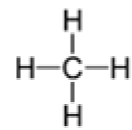
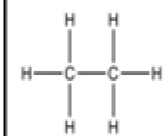
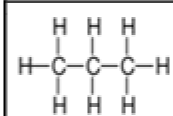
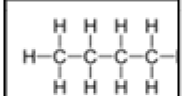
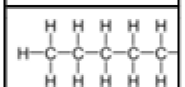
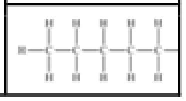
Alkanes

Distinguish between empirical, molecular and structural formulae for the alkanes (up to C6)

Number of Carbon Atoms	Name	Molecular Formula	Empirical Formula	General Formula	Structural Formula
1	Methane	CH_4	CH_4		
2	Ethane	C_2H_6	CH_3		
3	Propane	C_3H_8	C_3H_8	C_nH_{2n+2}	
4	Butane	C_4H_{10}	C_2H_5		
5	Pentane	C_5H_{12}	C_5H_{12}		
6	Hexane	C_6H_{14}	C_3H_7		

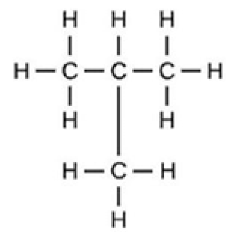
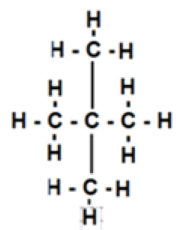
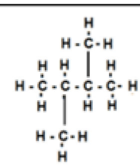
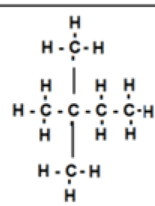
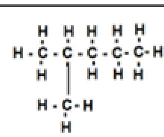
Describe the features of a homologous series with reference to alkanes

Homologous Series	Description
Functional Group	The functional group in alkanes consists of single-bonded carbon atoms.
Chemical Properties	Each family in the homologous series has similar chemical properties due to the presence of the same functional group.
Physical Properties	There are graduations in physical properties such as boiling and melting points due to the increasing size of the molecule with each successive member.
Structure	The homologous series consists of families of organic compounds, such as alkanes.
Incremental Units	Each member in a family differs from the next by a unit of CH2 (methylene group).

General Formula	Homologous series have a general formula for all its members; for alkanes, it is C_nH_{2n+2}

Deduce the structural formulae for the isomers of the non-cyclic alkanes up to C6

Isomers are chemical compounds that have the same chemical formula but differing structural formulas. Only some alkanes have isomers.

Name	Formula	Isomeric Structure/s
Butane (2-methyl propane)	C_4H_{10}	
Pentane (2,2-dimethylpropane)	C_5H_{12}	
Hexane (2,3-dimethylbutane)	C_6H_{14}	
2,2-dimethylbutane		
2-methlypentane		

Predict and explain the trends in the boiling points of members of a homologous series using alkanes as an example

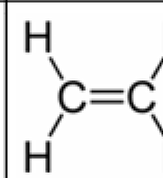
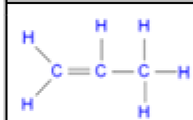
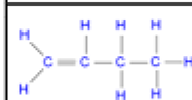
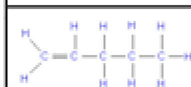
The boiling points of a homologous series increase as the number of carbon atoms increases. This is because the attractive forces between larger carbon changes and molecules are stronger. Therefore, these intermolecular forces require more energy to be broken. Since more energy is required to break the bonds, the boiling point increases as the number of carbon atoms increases.

