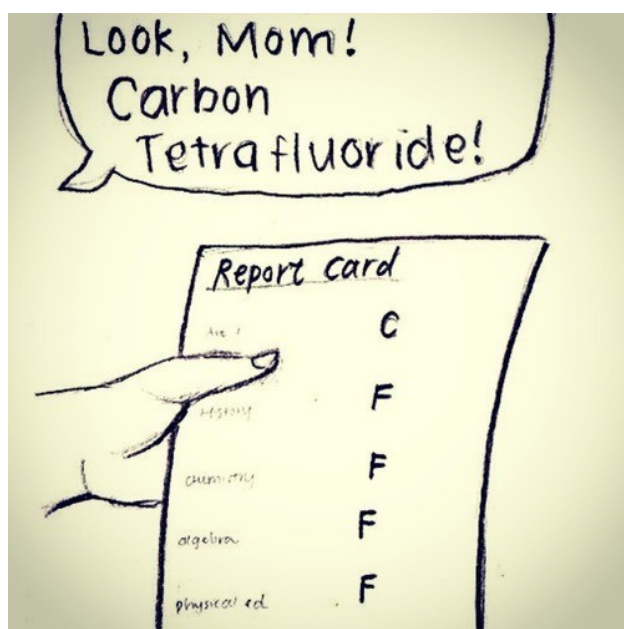




Kennedy

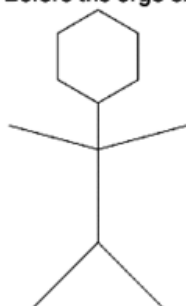
Baptist College

Properties and Structures of Materials (Organic Chemistry)



(AceOrganicChem.com n.d.)

Before the orgo exam:



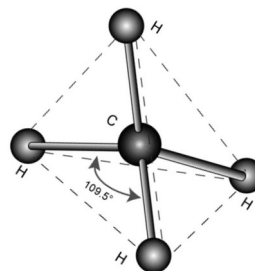
After the orgo exam:



Week	Outcomes	References and tasks	Tasks
8- 9	<ul style="list-style-type: none"> molecular structural formulae (condensed or showing bonds) can be used to show the arrangement of atoms and bonding in covalent molecular substances IUPAC nomenclature is used to name straight and simple branched alkanes and alkenes from C₁- C₈ hydrocarbons, including alkanes, alkenes and benzene, have different chemical properties that are determined by the nature of the bonding within the molecules 	Lucarelli Set 20, q 1-7 Lucarelli Set 20, q 11-12 Lucarelli Set 20, q 8-10, 13-18	
T1 w10- T2 w1	<ul style="list-style-type: none"> alkanes, alkenes and benzene undergo characteristic reactions such as combustion, addition reactions for alkenes and substitution reactions for alkanes and benzene 	Lucarelli Set 21, q 1-8	STAWA Investigation 46 pg 108: Reactivity of hydrocarbons Task 5: Test- Properties and Structure of Materials: Organic Chemistry (T2: Week 1) Task 6: Practical test- Post laboratory test 1 (T2: Week 2)

Bonding in Organic Compounds

In organic compounds, carbon is covalently bonded to other non-metals. Carbon has **four valence electrons** needing **four electrons** to achieve a **stable octet** and so forms **four** covalent bonds. These bonds can be **single, double or triple**. For example, the “simplest” organic compound is **methane** (CH₄).



(NA, 2009)

The carbon atom shares **one each** of its valence electrons with a hydrogen atom. The molecule is actually **tetrahedral** in shape so as to **minimise the repulsion** between the four single C-H bonds.

Hydrocarbons are molecular compounds containing the elements hydrogen and carbon. They are classified into various families of compounds based on structural similarities. We will study the families of:

- Alkanes
- Alkenes
- Cycloalkanes
- Cycloalkenes
- Benzene based compounds (aromatics)

Nomenclature (Naming)

1. Find the **longest continuous** carbon chain. Choose the **stem** name based on the number of carbon atoms in the **longest continuous** carbon chain.

