ORGANIC MOLECULES

Organic compounds contain carbon and hydrogen atoms. These compounds can be in the gaseous, liquid, or solid phase. All living matter contains organic compounds.

UNIQUENESS OF CARBON

Carbon is very unique and is the basic building block of all organic compounds. It's atoms have a valency of four in a tetrahedral arrangement.
This means it is able to **make four bonds.**

Carbon atoms can form single, double or triple bonds

C — C   C = C   C ≡ C

> **NOTE:**
> Carbon atoms have to form 4 bonds, but not necessarily with 4 other atoms

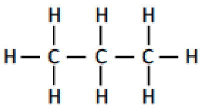
HYDROCARBONS

A hydrocarbon is a compound that contains only carbon and hydrogen atoms. These compounds can be saturated (single bonds) and unsaturated (double or triple bonds).

Hydrocarbon: A compound containing only carbon and hydrogen atoms.

Saturated compound:

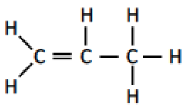
A compound in which all of the bonds between carbon atoms are single bonds.



(Alkanes)

Unsaturated compound:

A compound in which there is at least one double and/or triple bond between carbon atoms.



(Alkenes and alkynes)

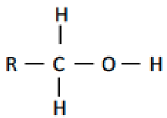
Test to differentiate between saturated and unsaturated solutions

1) Unknown solution → Add brown Br_2
- Brown colour vanishes immediately → Unsaturated ∴ alkene/alkyne
- Does not discolour immediately → Saturated ∴ alkane

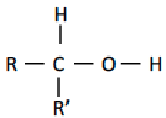
2) Unknown solution → Add purple $KMnO_4$
- Purple colour vanishes immediately. Brown precipitate forms → Unsaturated ∴ alkene/alkyne
- Purple colour does not vanish immediately → Saturated ∴ alkane

CLASSIFICATION OF ALCOHOL

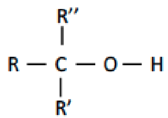
Primary
One C bonded to the C bonded to the OH



Secondary
Two C's bonded to the C bonded to the OH

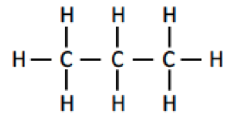


Tertiary
Three C's bonded to the C bonded to the OH



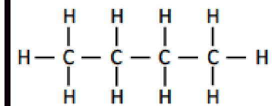
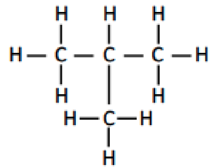
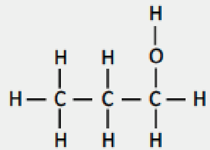
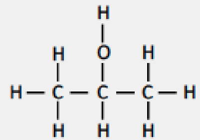
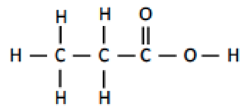
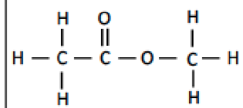
REPRESENTING ORGANIC COMPOUNDS

We use a variety of ways to draw or write organic compounds. We either make use of the molecular formula, condensed formula or we use full structural formulae.

Molecular formula	A chemical formula that indicates the type of atoms and the correct number of each in the molecule.	C_3H_8
Condensed formula	The notation shows the way in which atoms are bonded to each other in a molecule, but does not show all bond lines.	$CH_3CH_2CH_3$
Structural formula	This formula shows all the bonds and atoms in the molecule.	
General formula	Describes the homologous series formula for similar compounds.	Alkanes: C_nH_{2n+2}

ISOMERS

Isomers: Compounds having the same molecular formula but different structural formulae.

Chain isomers	Chain isomers have the same molecular formula but different arrangements of chains in the molecule.	butane 	2-methylpropane 
Positional isomers	These have the same molecular formula but the functional group is in a different position	propan-1-ol 	propan-2-ol 
Functional isomers	These have the same molecular formula but a different functional group. **Aldehydes and ketone** are functional isomers as well as **carboxylic acids and esters**	propanoic acid 	methyl ethanoate 

ORGANIC MOLECULES- NAMING

All organic compounds belong to a specific group which allows us to identify or name the compound. The group that compounds belong to, known as the **homologous series**, depends on the the **functional group** of the compound.

