HOW I TEACH IT

PHYSICAL SCIENCES

GRADE 12

ORGANIC CHEMISTRY

FROM: NOMBUSO HIGH

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ORGANIC CHEMISTRY

1. BASIC UNDERSTANDING

- ❑ Define organic molecule
- ❑ Organic compound of
- ➢ Carbon, Hydrogen, Oxygen atoms and the Halogens (-Br, -Cl, -I), which are often represented collectively as –X).

2. BASIC TERMINOLOGIES

- ❑ Hydrocarbons
- ❑ Saturated hydrocarbons
- ❑ Unsaturated hydrocarbons
- ❑ Homologous series
- ❑ Functional group
- ❑ Molecular formula
- ❑ Condensed structural formula
- ❑ Structural formula
- ❑ Isomers

3. ORGANIC MOLECULAR STRUCTURES

- ❑ functional groups
- ❑ saturated and unsaturated structures
- ❑ isomers

4. IUPAC NAMING AND FORMULAE

- ❑ Write IUPAC name when given structural formula vice versa
- ❑ Identify alkyl substituents
- ❑ writing IUPAC names with substituents

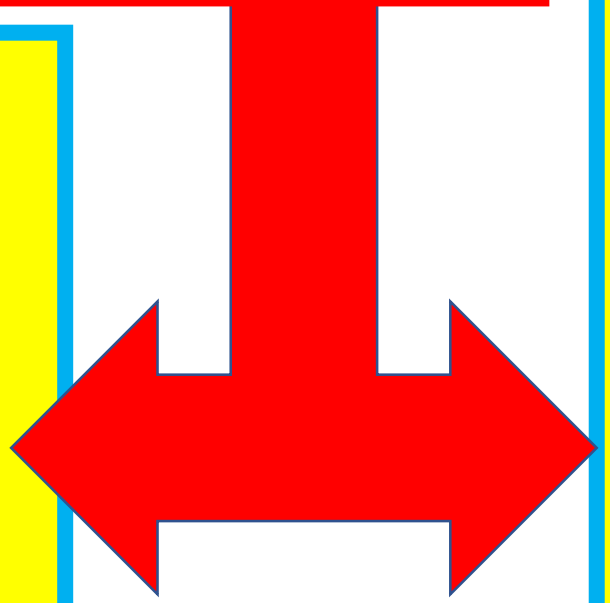
5. STRUCTURE AND PHYSICAL PROPERTIES

- ❑ boiling point, melting point, vapour pressure)
- ❑ relationships
- ➢ Strength of intermolecular forces (Van der Waal's forces), i.e. hydrogen bonds, dipole-dipole forces, induced dipole forces
- ➢ Type of functional groups
- ➢ Chain length
- ➢ Branched chains

ORGANIC CHEMISTRY CONTINUE...

7. PLASTICS AND POLYMERS

- Describe the following terms
  - Macromolecule
  - Polymer
  - Monomer
  - Polymerisation
- Distinguish between addition polymerisation and condensation polymerisation
- Identification of monomers from given addition polymers.
- equation for the polymerisation of ethene to produce polythene
- industrial uses of polythene.



6. TYPES OF REACTIONS

- Oxidation or combustion
- Substitution reaction
  - Hydrolysis of haloalkanes
  - Halogenation of alkanes
  - HX (X = Cℓ, Br) with alcohols to produce haloalkanes
- addition reaction
  - Hydrohalogenation
  - Halogenation
  - Hydration
  - Hydrogenation
- elimination reaction
  - Dehydrohalogenation of haloalkanes
  - Dehydration of alcohols
  - Cracking of alkanes
- Esterification

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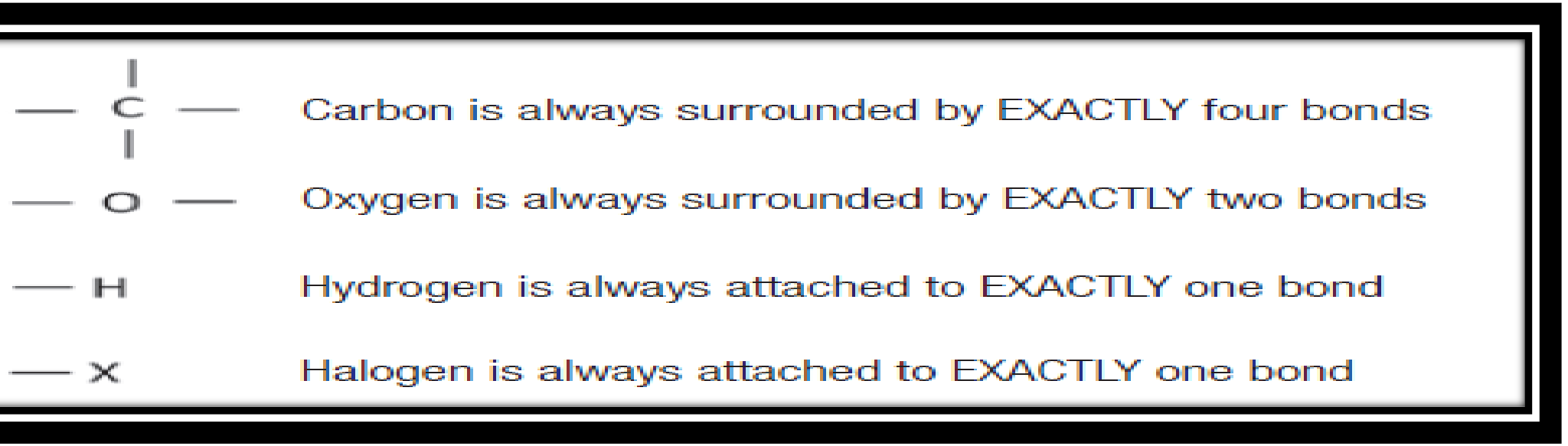
BASIC UNDERSTANDING

- **ORGANIC CHEMISTRY - is the branch of chemistry that deals with the study of carbon compounds.**
- **ORGANIC MOLECULES- molecules containing carbon atoms**
- **THE ORGANIC COMPOUNDS THAT WE STUDY CONSIST OF:**
  - **Carbon, Hydrogen, Oxygen atoms**
  - **Halogens (-Br, -Cl, -I), which are often represented as –X).**

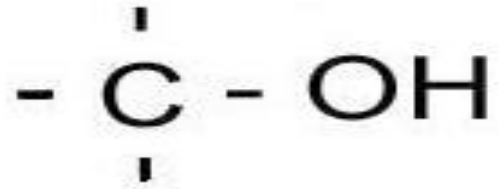


3 TYPES OF CARBON

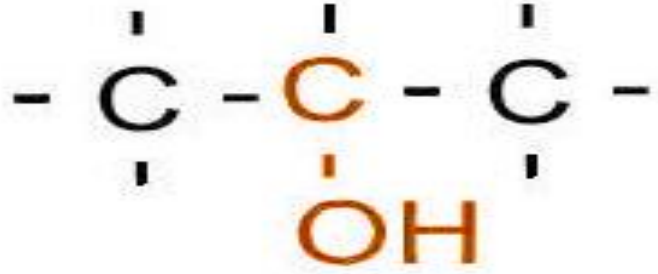
1. **Primary carbons – are carbons attached to one other carbons**
2. **Secondary carbons- are carbons attached to two other carbons**
3. **Tertiary carbons- are attached to three other carbons**

same thing appliers in alcohols, but in that case we will be talking about –OH looking at how is attached to carbon.

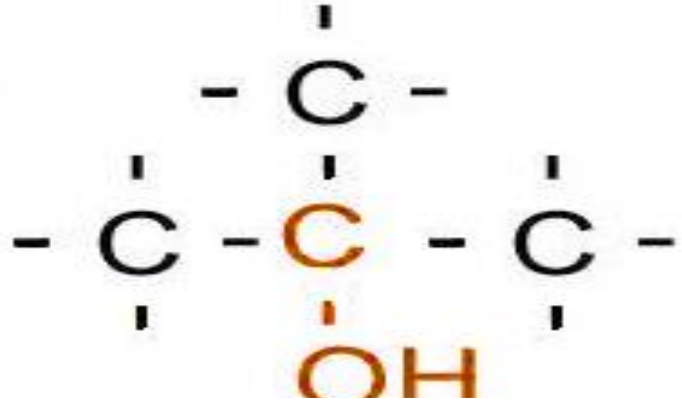
TYPES OF ALCOHOLS



PRIMARY ALCOHOL because OH is attached to carbon that is attached to one other carbon



SECONDARY ALCOHOL because OH is attached to carbon that is attached to two other carbon



SECONDARY ALCOHOL because OH is attached to carbon that is attached to two other carbon

1.DEFINITIONS

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BASIC TERMINOLOGIES

- **HYDROCARBONS** – compounds that contain only hydrogen and carbon.
- **SATURATED HYDROCARBONS** - containing only **single bonds**
- **UNSATURATED HYDROCARBONS** - containing **double** or **triple bonds** between carbon atoms
- **HOMOLOGOUS SERIES** - a series of compounds that have the same general formula and same functional group. Each member of homologous series differs from previous member by –CH_2 group
- **FUNCTIONAL GROUP** – A bond or an atom or a group of atoms that determine(s) the physical and chemical properties of a group of organic compounds.
- **CONDENSED STRUCTURAL FORMULA** – notation that shows how atoms in molecules are bonded (but DOES NOT SHOW ALL bond lines)
- **MOLECULAR FORMULA** – indicates the actual number of atoms of each element making up the compound
- **STRUCTURAL FORMULA** - shows all atoms and bonds in a molecule
- **ISOMERS** - are compounds that have the same molecular formula but different structural formulae.

