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SUBJECT: PHYSICAL SCIENCE

GRADE: 12

CHAPTER / MODULE: ORGANIC CHEMISTRY

UNIT / LESSON TOPIC: ORGANIC REACTIONS

LEARNING OUTCOMES AND ASSESSMENT STANDARDS:

LO1: practical scientific enquiry and problem solving skills

AS1.2 interpreting data to draw conclusions

AS1.3 solving problems

AS1.4 communicating and presenting information and scientific arguments

LO2: constructing and applying knowledge

AS2.1 recalling and stating specified concepts

AS2.2 indicating and explaining relationships

AS2.3 applying scientific knowledge

By the end of this unit, the Learner should be able to recognise

☼ Substitution, addition, elimination and combustion reactions.

LESSON OVERVIEW: (Knowledge areas)

1. Organic reactions – 40 minutes
2. Review Questions – 20 minutes

LESSON:

ORGANIC REACTIONS

Combustion reactions:

🚗 Hydrocarbons react with oxygen to form water and carbon dioxide and energy.

🚗 Alkane example:

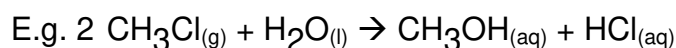
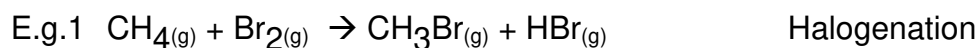


🚗 Alkenes & Alkynes undergo similar reactions to form the same products.

Substitution reactions

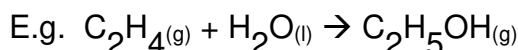
An atom or group of atoms in a molecule is substituted by another.

✂ One atom or group is removed and another takes its place.

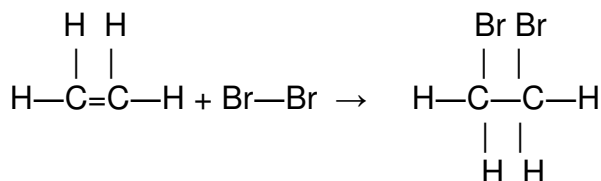


Addition reactions

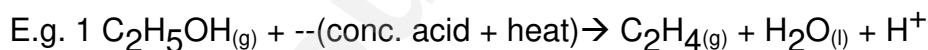
- + Reverse of elimination reactions.
- + The number of molecules decreases in addition reaction (on product side).
- + High T favour elimination reactions & low T favour addition reactions.
- + Therefore, we can drive reactions in opposite paths.
- + Addition reactions generally occur faster than substitutions reactions.



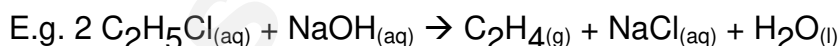
C=C (unsaturated) becomes C-C bond $\rightarrow$ saturated molecule (has full complement of H atoms). When the chains get longer, then the addition reaction obeys **Markovnikov's** rule i.e. *The positive part of the molecule added to the bonds to the carbon already bonded to the most hydrogen atoms and the negative part bonds to the carbon atom bonded to the most carbon atoms.*

**Elimination reactions**

- ✓ A molecule of a reactant breaks up to form 2 or more new molecules – similar to decomposition.
- ✓ Opposite of addition reactions.
- ✓ Number of molecules greater on product side.
- ✓ Single bond is ELIMINATED and double bond forms!



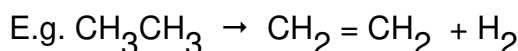
Dehydration is the elimination of the hydroxyl (-OH) and the H atom from the alcohol.



Dehydrohalogenation is the elimination of the halogen atom (Cl) and an H atom leaving a carbon = carbon bond – strong base is used.

Cracking

- ✖ Heating to a high temperature
- ✖ Produces unsaturated products

**Oxidation**

- ⊗ Alcohols for example can also undergo oxidation.
- Oxidation of a primary alcohol: $\text{K}_2\text{Cr}_2\text{O}_7$ as catalyst – forms an aldehyde.
- Oxidation of a secondary alcohol: $\text{K}_2\text{Cr}_2\text{O}_7$ as catalyst – forms a ketone.

ACTIVITIES:

1.

Hexane is a compound used as a fuel.

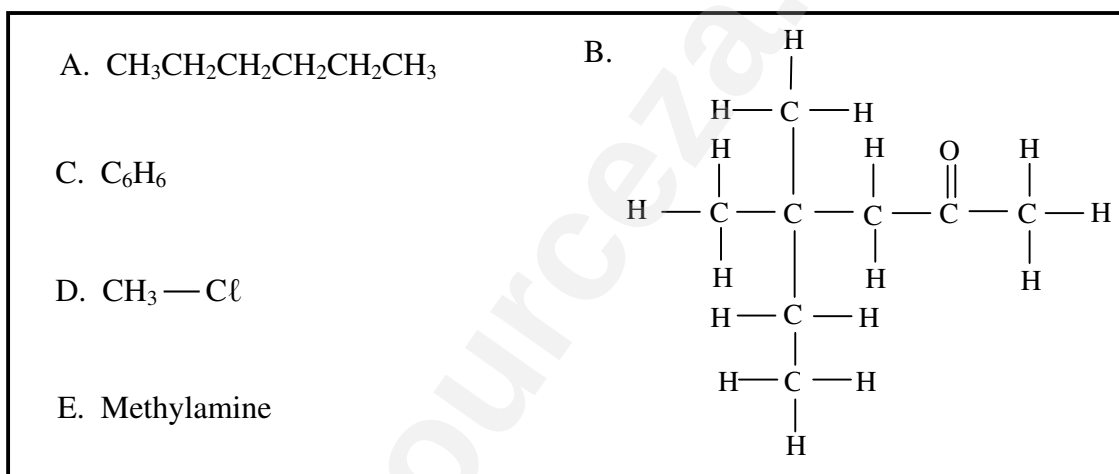
a. How does the boiling point of hexane compare to that of butane? (Write only LOWER THAN BUTANE, HIGHER THAN BUTANE or EQUAL TO BUTANE as your answer.)