Homologous series: A series of organic compounds that can be described by the same general formula OR in which one member differs from the next with a 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

NAMING ORGANIC COMPOUNDS

Every distinct compound has a unique name, and there is only one possible structure for any IUPAC (International Union of Pure and Applied Chemistry) name. The IUPAC method for naming is a set pattern. It indicates the **longest chain** (the longest continuous chain), the **functional group** and names of **substituent groups (side chains)** or atoms attached to the longest chain.

Three parts of an IUPAC name:

Substituent Prefix — **Root name** — **Functional group suffix**

The **root name** indicates the number of carbon atoms in the longest chain. This chain **must contain the functional group**. The **prefix** indicates the **number and location** of atoms or groups (substituents) attached to the longest chain. The **suffix** identifies the **functional group.**

Steps to naming organic compounds:

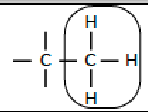
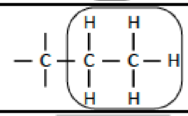
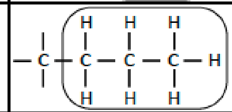
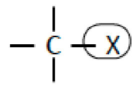
1. Identify the longest continuous carbon chain which must contain the functional group.
2. Number the longest carbon chain beginning at the carbon (carbon 1) nearest to the functional group with the alkyl substituents on the lowest numbered carbon atoms of the longest chain.
3. Name the longest chain according to the number of carbons in the chain. (**the root name**)
4. The **suffix** of the compound name is dependent on the functional group.
5. Identify and name substituents (alkyl and halogen substituents), indicating the position of the substituent
6. For several identical side chains use the prefix di-, tri-, tetra-
7. Arrange substituents in alphabetical order in the name of the compound, ignore the prefix di-, tri-, tetra- (**substituent prefix**)
8. Indicate position using numbers.

Number of carbon atoms in main chain	Root name
1	meth–
2	eth–
3	prop–
4	but–
5	pent–
6	hex–
7	hept–
8	oct–
9	non–
10	dec–

Number of substituents	Substituent prefix
2	**di** eg. dimethyl
3	**tri** eg. triethyl
4	**tetra** eg. tetramethyl

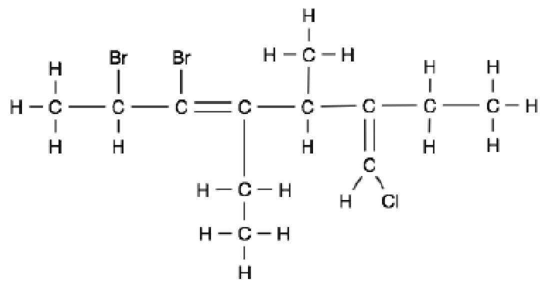
NOTE:
A maximum of THREE substituent chains (alkyl substituents) are allowed on the main chain

NOTE:
comma between numbers
number , number
dash between letter and number
letter – number – letter

Substituent	Formula	Structural formula	Name
Alkyl	CH_3–		methyl–
	CH_3CH_2–		ethyl–
	$CH_3CH_2CH_2$–		propyl–
Halogen	X–		X represents a halogen: Fluorine: fluoro– Chlorine: chloro– Bromine: bromo– Iodine: iodo–

EXAMPLE:

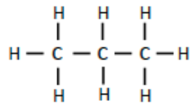
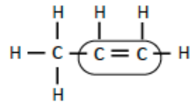
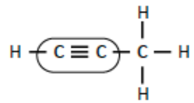
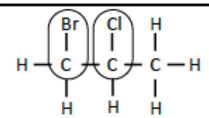
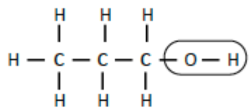
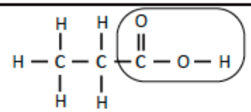
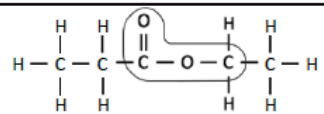
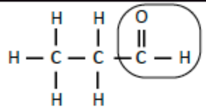
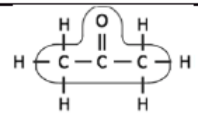
Write down the name of the molecule below:



Substituents	Main chain	Functional group
1–chloro	7 = hept	1,4–diene
2,4–diethyl		
3–methyl		
5,6–dibromo		

5,6–dibromo–1–chloro–2,4–diethyl–3–methylhept–1,4–diene

ORGANIC FUNCTIONAL GROUPS

Homologous series and General formula	Functional group	Suffix	Examples: Structural formula	Examples: Condensed formula	Examples: Name	Properties
Alkanes C_nH_{2n+2}	Single bonds R — C — C — R'	-ane		$CH_3CH_2CH_3$	prop**ane**	**Polarity:** Non-Polar **IMF:** Weak London **Reactions:** Substitution, Elimination, Combustion
Alkenes C_nH_{2n}	Double bonds R — C = C — R'	-ene		$CH_3CH{=}CH_2$	prop**ene**	**Polarity:** Non-polar **IMF:** London **Reactions:** Addition, combustion
Alkynes C_nH_{2n-2}	Triple bonds R — C ≡ C — R'	-yne		$CH{\equiv}CCH_3$	prop**yne**	**Polarity:** Non-polar **IMF:** London **Reactions:** Addition
Haloalkane/ Haloalkene (Alkyl halide)	Halogens (Group 17) X | R — C — R'	fluoro– chloro– bromo– iodo–		$CH_2BrCHClCH_3$	1–bromo–2–chloropropane	**Polarity:** Polar **IMF:** Dipole–Dipole **Reactions:** Elimination, Substitution
Alcohols $C_nH_{2n+2}O$	Hydroxyl R — O — H	-ol		$CH_3CH_2CH_2$**OH**	propan–1–**ol**	**Polarity:** Polar **IMF:** Strong Hydrogen bonds **Reactions:** Substitution, Elimination, Esterification, Combustion
Carboxylic acids $C_nH_{2n}O_2$	Carboxyl O ‖ R — C — O — H	-oic acid		CH_3CH_2**COOH**	propan**oic acid**	**Polarity:** Polar **IMF:** Strong Hydrogen bonds **Reactions:** Esterification
Esters R–COO–R'	Carbonyl O ‖ R — C — O — R'	-yl (alch.) -oate (carbox.)		CH_3CH_2**COO**CH_2CH_3 (carbox.) (alch.)	eth**yl** propan**oate**	**Polarity:** Polar **IMF:** Dipole–Dipole **Reactions:** Formed by esterification
Aldehydes $C_nH_{2n+1}CHO$	Formyl O ‖ R — C — H	-al		CH_3CH_2**CHO**	pronan**al**	**Polarity:** Polar **IMF:** Dipole–Dipole
Ketone R–COC–R'	Carbonyl O ‖ R — C — R'	-one		CH_3**CO**CH_3	propan–2–**one**	**Polarity:** Polar **IMF:** Dipole–Dipole

ORGANIC INTERMOLECULAR FORCES

Intermolecular forces are forces that exist between molecules in the solid, liquid and gaseous phases. They are electrostatic attractive forces. The strength of the IMF will determine the freedom of the particles, determining the phase of the substance (solid, liquid, gas).

Intermolecular force are a weak force of attraction between molecules or between atoms of noble gases

The types of intermolecular forces that exists between different types of organic molecules and the strength of the intermolecular forces will affect the physical properties of a molecule.