2. ORGANIC MOLECULAR STRUCTURES

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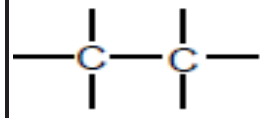
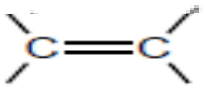
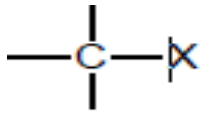
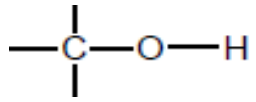
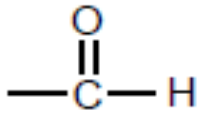
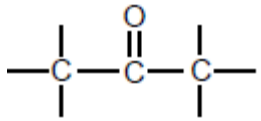
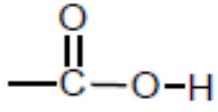
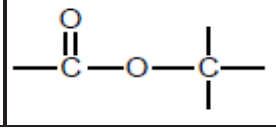
ORGANIC MOLECULAR STRUCTURES

Homologous series		General formula	Functional Group	Suffix	Example name	Structural formula	Condensed structural formula	Molecular formula
Hydrocarbons	Alkanes	C_nH_{2n+2}		-ane	propane		$CH_3CH_2CH_3$	C_3H_8
	Alkenes	C_nH_{2n}		-ene	propene		$CH_2=CHCH_3$	C_3H_6
	Alkynes	C_nH_{2n-2}		-yne	propyne		$CH{\equiv}CCH_3$	C_3H_4
Haloalkanes/ alkyl halides		$C_nH_{2n+1}X$ (X = F, Cl, Br or I)		-ane	2-bromopropane		$CH_3CHBrCH_3$	C_3H_7Br
Alcohols		$C_nH_{2n+1}OH$		-ol	propan-2-ol		$CH_3CHOHCH_3$	C_3H_7OH
Aldehydes		$C_nH_{2n}O$ n =1, 2, ...		-al	propanal		CH_3CH_2CHO	C_3H_6O
Ketones		$C_nH_{2n}O$ n = 3, 4, ...		-one	propanone		CH_3COCH_3	C_3H_6O
carboxylic acids		$C_nH_{2n}O_2$ n = 1, 2, ...		-oic acid	propanoic acid		CH_3CH_2COOH	$C_3H_6O_2$
Esters		$C_nH_{2n}O_2$ n = 2, 3, ...		-oate	ethyl methanoate		CH_3CH_2OOCH	$C_3H_6O_2$

3. IUPAC NAMING AND FORMULAE

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IUPAC NAMING AND FORMULAE

- Each IUPAC name consists of three parts:

Prefix:	Root:	Suffix:
Position and names of substituents (side chains), listed alphabetically.	Number of C-atoms in the main C-chain. 1-meth- 2-eth 3-Prop but for now know 1&2	Determined by the homologous series. alkane- ane Alkene- ene aldehydes- al etc.

STEP 1

Identify the functional group in the compound and the homologous series it belongs to. This determines the suffix (ending).

STEP 2

1. Find the longest chain of carbon atoms. It must include the functional group, and need not be in a straight line. **MAXIMUM OF 8 CARBONS**

2. **Number** the carbon atoms in this chain from the side **nearest to the functional group**

   e.g. a double or triple bond, a hydroxyl group, a carbonyl group or a carboxyl group.

3. In the case of **alkanes or haloalkanes**, start numbering from the carbon **nearest to** **a substituent (side chain)** e.g. an alkyl group or halogen atom.

4. Determine the root of the name from the number of C-atoms in the longest (main) C-chain.

1 = meth-	2 = eth-	3 = prop-	4 = but-	5 = pent-
6 = hex-	7 = hept-	8 = oct-	9 = non-	10 = dec –

For know only first 2 and there will be maximum of 3 substituent chain.

5. Indicate the **position of the functional group** (except in the case of the alkanes). For alkenes and alkynes, give the smaller of the numbers of the C-atoms between which the double or triple bond exists

STEP 3

1. Determine whether there are any substituents.
2. Count the number of C-atoms in the substituent to determine the prefix and end it on –yl.
3. Write the number of the C-atom on the main chain where the alkyl group is attached, in front of the alkyl name.
4. Separate the number and the name with a hyphen, e.g. 2-methyl.
5. If a substituent occurs more than once, use the appropriate prefix: twice – di; three times – tri; four times – tetra e.g. 3,4-dimethyl
6. If there is more than one substituent, write their names and positions in alphabetical order.

- Numbers and letters of the alphabet are separated by a hyphen. (e.g. 2-methylpropane)
- Numbers are separated by the comma, and no space between the substituent(s) and the parent chain. (e.g. 2,2-dichloropentane)

GRADE 12 USEFUL INFORMATION IN IUPAC NAMING AND FORMULAE

- **Naming is restricted to compounds with the functional groups alkanes, alkenes, alkynes, alkyl halides, aldehydes, ketones, alcohols, carboxylic acids and esters, up to a maximum of 8 carbon atoms in the parent chain (i.e. the longest chain)**

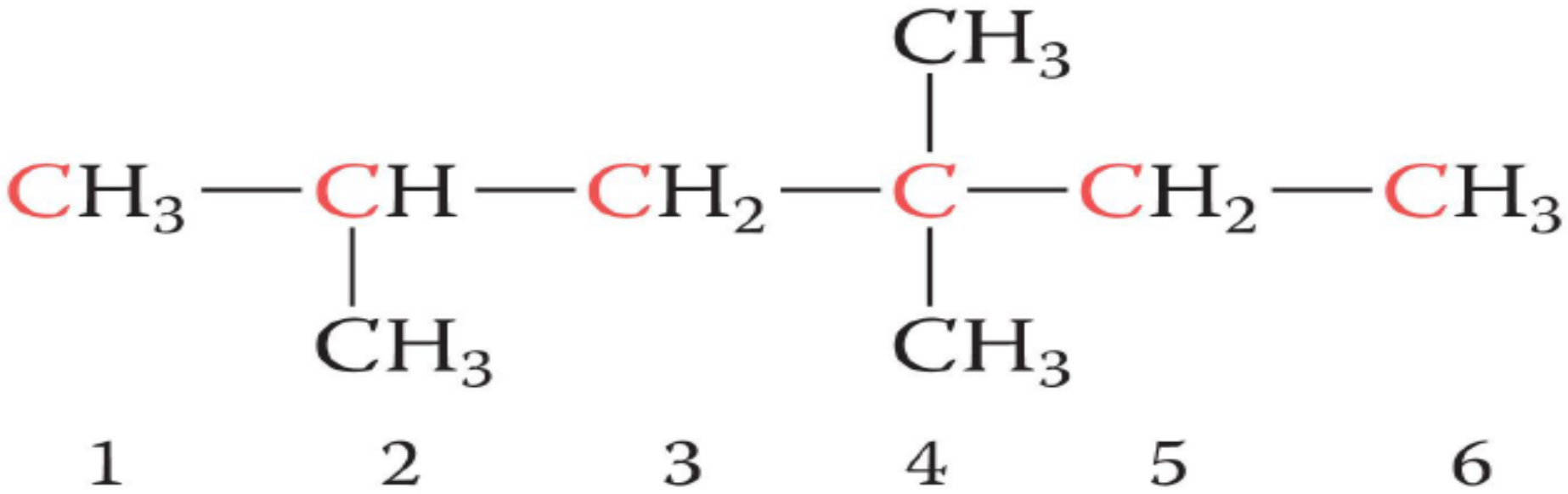
- **Organic compounds are restricted to one type of functional group per compound and to a maximum of two functional groups of the same type per compound.**

- **The only substituent chains that are allowed in naming and reactions are: methyl and ethyl- groups**

- **A maximum of THREE substituent chains (alkyl substituents) are allowed on the parent chain**

IUPAC NAMING EXAMPLE 1 ALKANE

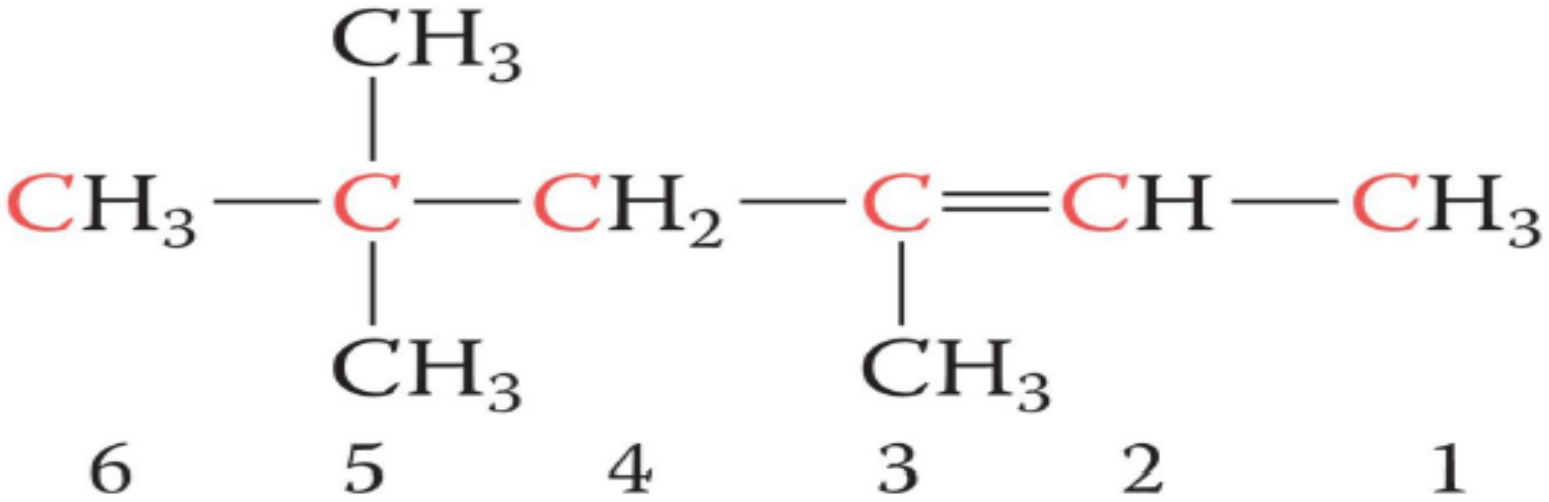
- What is the name of the following alkane?



- The longest chain has six carbons, so it is a *hexane* derivative. The methyl groups are in the 2, 4, and 4 positions.
- The name is 2,4,4-trimethylhexane.

IUPAC NAMING EXAMPLES 2 ALKENE

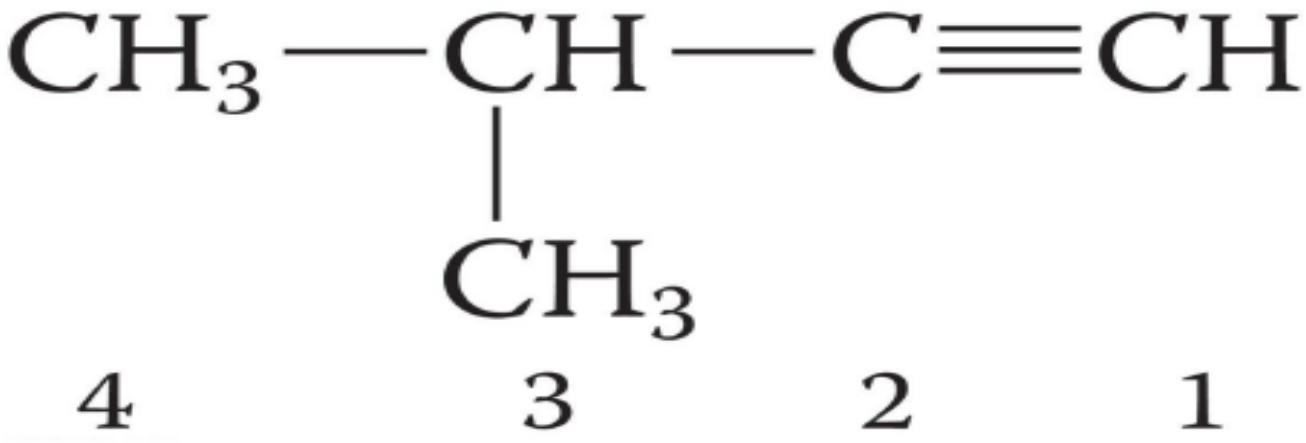
- What is the name of the following alkene?



