MINISTRY OF EDUCATION

SECONDARY ENGAGEMENT PROGRAMME

GRADE 11

CHEMISTRY

WEEK 2 **LESSON 1**

TOPIC: Hydrocarbons

SUB-TOPIC: The Reactions Of Alkanes

OBJECTIVE: Given the necessary clues students will describe correctly the reactions of alkanes.

CONTENT

What are Alkanes?

Alkanes are chemical compounds that consist of carbon and hydrogen atoms that are covalently bonded and are also known as hydrocarbons. (See the previous lesson for more information on Alkanes).

The Reactions of Alkanes

- **Alkanes burn in Air or Oxygen**

Alkanes burn in air or oxygen to produce steam and Carbon dioxide. These reactions produce a clear blue, non-smoky flame. This is because no unreacted carbon remains in the flames to make them smoky. The reactions produce large amounts of energy and are therefore exothermic. This is the reason alkanes are commonly used as fuel.

An example of this reaction is the combustion of methane:

$$CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(g)$$

- **Substituting Hydrogen for Halogen (Halogenation)**

Alkanes consist of carbon and hydrogen atoms that are covalently bonded. However, under the right conditions alkanes can bond with halogens where the halogen substitutes or replaces the hydrogen from the alkane. This means that the carbon atom now becomes covalently bonded to the halogen. This process is known as substitution reactions. Carbons bond with the maximum amount of hydrogen atoms, hence in the substitution reaction one halogen replaces one hydrogen until all the hydrogen atoms are replaced.

For this reaction to occur, Ultra-violet light is necessary and works best for this reaction. However, sunlight is often sufficient.

A substitution reaction works in stages and the speed of the reaction is dependent on **three** factors:

- **Light intensity**

The intensity of light used in this reaction is a key factor. The greater the light intensity, the faster the reaction will occur resulting in the formation of products.

- **The reactivity of the halogen**

The more reactive the halogen, the faster the reaction while the less reactive the halogen the slower the reaction. The most reactive halogen with alkanes is fluorine and the least reactive halogen with alkanes is iodine.

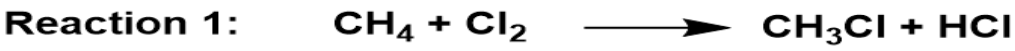
- **The reactivity of the alkane**

The smaller the alkane molecule means the faster the reaction. Methane being the smallest alkane molecule reacts the fastest in the substitution reaction.

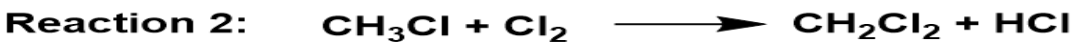
List of Halogens

- Fluorine (F)
- Chlorine (Cl)
- Bromine (Br)
- Iodine (I)
- Astatine (At)
- Tennessine (Ts)

The reaction between Alkane and a Halogen (In this example, Chlorine)



As seen above, when the alkane known as Methane (CH_4) reacted with chlorine (Cl_2) one hydrogen was replaced by one chlorine (Cl), however, since there are 2 chlorine (Cl) atoms the hydrogen that was replaced and the remaining chlorine, formed hydrochloric acid (HCl). The products of this reaction are CH_3Cl + HCl. Notice there is H_3 and Cl in the solution due to the replacement of the hydrogen.



Halogens continue to replace the hydrogens. The process is repeated with the addition of more chlorine (Cl_2 -gas) to repeat the process where one hydrogen again is replaced by one chlorine (Cl- atom). The next chlorine (Cl) atoms bonds with the hydrogen that was replaced forming hydrochloric acid (HCl). The products of this reaction are CH_2Cl_2 + HCl.

The solution from reaction 2 is added to more chlorine (Cl_2) to repeat the process. Notice that there is only one H-atom in the solution and the number of Cl-atoms has increased. The new compound formed here is known as trichloromethane $CHCl_3$ or Chloroform.

State 2 uses of this product.

The solution from reaction 3 is added to more chlorine (Cl_2) to repeat the process. Notice that at this stage all the H-atoms have been replaced by Cl-atoms. The new compound formed here is known as tetrachloromethane CCl_4.

State 2 uses of this product.

References

https://courses.lumenlearning.com/introchem/chapter/alkanes/

https://www.khanacademy.org/science/organic-chemistry/bond-line-structures-alkanes-cyCloalkanes#naming-alkanes

https://www.chemguide.co.uk/organicprops/alkanes/halogenation.html

https://www.bbc.co.uk/bitesize/guides/z3mpk7h/revision/3

https://www.britannica.com/science/halogen

Tindale, A. (2016). Reactions of Carbon Compounds. In A. Tindale, *Concise Revision Course CSEC Chemistry* (p. 137). London: HarperCollins Publishers Limited.