TYPES OF IMF			
	Hydrogen Bonds	•Strongest of all the intermolecular forces •Act over shorter distances. •Between molecules that are strongly polar that contain hydrogen bonded to a small highly electronegative atom such as **N, O or F.**	Alcohols (1 bonding site) Carboxylic Acids (2 bonding sites)
	Dipole-Dipole Forces	•Stronger than Dispersion forces/Induced Dipole forces. •Between slightly polar molecules. •Force of attraction between the δ^+ end of the one molecule and the δ^- end of another.	Aldehydes Ketones Esters Alkyl Halides
	Induced Dipole Forces (London)	•Very weak Van der Waals forces. •Between non-polar molecules that form induced (temporary) dipoles and these temporary dipoles attract each other	Alkanes Alkenes Alkynes

RELATIONSHIP BETWEEN PHYSICAL PROPERTIES AND IMF

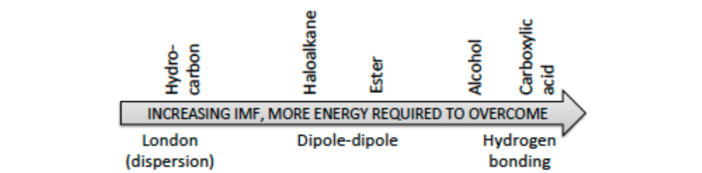
PHYSICAL PROPERTY	RELATIONSHIP TO IMF
Melting Point: The temperature at which the solid and liquid phases of a substance are at equilibrium. It is the temperature where solid particles will undergo a phase change (melt) and become a liquid.	Directly proportional
Boiling Point: The temperature at which vapour pressure of the substance equals atmospheric pressure. It is the temperature where liquid boils and turns into a vapour (gas).	Directly proportional
OPTIONAL	
Vapour Pressure: This is the pressure that an enclosed vapour at equilibrium exerts on the surface of its liquid.	Inversely proportional
Viscosity: this is the measure of a liquid's resistance to flow. A liquid with high viscosity resists motion e.g. syrup. A liquid with low viscosity is runny e.g water.	Directly proportional
Solubility: Substances will only dissolve in substances that are like bonded. A non-polar substance will dissolve in a non-polar substance. A polar substance will dissolve only in polar substances.	Inversely proportional
Density: Density is a measure of the mass per unit volume. The solid phase of the substance is generally more dense than the gaseous and liquid phase.	Directly proportional
Flammability: The ability to burn in air or ignite causing combustion. Most organic compounds are flammable and burn in oxygen to form carbon dioxide and water.	Inversely proportional
Odour: Different functional groups attach differently to different receptors in our nose. Different organic substances give off odour quicker based on their intermolecular forces and distinct odours.	Inversely proportional

COMPARING IMF

1. Identify the type of intermolecular force.
2. Discuss the difference between the two compounds (① → ④).
3. Discuss how this difference either ↑ or ↓ the strength of the intermolecular force.
4. Discuss how the physical property is affected (↑ or ↓).
5. Discuss energy required to overcome forces.

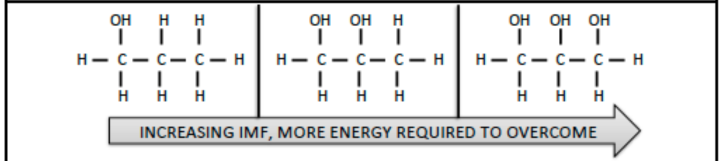
① TYPE OF FUNCTIONAL GROUP

The more polar the molecule, the stronger the IMF



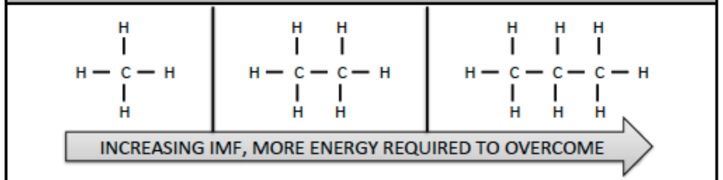
② NUMBER OF FUNCTIONAL GROUPS

An increase in functional groups increase the IMF



③ CHAIN LENGTH: MOLECULAR MASS

The greater the number of carbon atoms in the chain, the greater the molecular mass. An increase in molecular mass increases the IMF



④ CHAIN LENGTH: BRANCHES

More branching results in a smaller contact surface area and lower the strength of the IMF