- The longest chain with the double bond has six carbons, so it is a *hexene* derivative. The double bond is the second bond, so it is a *2-hexene*. The methyl groups are in the **3 and 5, 5** positions.
- The name is **3,5, 5** -trimethyl-2-hexene.

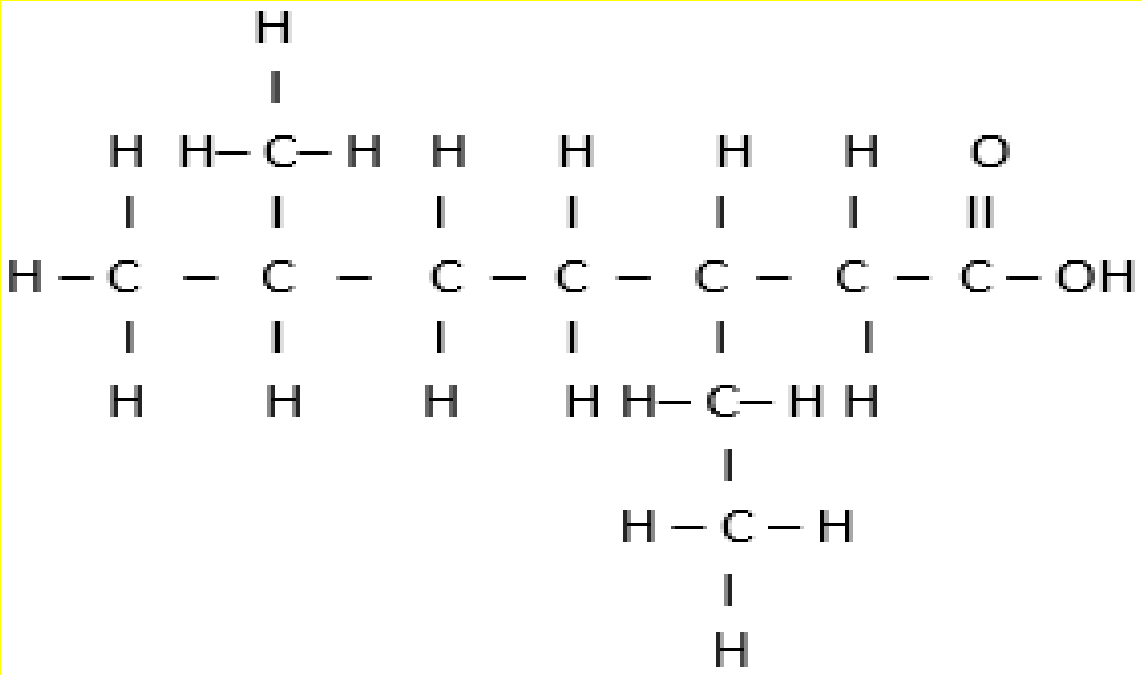
IUPAC NAMING EXAMPLES 3 ALKYNE

- What is the name of the following alkyne?



- The longest chain with the triple bond has four carbons, so it is a *butyne* derivative. The triple bond is the first bond, so it is a *1-butyne*. The methyl group is in the 3 position.
- The name is 3-methyl-1-butyne.

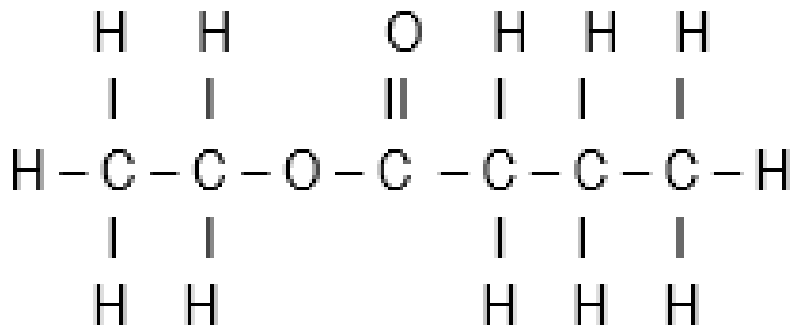
IUPAC NAMING EXAMPLES 4 CARBOXYLIC ACID



- The compound contains a –COOH group – a carboxylic acid.
- The suffix –*oic acid* replaces the –*e* in the corresponding alkane.
- The longest chain containing the carboxyl group has 7 C atoms – the parent name is *hept-*.
- Two substituents are present. The carboxyl C atom is always C number 1, but the number is not shown in the name.
- An ethyl group is on C number 3 and a methyl group on C number 6.
- Hyphens separate numbers and prefixes.
- The compound is **3-ethyl-6-methylheptanoic acid**

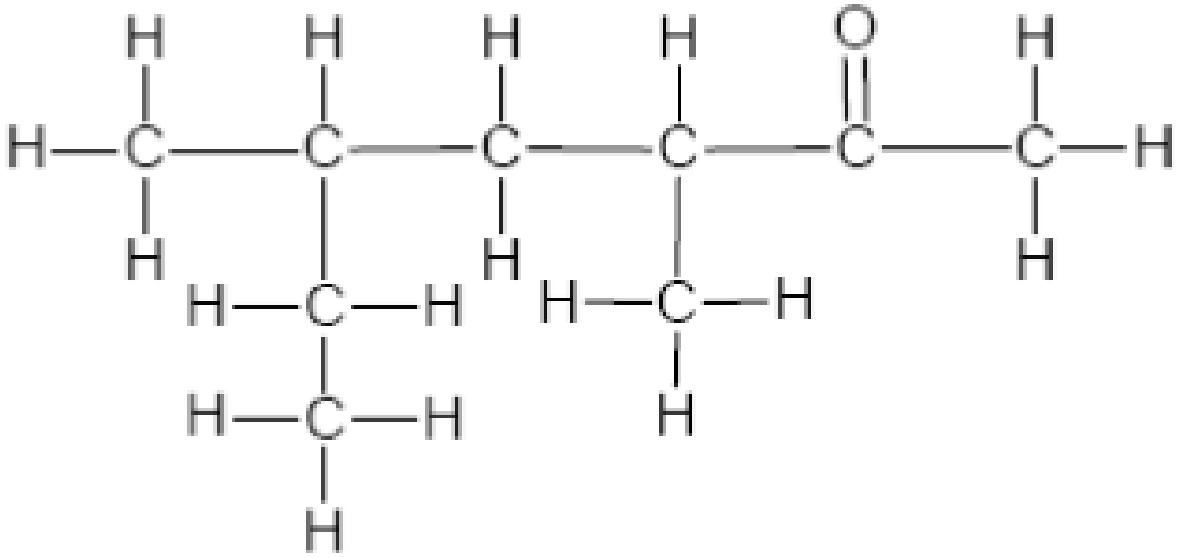
IUPAC NAMING EXAMPLES 5 ESTER

The IUPAC name of the accompanying compound can be determined as follows:



- The compound contains a –COOR group – an ester.
- The ester has two groups, an alkyl and an acyl, that are named separately:**alkyl acyl**
- The **alkyl group** (originally form ethanol) has 2 C atoms. The parent alkane, ethane, is changed to an alkyl group, i.e. ethyl. This is the first part of the name of the ester.
- The **acyl group** (originally from butanoic acid) has 4 C atoms. The parent acid is butanoic acid. The –*oic* in the name is changed to –*oate*, i.e.butanoate. This is the second part of the name of the ester.
- The name of the compound is **ethyl butanoate**.

IUPAC NAMING EXAMPLES 6 KETONE

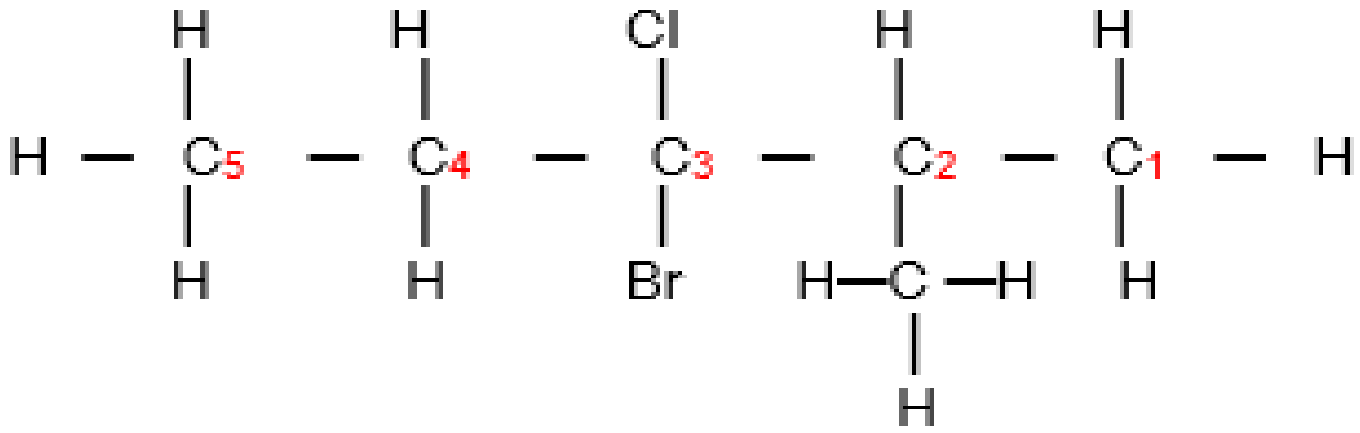


The IUPAC name of the above compound can be determined as follows:

- The compound contains a RCOR' group, – a ketone. The –*e* in the corresponding alkane is replaced with *-one*.
- The longest chain containing the carbonyl group has 7 C atoms - the parent name is *hept*.
- Numbered from the left, the carbonyl C atom is C_6. Numbered from the right it is C_2. The latter gives the lower number. The number is written between the parent name and the suffix. Hyphens separate the number from the parent name and from the suffix, i.e. heptan-2-one.
- Two substituents are present: two *methyl* groups on C_3 and C_5.
- The compound is **3,5-dimethylheptan-2-one**

IUPAC NAMING EXAMPLES 7 HALOALKANE

Write the IUPAC name of the following organic compound.

