petroleum (Crude Oil)**

Petroleum is also found underground and is a brownish liquid that is used as fuel, as well as for making plastics. However, before petroleum is used as fuel, petroleum must be separated into its different components (fractions). This is done by fractional distillation.



Figure 2: Petroleum (crude oil)

Fractional Distillation

In fractional distillation, the petroleum is heated separated into its different components through the following steps:

- Impurities are removed
- The petroleum is heated to about 400°C in a fractionating tower in an oil refinery.
- The vapours of the different fractions (components) of the petroleum rise and condense at different heights in the tower. Vapours that keep rising and do not condense in the tower are removed at the top.
- The fraction which remains in the liquid form is known as bitumen (asphalt), and it sinks to the bottom of the tower.
- The fractions have various uses, as illustrated in the diagram below (*Figure 3*)

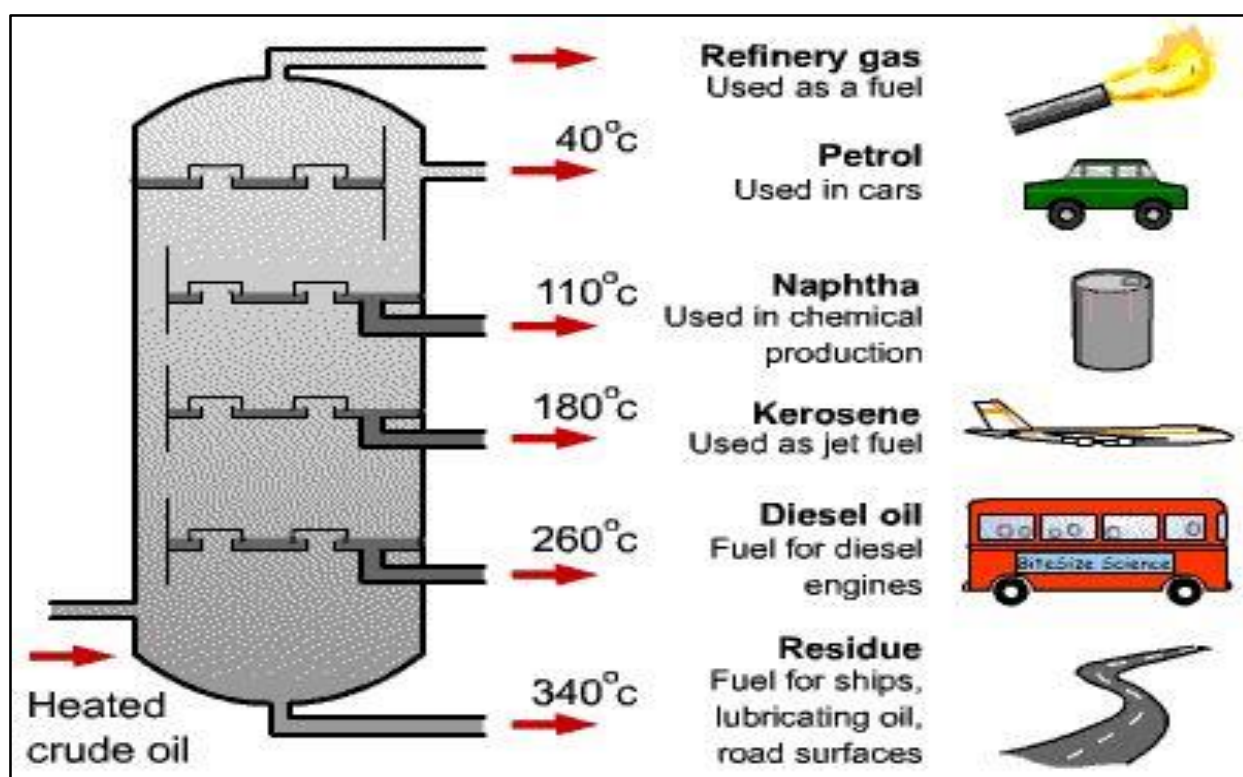


Figure 3: The use of the various fractions (components) of petroleum (crude oil)

Cracking of Hydrocarbon Compounds

Cracking is the process by which long-chain hydrocarbon molecules are broken down into shorter chain hydrocarbon molecules. These long-chain molecules can be broken down by breaking Carbon-Carbon bonds. Cracking is important because the shorter chain molecules are more useful hydrocarbons.