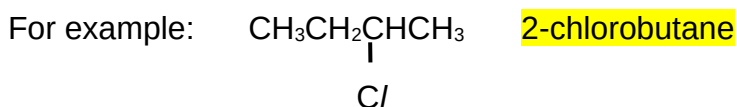
Number of Carbons	Stem Name
One	meth-
Two	eth-
Three	prop-
Four	but-
Five	pent-
Six	hex-
Seven	hept-
Eight	oct-
Nine	non-
Ten	dec-

2. Number the carbon atoms sequentially so that the principle functional group has the lowest number.

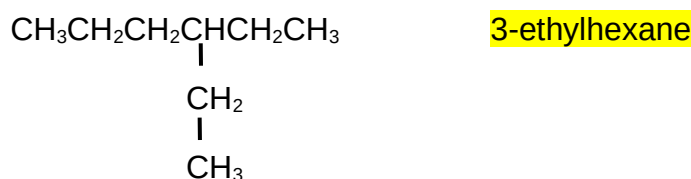
The order of priority of the principle functional groups is (from highest to lowest): alkene; halogen then alkyl groups.

For example: $\text{CH}_3\text{CH}_2\text{CH}=\text{CHCH}_3$ **pent-2-ene**

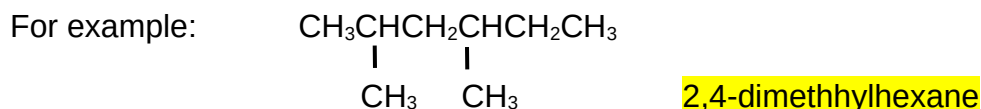
3. If there is a **substituted group** (eg a halogen), number the carbons from the end which gives the **lowest number** to the substituted group.



4. If there is an **alkyl group** (other carbon atoms not part of the main chain – also called a **branch**), name this using the **stem name** for the number of carbons and use the suffix **-yl**. Put a **number** in front to indicate which carbon it comes from then write the stem name.

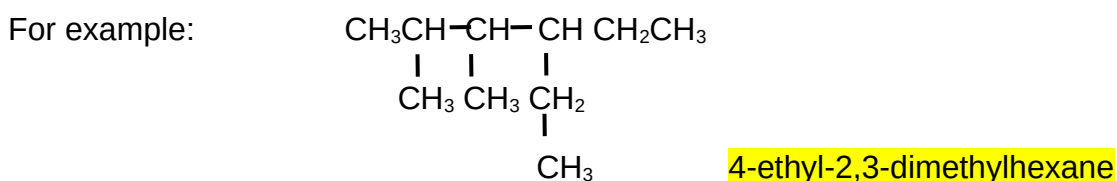


5. If there is more than one of a **substituted group**, write the numbers to indicate which carbon they come off, then follow with the prefix **di, tri, tetra, penta, etc**, then the branch name and -yl. Always finish with the **straight chain** name.



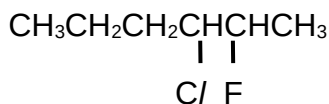
6. Note that numbers are separated from words by **hyphens** and numbers are separated from each other by **commas**. There should be **no spaces** or **capital letters** in the name at all (unless it is the beginning of a sentence).

7. If there are different types of **alkyl groups** in the same chain, again use numbers, and put the alkyl groups in **alphabetical order** according to the stem name (note: you disregard the **numerical prefix** when alphabetizing).



8. there are **substituted halogens**, the same rules apply as for alkyl groups, but use **fluoro-**, **chloro-**, **bromo-** and/or **iodo-**. Again, substituted groups are named alphabetically.

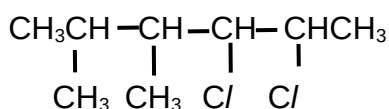
For example:



3-chloro-2-fluorohexane

9. If there are alkyl groups and substituted halogens, name the **halogens** before the **alkyl groups**. If the lowest numbers occur by counting from either end, number so the **halogen** gets the lowest number. In the case of a tie between two halogens, the first **alphabetically** gets the lowest number.

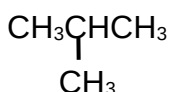
For example:



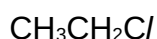
2,3-dichloro-4,5-dimethylhexane

10. If there is only **one option** for a substituted halogen or alkyl groups, **do not use numbers**.

For example:



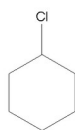
methylpropane



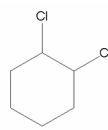
chloroethane

Cycloalkanes

1. The name begins with the prefix **cyclo-** to distinguish it from straight chain aliphatics.
2. Note the shorthand way of drawing rings, where each **corner** represents a carbon. It is assumed that the remaining bonds are between the **carbon** and **hydrogen** atoms.
3. If there is one substituted group, **no numbering** is required. If there is more than one, numbering **is required**.