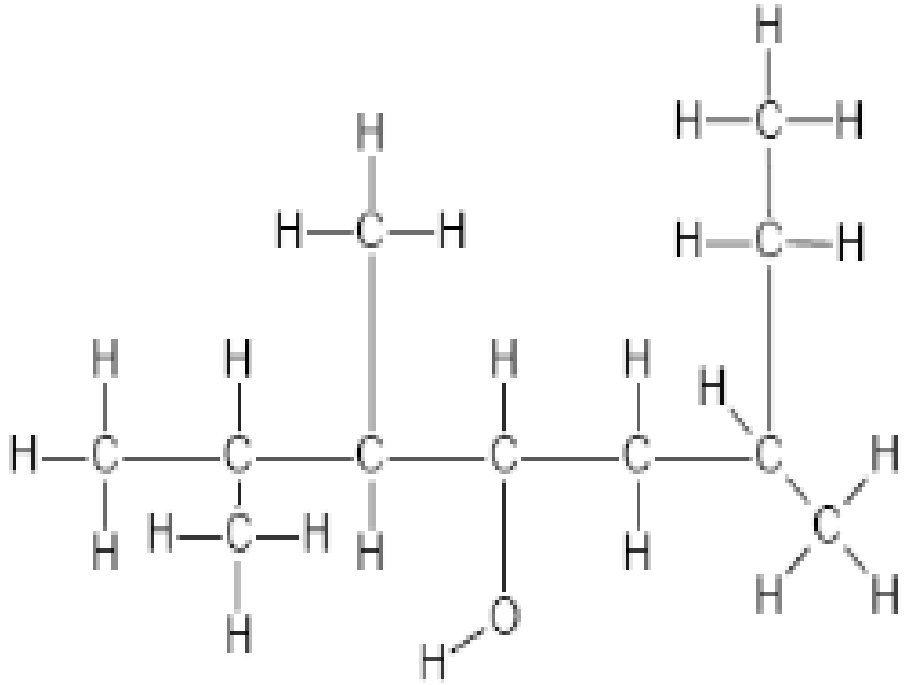


The IUPAC name of the accompanying compound can be determined as follows:

- The compound is an alkane containing two halogen atoms – a haloalkane.
- The longest chain contains 5 C atoms - the parent name is ***pentane***.
- Three substituents are present: a *methyl* group, *bromine* and *chlorine* atoms.
- Numbering from the left, the *methyl* group is on C_4, the Br and Cl atoms on C_3.
- Numbering from the right, the *methyl* group is on C_2, the Br and Cl atoms on C_3.
- The latter gives the lower numbers.
- Alphabetically ***bromo*** comes before ***methyl***.
- The compound is **3-bromo-3-chloro-2-methylpentane**.

IUPAC NAMING EXAMPLES 8 ALCOHOL

The IUPAC name of the accompanying compound can be determined as follows:



- The compound is an alkane containing a *hydroxyl* group – an alcohol.
- The suffix –*ol* replaces the –*e* in the corresponding alkane.
- The longest chain containing the hydroxyl group has 8 C atoms - the parent name is *oct*-.
- Numbered from the right, the *hydroxyl* group is on C_5.
- Numbered from the left it is on C_4. The latter gives the lower number. The number is written between the parent name and the suffix. Hyphens separate the number from the parent name and from the suffix i.e. octan-4-ol.
- Two substituents are present: three *methyl* groups on C_2, C_3 and C_6 The compound is **2,3,6-trimethyloctan-4-ol**.

4. STRUCTURE AND PHYSICAL PROPERTIES

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STRUCTURE AND PHYSICAL PROPERTIES

- For the purpose of the study of physical properties in grade 12 we will be confining ourselves to three physical properties of organic compounds and examine how do they relate to following:

  (i) intermolecular forces;

  (ii) the number and type of functional groups;

  (iii) chain length

  (iv) branched chains.

Those three physical properties are:

1. **Boiling point**
2. **Melting point**
3. **Vapour pressure.**

DEFINITIONS

1. **BOILING POINT** - the temperature at which substance changes from **liquid** to **gas**. ***Reached when vapour pressure of a liquid equals atmospheric pressure (external pressure)***
2. **MELTING POINT** - the temperature at which substance changes from **solid** to **liquid**.
3. **VOLATILITY** is the ease at which a liquid changes into a vapour and **VAPOUR PRESSURE** - refers -pressure caused by the produced vapour.

- **INTERMOLECULAR FORCES** are attractive forces between organic molecules.
  - 1. Van der Waals forces: London (or dispersion) forces,
  - 2. Van der Waals forces: Dipole-dipole forces and
  - 3. Hydrogen bonding

    (in order of increasing strength)

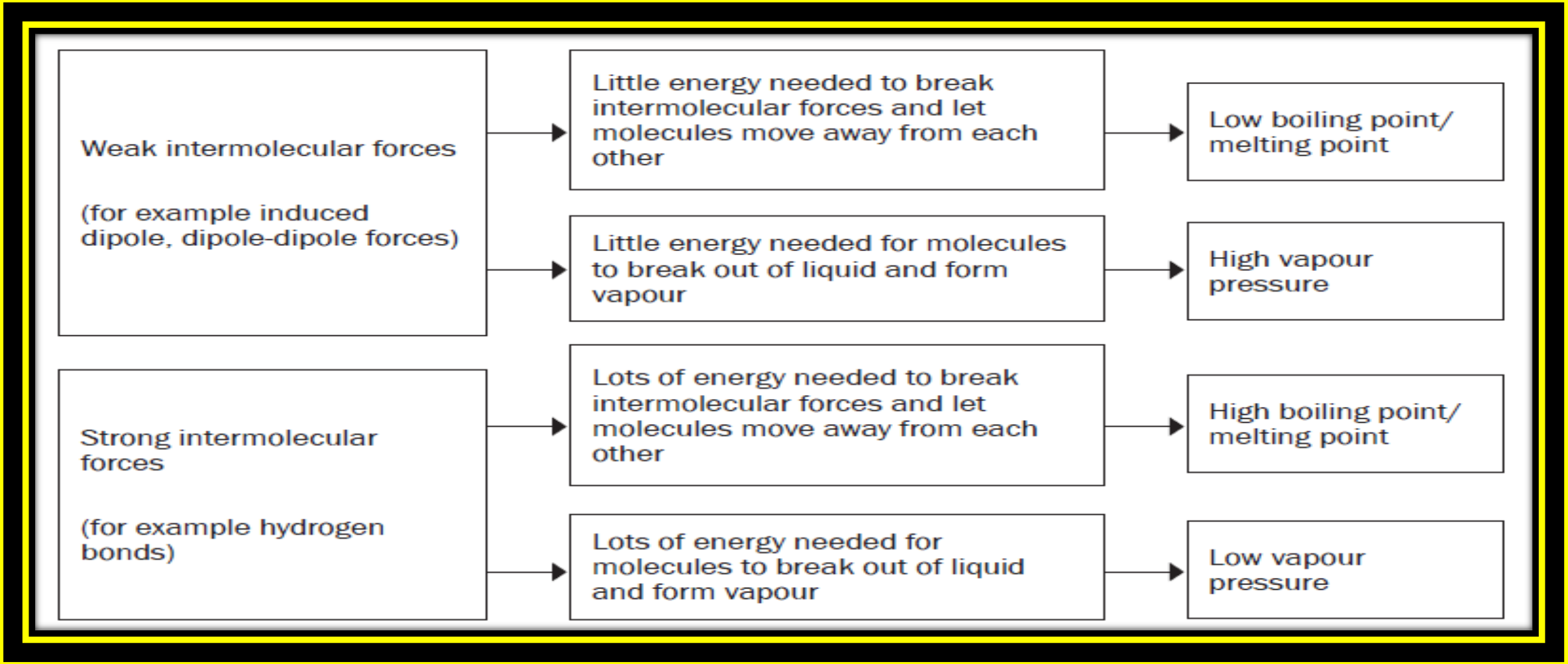
IN GENERAL:

As the strength of the intermolecular forces **INCREASES**:

- Vapour pressure **DECREASES.**
- Melting and boiling points **INCREASE**

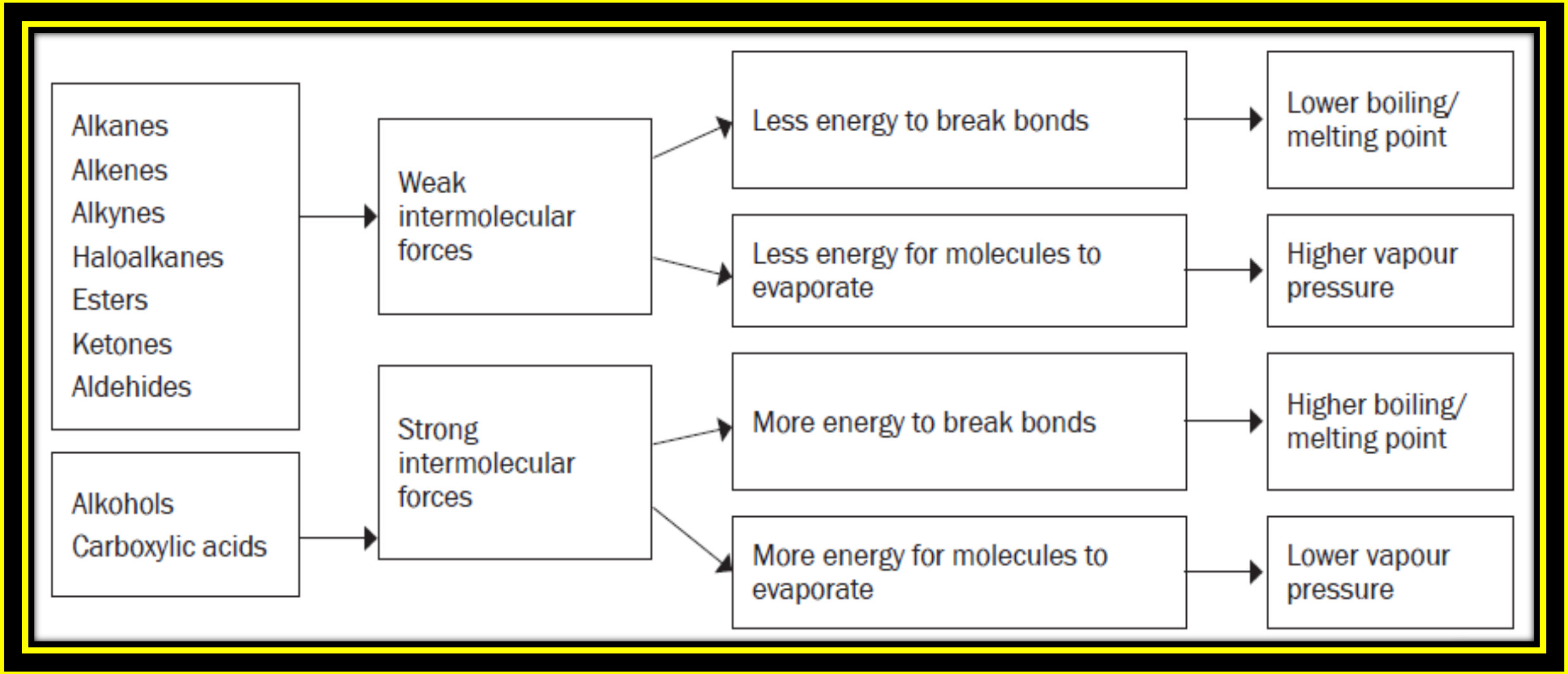
BOILING POINT, MELTING POINT, VAPOUR PRESSURE IN RELATION TO

1. Strength of intermolecular forces (Van der Waal's forces),
   i.e. hydrogen bonds, dipole-dipole forces, induced dipole forces