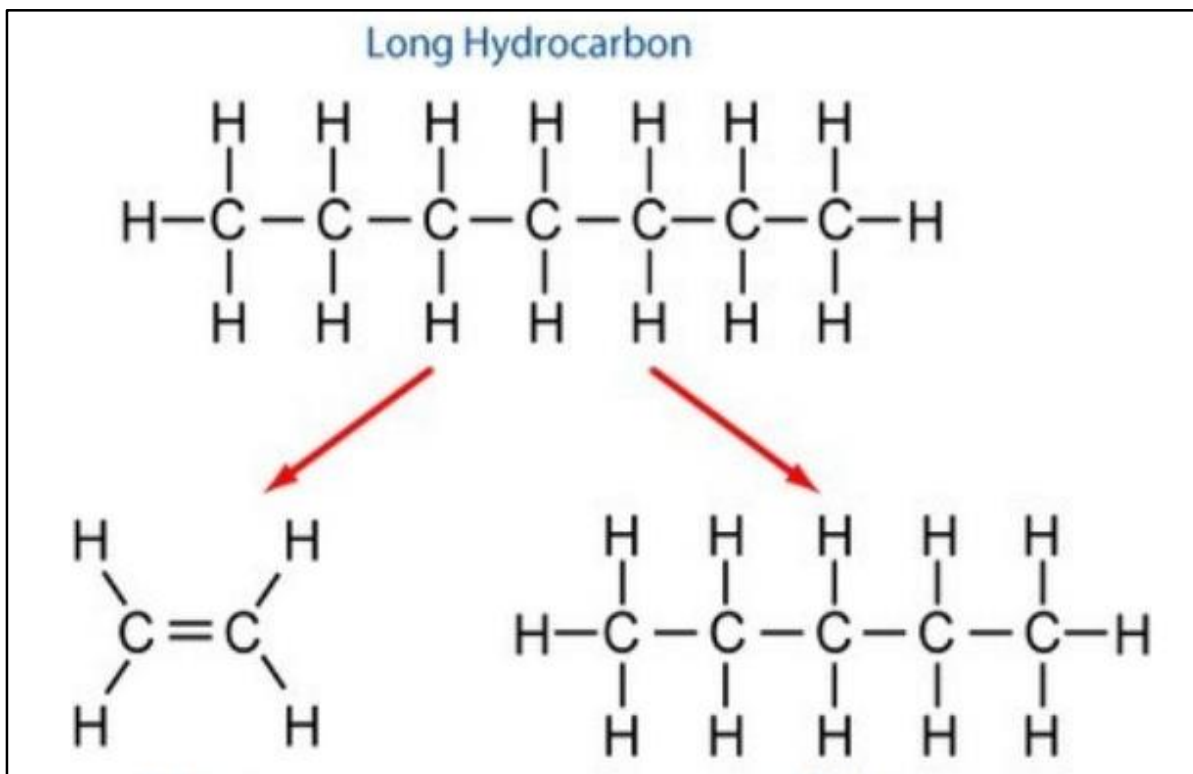


Figure 4: Cracking of long-chain hydrocarbon molecules into shorter chains of hydrocarbon molecules

Cracking can be done in two ways:

- **Thermal Cracking**

This method uses high temperatures (750°C) and high pressures (up to 70 atmospheres).

- **Catalytic Cracking**

This method uses temperatures of about 500°C, at relatively low pressures, in the presence of a catalyst (increases the rate of the reaction).

Bibliography

Tindale, A. (2016). Sources of Hydrocarbon Compounds. In A. Tindale, *A Concise Course CSEC Chemistry* (pp. 134-135). London: HarperCollins Publishers Limited.

For further resources:

<https://www.khanacademy.org/science/organic-chemistry>