Chlorocyclohexane



1,2-dichlorocyclohexane

Cycloalkenes

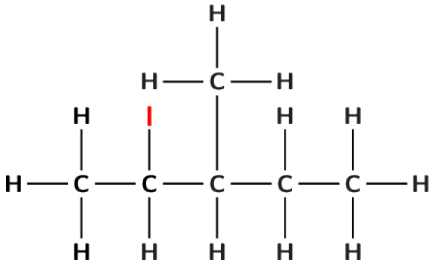
1. **Cycloalkenes** are named similar to the **cycloalkanes** (ie add the prefix cyclo-) and the double bond is given the **lowest** number position.

Benzene

1. Benzene and its derivatives are named similar to cyclic hydrocarbons, but ending with the suffix **-benzene**.

Alkanes

Alkanes are **saturated**, they contain only **single bonds** between carbon atoms.

Name	Molecular formula	Structural formula	Condensed formula
	C_2H_6		
Butane			
			$CH_3CH(CH_3)CH_2CH_3$
			

Alkanes: Structural isomerism

Structural isomers are compounds having the same molecular formula but different structural formula.

Draw the three structural isomers of C_5H_{12} . Name them and write their condensed formula.

Alkenes

Alkenes contain a **double bond** between carbon atoms and so are **unsaturated**.


Name	Molecular formula	Structural formula	Condensed formula
	C_2H_4		
			$CH_3CH_2CHCHCH_3$
3,4-diethylhex-1-ene			

Alkenes: Geometric (cis-trans) isomerism

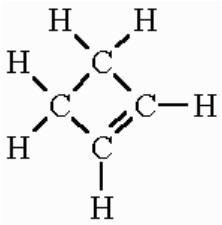
Geometric isomers have the same molecular and structural formula but a different geometry. The different geometry is a result of the inability of double bonded carbon atoms to rotate along the axis of their double bond.

Draw the **cis** and **trans** isomers of but-2-ene.

Cycloalkanes

Name	Molecular formula	Structural formula	Condensed formula
			$\text{CH}_2\text{CH}_2\text{CH}_2$
1,2-dichlorocyclohexane			
			

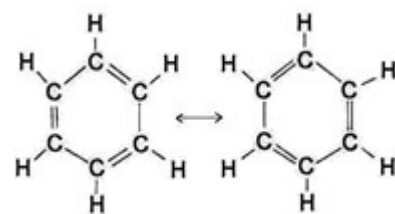
Cycloalkenes

Name	Molecular formula	Structural formula	Condensed formula
			CHCHCH_2
4-chlorocyclohexene			
			

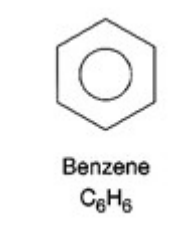
Benzene compounds- aromatics

These are the hydrocarbons containing the benzene ring.

The benzene ring has the formula C_6H_6 and is particularly stable.



Due to the arrangement of its electrons, the benzene ring is represented as follows:



Benzene
 C_6H_6

Name	Molecular formula	Structural formula	Condensed structural formula
methylbenzene			
			$(CH)_3CClCHCCI$

Physical Properties of Hydrocarbons

1. Melting and Boiling Points

2. Solubility

Chemical Properties of Hydrocarbons

1. Addition

As alkenes are unsaturated, they have the capacity to bond to more atoms. They are therefore more reactive than alkanes and readily undergo addition reactions.

Use condensed structural formula to show the addition reactions for:

- a) Pent-1-ene + hydrogen
- b) Pent-1-ene + fluorine
- c) Pent-1-ene + Hydrogen chloride

2. Substitution

Substitution reactions occur when an alkane or benzene is combined with another element. The C-H bond breaks and the hydrogen is substituted with another element which requires one bond, for example a halogen.

The reactions tend to be slow with one substitution at a time and they require UV light as a catalyst.

Use condensed structural formula to show the substitution reactions for:

- a) Ethane + bromine (first substitution)
- b) Methane + chlorine (complete substitution)
- c) Benzene + Cl_2

3. Combustion

Hydrocarbons are excellent fuels. When ignited in excess air (O_2) they produce carbon dioxide and water vapour and also release considerable amounts of heat energy. This is called complete combustion.

Use molecular formula to write balanced chemical equations for the following combustion reactions (assume complete combustion):

- a) Methane in air
- b) Butane in air

Incomplete combustion will occur if the air (O_2) supply is limited. Carbon monoxide and even soot (solid carbon) can be produced.

Use molecular formula to write balanced chemical equations for the following reactions where incomplete combustion occurs:

- a) Methane in limited oxygen
- b) Butane in limited oxygen

Bibliography

AceOrganicChem.com n.d.: , (AceOrganicChem.com n.d.),

Arboretictruth 2012: , (Arboretictruth 2012),