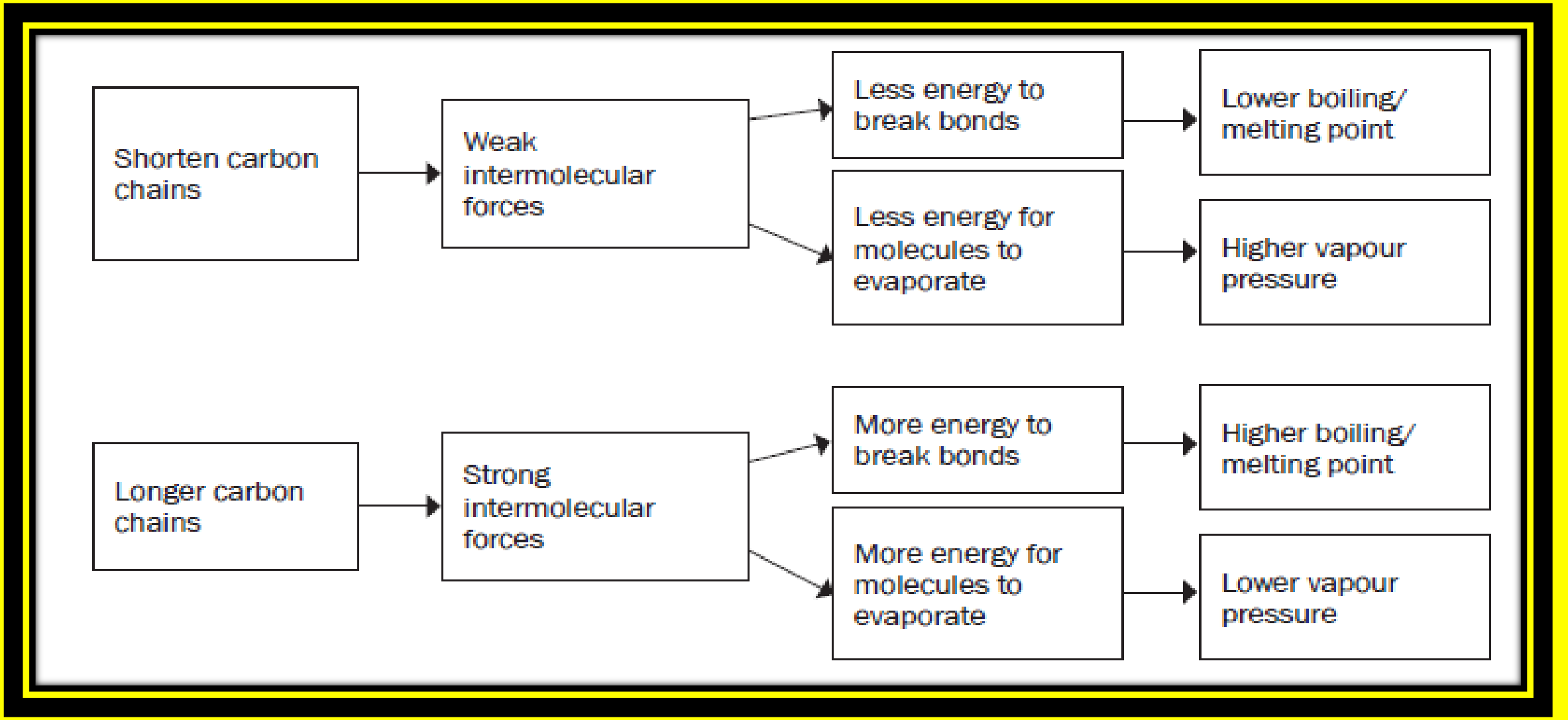
BOILING POINT, MELTING POINT, VAPOUR PRESSURE IN RELATION TO

2. Type of functional groups



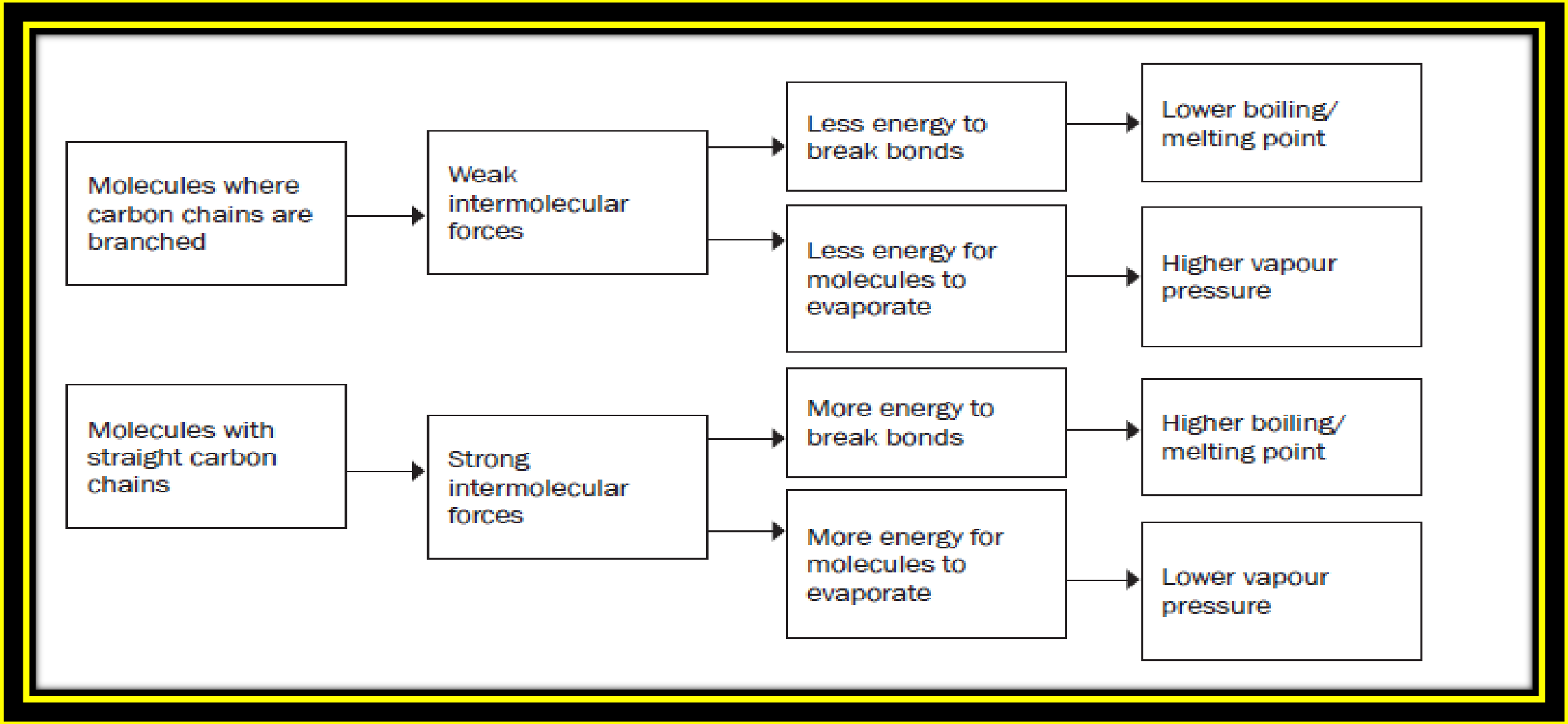
BOILING POINT, MELTING POINT, VAPOUR PRESSURE IN RELATION TO

3. Chain length



BOILING POINT, MELTING POINT, VAPOUR PRESSURE IN RELATION TO

4. Branched chains ....*relate it to chain length.*



STRUCTURE AND PHYSICAL PROPERTIES ACTIVITY 1

1. In which one of the following alternatives are the three compounds listed in order of their increasing boiling point?

A pentanoic acid, pentane, pentan-1-ol
B pentan-1-ol, pentane, pentanoic acid
C pentane, pentan-1-ol, pentanoic acid
D pentane, pentanoic acid, pentan-1-ol **(2)**

2. Two compounds A and B, have the molecular formula $C_2H_4O_2$.

2.1 What is meant by the term structural isomers? **(2)**

2.2 Compound A has a lower vapour pressure than compound B.

2.2.1 How will the boiling point of compound A compare to that of compound B. Only write HIGHER THAN, LOWER THAN, or EQUAL TO. **(1)**

2.2.2 Write down the name of compound A. **(1)**

2.2.3 To which class of organic compound does compound B belong? **(1)**

2.2.4 Write down the structural formula for compound B and give its IUPAC name. **(3)**

2.2.5 Explain in terms of intermolecular forces and energy why compound A has a lower vapour pressure than compound B. **(3)**

STRUCTURE AND PHYSICAL PROPERTIES ACTIVITY 1 MEMO

1. C (2)

2.1 Structural isomers are organic molecules with the same molecular formula, but different structural formulae. (2)

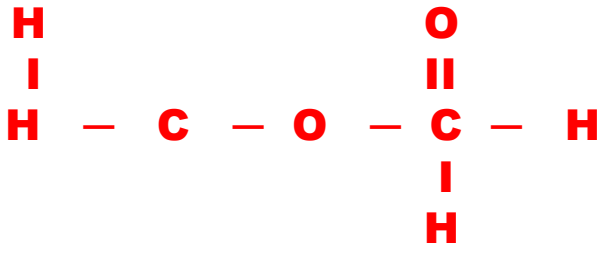
2.2

2.2.1 Higher than.....since the vapour pressure is low implies that boiling point is high (1)

2.2.2 Ethanoic acid (1)

2.2.3 Ester (1)

2.2.4



Methyl methanoate (3)