- b. Give a reason for your answer to a.
 c. Write down a balanced equation for the reaction which takes place when hexane is burnt in an excess of oxygen. (Structural formulae are not required.)

2. Study the following reactions and state whether they are a substitution, addition or elimination reaction.

- a) $\text{CH}_2\text{Cl} - \text{CH}_2\text{Cl} \rightarrow \text{CH}_2\text{Cl} = \text{CHCl} + \text{HCl}$
 b) $\text{CH}_2 = \text{CH}_2 + \text{Cl}_2 \rightarrow \text{CH}_2\text{Cl} - \text{CH}_2\text{Cl}$
 c) $\text{CH}_3\text{CH}_2\text{OH} \rightarrow \text{CH}_2 = \text{CH}_2 + \text{H}_2\text{O}$
 d) $\text{C}_2\text{H}_6 \rightarrow \text{CH}_2 = \text{CH}_2 + \text{H}_2$
 e) $\text{CH}_3\text{CH}_2\text{Br} + \text{H}_2\text{O} \rightarrow \text{CH}_3\text{CH}_2\text{OH} + \text{HBr}$

3. Consider the organic compounds labelled A – E.



- 3.1 Write a balanced chemical equation for the preparation of compound D using an alkane as one of the reactants. (3)
 3.2 Write down the IUPAC name for compound B? (2)
 3.3 Write down the structural formula of an isomer of compound A that has only FOUR carbon atoms in the longest chain. (2)
 3.4 Write down the structural formula for compound C. (2)

ANSWERS / RUBRICS:

ACTIVITY 1

1.
 a. higher

b. larger molecules have more atoms that can exert intermolecular forces on one another therefore the intermolecular forces are stronger. Stronger IMF's require more energy to separate, thus a higher boiling point.

c. $2 \text{C}_6\text{H}_{14} + 19 \text{O}_2 \rightarrow 14 \text{H}_2\text{O} + 12 \text{CO}_2$

2. a) Elimination

a) Addition

b) Elimination

c) Elimination

d) Substitution

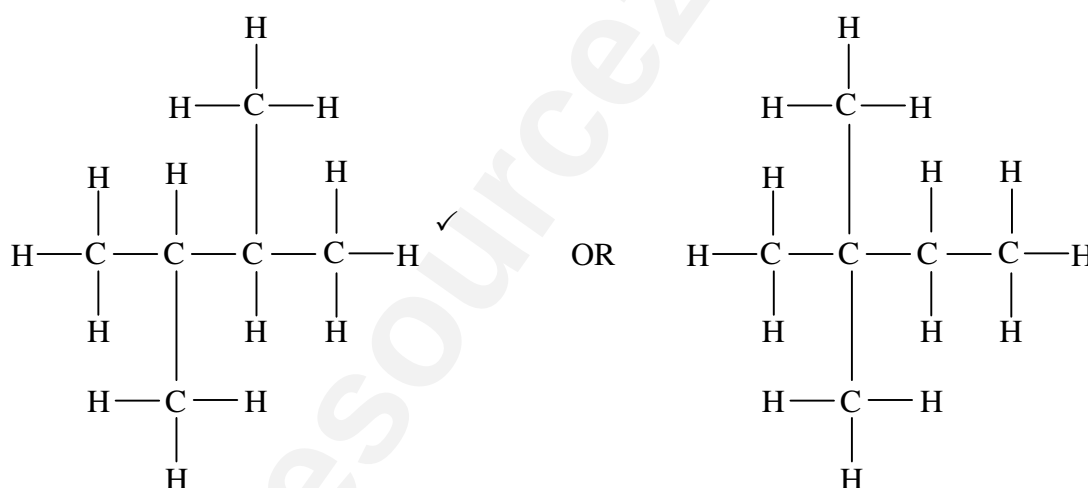
e) Substitution

3.

3.1 $\text{CH}_4 + \text{Cl}_2 \checkmark \rightarrow \text{CH}_3\text{Cl} + \text{HCl} \checkmark$ (bal $\checkmark$) (3)

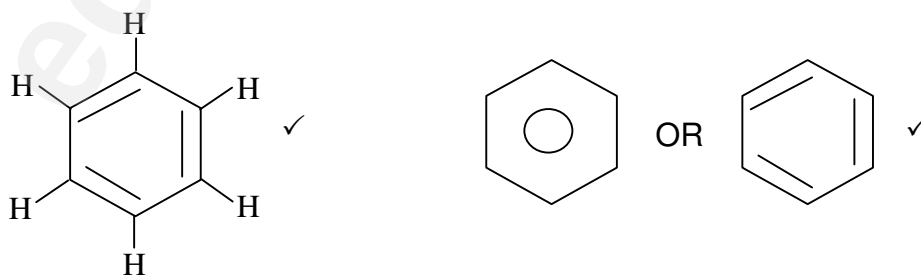
3.2 4,4-dimethyl-2-hexanone/4,4-dimetiel-2-heksanoon $\checkmark \checkmark$ (2)

3.3



(2)

3.4



(2)