2.2.5 Compound A has strong hydrogen bond and compound B has weak Van der Waals forces. More energy is needed to overcome the Intermolecular forces in compound A than in compound B. (3)

5. TYPES OF REACTIONS

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1. OXIDATION REACTION

- **Oxidation reaction is one of the special type of reaction also called combustion reaction.**
- **Oxidation reaction- it is a reaction of oxygen with alkanes/alkenes/alkynes,**

Product is always carbon dioxide(O_2) +water (H_2O), that is what is special about it.

$$\text{alkane} + O_2(g) \rightarrow CO_2(g) + H_2O(g) + \text{energy}$$

E.g. $2C_2H_6(g) + 7O_2(g) \rightarrow 4CO_2(g) + 6H_2O(g) + \text{energy (balanced)}$

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

- **STEPS TO BALANCE REACTION AFTER COMBUSTION REACTION**

1. **Put a 2 in front of the alkane, alkene or alkyne.**
2. **Balance the C-atoms on the right hand side.**
3. **Balance the H-atoms on the right hand side.**
4. **Balance the O-atoms on the left hand side.**
5. **Check whether the balancing ratio is in the simplest form.**

2. SUBTITUTION REACTIONS

- Take place in **SATURATED COMPOUNDS** (e.g. Alkanes and Haloalkanes)
- It is a reaction where by a **hydrogen atom** or a **functional group** is **substituted** by another functional group on the carbon chain…**SUBSTITUTION**
- Additional energy (e.g. sunlight hf or heat Δ) is needed for the reactions to take place

HALOGENATION- addition of halogen(**Br, Cl, I**) in saturated compound

e.g. alkane + halogene → haloalkane + HX where X is a halogen

ethane + $Br_2 \rightarrow C_2H_5Br$ + HBr

HYDROLYSIS- addition of water (H_2O) in saturated compound

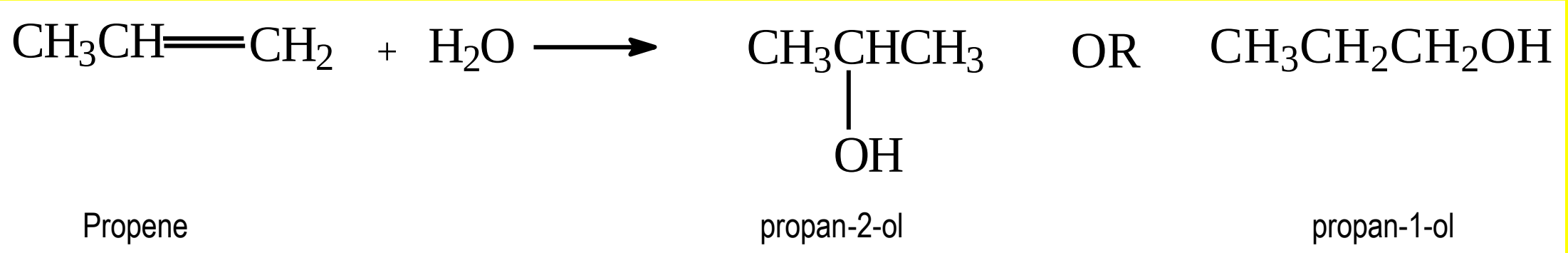
- **This reaction produces alcohol**
  - E.g1 haloalkane + $H_2O \rightarrow$ **alcohol** + HX where X is a halogen

    $C_2H_5Br + H_2O \rightarrow$ ethanol + HBr
  - E.g2 **haloalkane + base**

    Haloalkane + NaOH → **alcohol** + NaX where X is a halogen

3. ADDITION REACTIONS

- Take place in **UNSATURATED COMPOUNDS** (e.g. Alkenes and alkynes).
- It is a reaction where by a there is a breaking of double or triple bond to produce saturated compounds.
- Take place faster than substitution reaction
- Take place according **MARKOVNIKOV'S RULE**



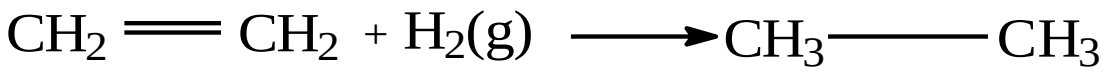
MARKOVNIKOV'S RULE

- To determine which product is formed, we use **MARKOVNIKOV'S RULE**,
- which states that in an addition reaction, H attaches to the C with the greater number of H atoms, major product will be formed.
- Hence the secondary alcohol, propan-2-ol, is the major product formed, while propan-1-ol is the minor product.

3. ADDITION REACTIONS CONTINUE...

HYDROGENATION- addition of hydrogen across a carbon-carbon double or triple bond

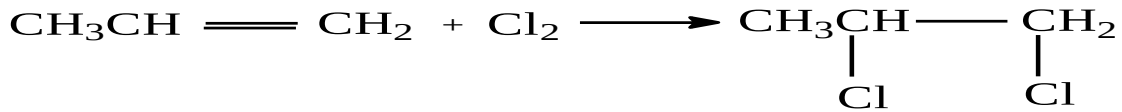
e.g. alkene + hydrogen → alkane (catalyst: Pt, Pd or Ni)



Ethene Ethane

HALOGENATION- addition of halogen(Br, Cl, I) across a carbon-carbon double or triple bond

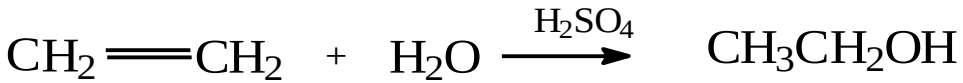
e.g. alkene + halogene → haloalkane



propene 1,2-dichloropropane

HYDRATION- Is the addition of water to an alkene (across a double bond).

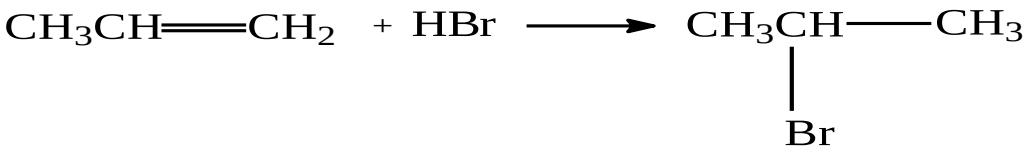
e.g. alkene + H_2O → Alcohol (Catalyst: concentrated sulphuric acid)



ethane **ethanol**

HYDROHALOGENATION- This is the addition of H-X (HCℓ; HBr; HI) across a carbon-carbon double/triple bond.

e.g. alkene + HX → haloalkane where X is a halogen



propene 2-bromopropane

4. ELIMINATION REACTIONS

- Take place in **SATURATED COMPOUNDS** (e.g. Alkanes, haloalkanes or Haloalkanes)
- It is a reaction where by two atoms or group of atoms are removed from adjacent carbon atom.
- This involve breaking up of large molecules to smaller and useful molecule.
- Take place according **ZAITSEV'S RULE**

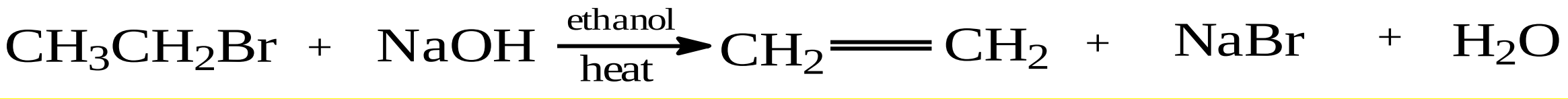
ZAITSEV'S RULE

- To determine which product is formed, we use **ZAITSEV'S RULE**,
- which states that in an elimination reaction, If more than one product is possible during elimination, then the product with the double bond that is more highly substituted will form. This is similar to MARKOVNIKOV'S RULE.

4. ELIMINATION REACTIONS CONTINUE...

DEHYDROHALOGENATION OF HALOALKANES- is the removal of hydrogen and a halogen from a carbon chain (usually haloalkane) and the formation of an alkene.

e.g. Haloalkane → alkene + HX



DEHYDRATION- Is the removal of water to an alkene (across a double bond).

e.g. Alcohol → alkene + H_2O

DEHYDROGENATION- removal of hydrogen across a carbon-carbon double or triple bond

e.g. Alkane → alkene + hydrogen (catalyst: Pt, Pd or Ni)

CRACKING- is the breaking up of large molecules into smaller ones.

e.g. Alkane → short chain alkane + alkene

pentane → propane + ethene

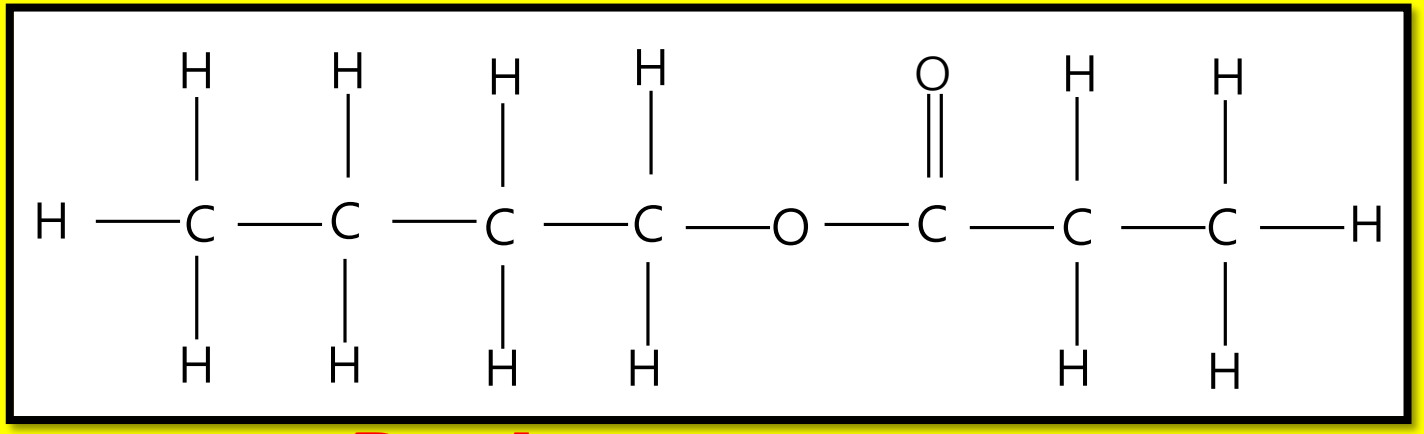
5. ESTERIFICATION REACTIONS

- Take place only in **ESTERS**
- Take place when **alcohol** and **carboxylic** acid are heated in the presence of catalyst concentrated acid (H_2SO_4). During this reaction, water is eliminated.
- **Ester named** as **alkyl alkanoate**
  - **Alkyl** from c-chain with **alcohol.**
  - **Alkanoate** from c-chain in **carboxylic acid**

e.g.

$CH_3CH_2CH_2CH_2OH + CH_3CH_2COOH \rightarrow CH_3CH_2CH_2CH_2OOCCH_2CH_3 + H_2O$

Butanol **Propanoic acid** **Butyl propanoate**



Butyl propanoate

TYPES OF REACTION ACTIVITY 1

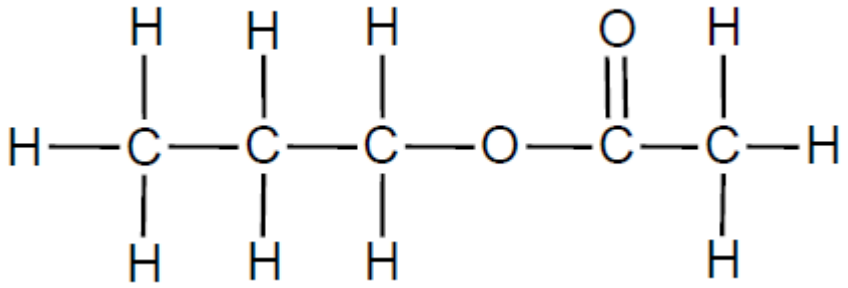
1. Consider the reaction represented by the equation below:

$CH_3CHCH_2 + H_2 \rightarrow CH_3CH_2CH_3$

This reaction is an example of …

A Hydration
B Dehydration
C Substitution
D Hydrogenation

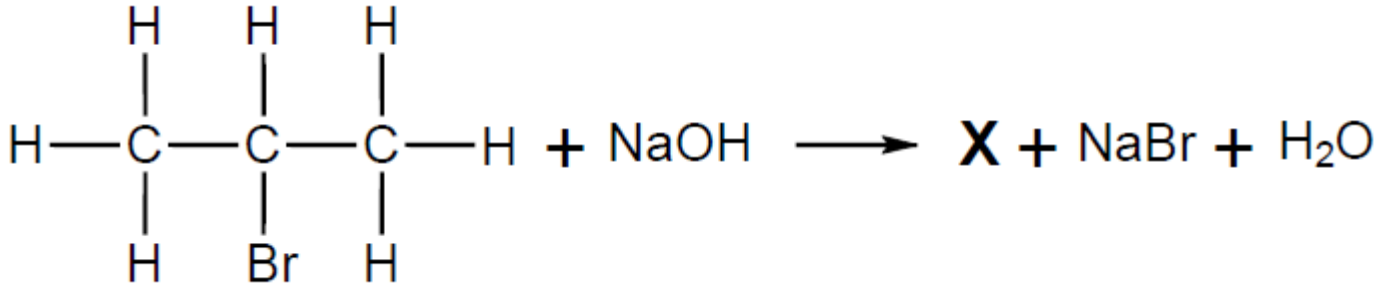
2. Consider the structural formula of a compound below.



Which ONE of the following pairs of reactants can be used to prepare this compound in the laboratory?

A Propanoic acid and ethanol
B Propanoic acid and methanol
C Ethanoic acid and propan-1-ol
D Methanoic acid and propan-1-ol

3. The equation below represents the reaction that takes place when an organic compound and concentrated sodium hydroxide are strongly heated. X represents the major organic product formed.



Which ONE of the following is the correct IUPAC name for compound X?

A Prop-1-ene
B Prop-2-ene
C Propan-1-ol
DPropan-2-ol

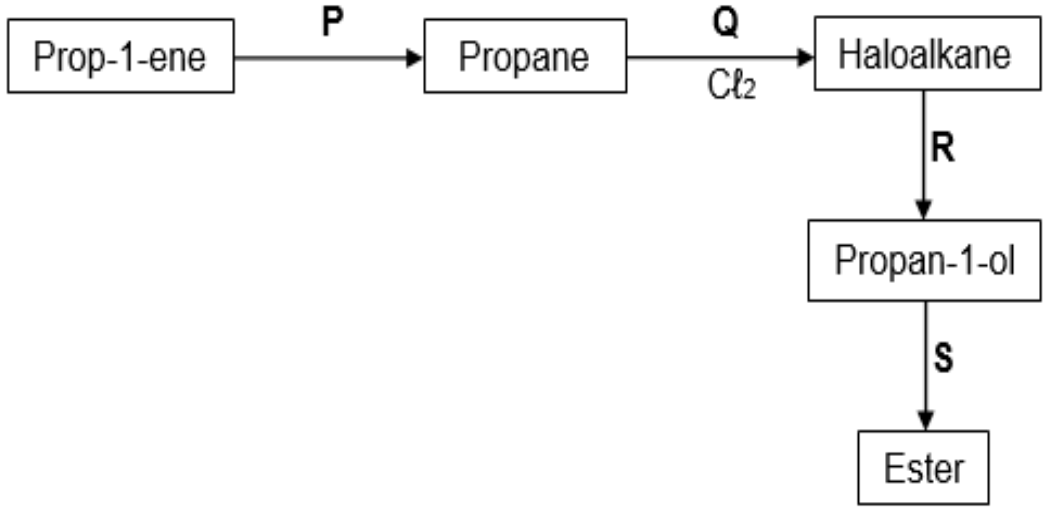
4. The following equation represents the cracking of a hydrocarbon at high temperature and pressure

$C_{11}H_{24} \rightarrow 2C_2H_4 + \mathbf{Y} + C_4H_{10}$

Which ONE of the following is the IUPAC name of product Y?

A Prop-1-ene
B Propane
C Ethene
D Ethane

The flow diagram below shows the preparation of an ester using prop-1-ene as a starting reagent. **P**, **Q**, **R** and **S** represent different organic reactions.



5.1 Write down the type of reaction represented by:

5.1.1 Q

5.1.2 R

5.2 For reaction P write down the:

5.2.1 Type of addition reaction

5.2.2 Balanced equation using structural formulae

5.3 Write down the structural formula of the haloalkane formed in reaction **Q.**

5.4 In reaction **S** propan-1-ol reacts with ethanoic acid to form the ester.

For this reaction write down the:

5.4.1 Name of the reaction that takes place

5.4.2 FORMULA or NAME of the catalyst needed

5.4.3 Structural formula of the ester formed

5.4.4 IUPAC name of the ester formed

5.5 The propan-1-ol formed in reaction **R** can be converted to prop-1-ene. Write down the FORMULA or NAME of the inorganic reagent needed.

5.6 What is the products formed during the COMPLETE combustion of Octane?

TYPES OF REACTION ACTIVITY 1 MEMO

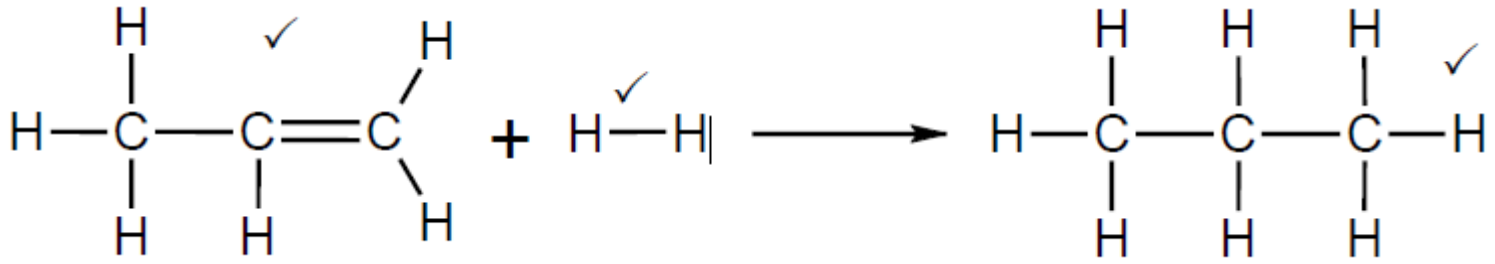
1. D
2. C
3. A
4. A

5.1.1 Substitution OR halogenation

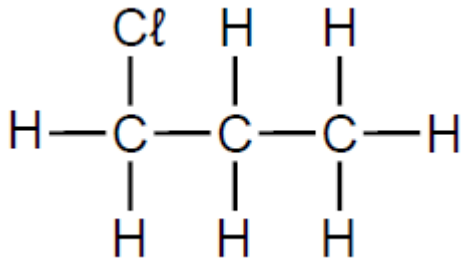
5.1.2 Substitution / hydrolysis

5.2.1 Hydrogenation

5.2.2



5.3

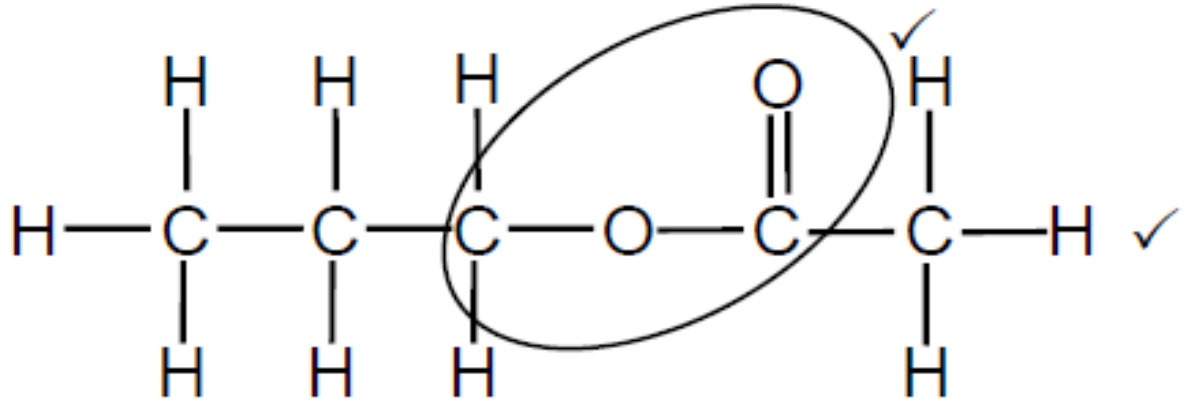


TYPES OF REACTION ACTIVITY 1 MEMO CONTINUE...

5.4.1 Esterification

5.4.2 Concentrated sulphuric acid (H_2SO_4)

5.4.3



5.4.4 Propyl ethanoate

5.5 sulphuric acid (H_2SO_4)

5.6 CO_2 and H_2O

6. PLASTICS AND POLYMERS

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DESCRIPTION OF THE CONCEPTS

- **MACROMOLECULE-** A molecule that consists of a large number of atoms
- **POLYMER-** A large molecule composed of smaller monomer units covalently bonded to each other in a repeating pattern **(MONOMER +MONOMER = POLYMER)**
- **MONOMER-**Small organic molecules that can be covalently bonded to each other in a repeating pattern
- **POLYMERISATION-** A chemical reaction in which monomer molecules join to form a polymer
- **ADDITION POLYMERISATION-** reaction in which small molecules join to form very large molecules by adding on double bonds
- **ADDITION POLYMER** -A polymer formed when monomers (usually containing a double bond) combine through an addition reaction
- **CONDENSATION POLYMERISATION** -Molecules of two monomers with different functional groups undergo condensation reactions with the loss of small molecules, usually water
- **CONDENSATION POLYMER** -A polymer formed by two monomers with different functional groups that are linked together in a condensation reaction in which a small molecule, usually water, is lost

DISTINGUISH BETWEEN ADDITION POLYMERISATION AND CONDENSATION POLYMERISATION

ADDITION POLYMERISATION → **ADDITION POLYMER**

REACTION — PRODUCT

CONDENSATION POLYMERISATION → **CONDENSATION POLYMER**

REACTION — PRODUCT

ADDITION POLYMERISATION

- The monomer must contain a double bond or a triple bond,
- Is the direct addition of the same monomer molecules to form a single product.
- E.g. Polymerisation of ethene to form Polythene $N(CH_2{=}CH_2) \rightarrow (-CH_2-CH_2-)$
- The name of the polymer is derived from the monomer used.

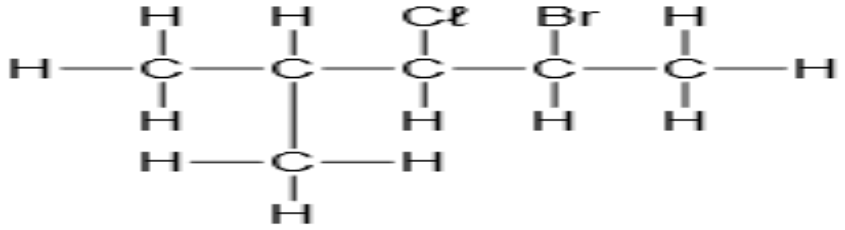
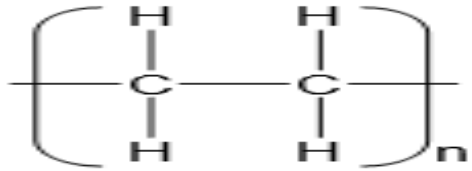
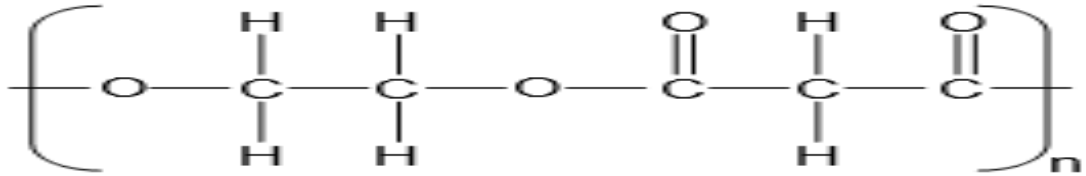
E.g. If the monomer is ethene the polymer will be polyethene.

VS

CONDENSATION POLYMERISATION

- Monomers have functional group instead of Double bond.
- the reaction between monomers which are not always the same to form two products.
- E.g. Polymerisation to produce polyesters is called esterification .H_2O is eliminated and the organic product contains an ester functional group.
- The name of the polymer is deduced from the names of the 2 bonding molecules – an organic alcohol and a carboxylic acid.

EXAMPLE 1 AND SUGGESTED SOLUTION (Nov 2014)

A	2,2,4-trimethylhexane	B	$CH_3CH_2CH_2CH_2CHO$
C		D	
E		F	Pentan-2-one

Write down the LETTER that represents the following:

1. **A condensation polymer.**
2. **The monomer of compound D.**
3. **Type of polymerisation reaction that produces compound D.**

ANSWERS

1. **As we have said above that in condensation polymer- Monomers have functional group instead of Double bond and the organic product contains an ester functional group. Answer could be D or E but in D there is no functional group for ester since we know that in ester carbonyl group is attached to oxygen Correct answer is E**
2. **Since there are two carbon it mean the monomer is ETHENE**
3. **ADDITION POLYMERISATION . Since it is the direct addition of the same monomer molecules to form a single product.**

- IDENTIFICATION OF MONOMERS FROM GIVEN ADDITION POLYMERS.

AND

- EQUATION FOR THE POLYMERISATION OF ETHENE TO PRODUCE POLYTHENE

WILL BE DONE IN EXAMPLES BELOW.

INDUSTRIAL USES OF POLYTHENE.

1. sandwich bags,

2. cling wrap,

3. liners for tanks and ponds,

4. car covers,

5. squeeze bottles,

6. water pipes,

7. moisture barriers in construction,

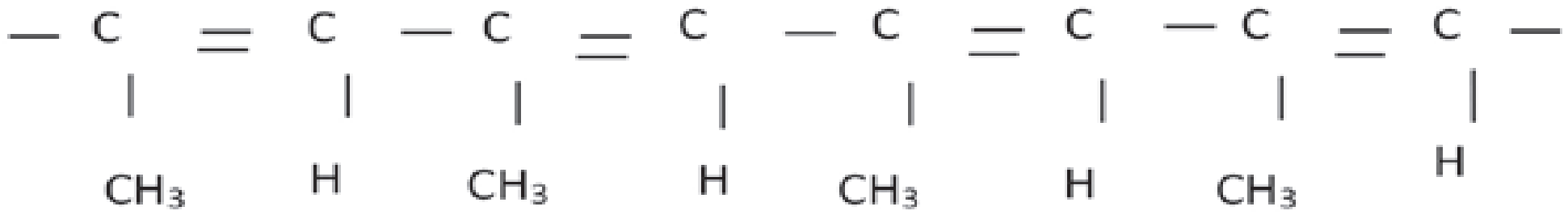
8. freezer bags,

9. wire and cable insulation,

10. extrusion coating.

PLASTICS AND POLYMERS ACTIVITY 1

1. Give the definition of a macromolecule (1)
2. Explain the difference between a monomer and a polymer. (2)
3. What is the chemical reaction in which a monomer molecules join to form a polymer called? (1)
4. The polymer below is the product of a polymerisation reaction



4.1 What is the IUPAC name of the monomer used to form this polymer? (1)

4.2 Give the structural formula of the monomer used to form this polymer. (2)

4.3 Is this an example of an addition or condensation polymerisation?
Give a reason for your answer. (2)

5. A carboxylic acid monomer and an amine monomer has joined in an amide linkage as shown below.

Adipic acid **1,6-diaminohexane**

Name the type of polymerisation that occurs in this equation. Give a reason for your answer. (2)

PLASTICS AND POLYMERS ACTIVITY 1 CONTINUE...

6. Write an equation for polymerisation of ethane to form polyethene.

(2)

7. Is (6) an example of addition or condensation polymerisation? Give a reason for your answer.

(2)

8. Name at least three industrial uses of polythene.

(3)

PLASTICS AND POLYMERS ACTIVITY 1 MEMO

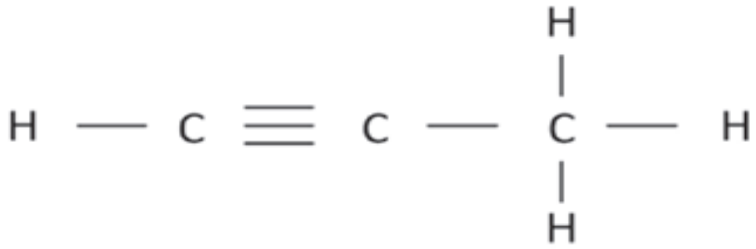
1. **Macromolecule** - A molecule that consists of a large number of atoms. (1)
2. **MONOMER-** Small organic molecules that can be covalently bonded to each other in a repeating pattern

   POLYMER- A large molecule composed of smaller monomer units covalently bonded to each other in a repeating pattern **(MONOMER +MONOMER = POLYMER)**

   (2)
3. Polymerisation (1)

4.1 prop- 1 -yne (1)

4.2

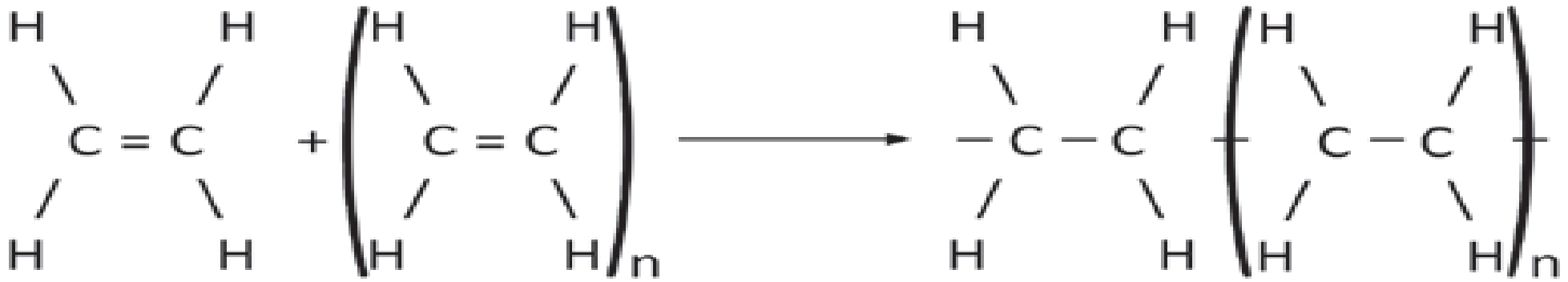


5. **Condensation polymerisation**, because **two monomers** with different functional groups are joined and when they join it leads to the **loss of a small molecule**, in this case, water.

(2)

PLASTICS AND POLYMERS ACTIVITY 1 MEMO CONTINUE...

6.



(2)

7. Addition polymerisation monomers combined through an addition reaction. **(2)**

8. Any of the following:

- ✓ sandwich bags,
- ✓ cling wrap,
- ✓ Car covers,
- ✓ squeeze bottles,
- ✓ liners for tanks and ponds,
- ✓ moisture barriers in construction,
- ✓ freezer bags, water pipes,
- ✓ wire and cable insulation,
- ✓ extrusion coating.

(3)

ACKNOWLEDGEMENT OF THE SOURCES

1. Mind the gab physics grade 12 book
2. Grade 12 physics exam guidelines
3. KZN ATP
4. CAPS DOCUMENT
5. DBE GRADE 12 past exam papers

Nov 2013, Nov 2014, and Feb-march 2015.

THE END

THANK YOU
for your
ATTENTION!

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