Alkenes

Deduce structural formulae for the isomers of the straight chain alkenes up to C6

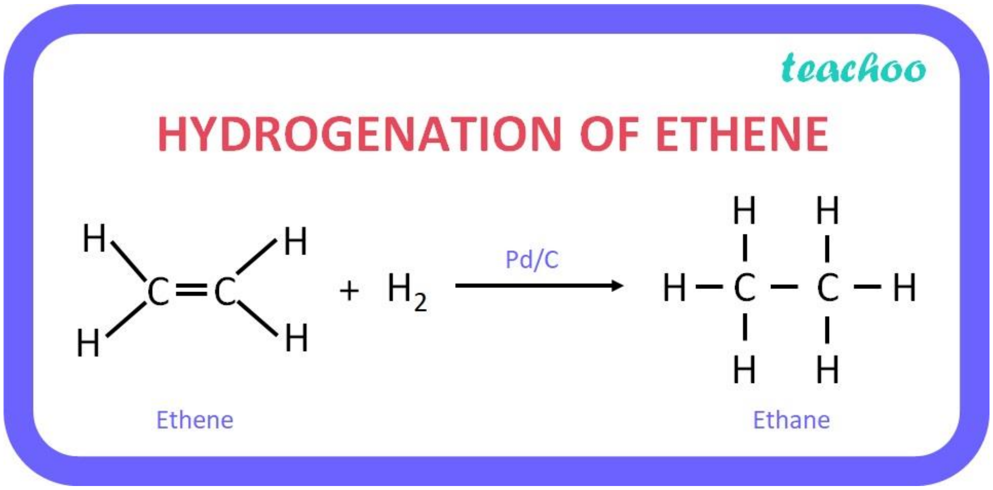
Alkenes are unsaturated hydrocarbonds that contain one carbon double bond. Alkenes can only be formed with 2 or more carbon atoms, because there has to be 2 carbon atoms for a double bond to be present.

Name the alkenes up to C6, structural, empirical and molecular formulae

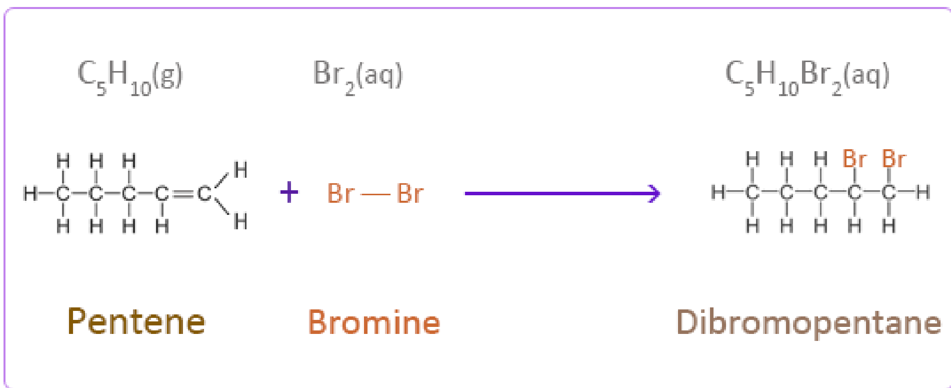
Number of carbon atoms	Name	Molecular Formula	General Formula	Structural Formula
2	Ethene	C_2H_4		
3	Propene	C_3H_6		
4	But - 1 - ene	C_4H_8	C_nH_{2n}	
5	Pent - 1 - ene	C_5H_{10}		
6	Hex - 3 - ene	C_6H_{12}		

Outline the economic importance of reactions of alkenes

Hydrogenation: Alkenes undergo hydrogenation, a reaction in which hydrogen gas reacts with the double bond of the alkene in the presence of a catalyst to form alkanes. This process is used in producing margarine from vegetable oils, improving their texture and stability for food applications.



Halogenation: Alkenes react with halogens, such as bromine, to form halogenoalkanes. For example, ethene reacts with bromine to produce dibromoethane, a colorless compound. This reaction is used in testing for unsaturation in organic compounds and is important in organic synthesis.



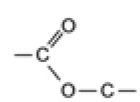
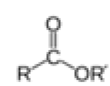
Chemical Synthesis: Alkenes serve as starting materials for the synthesis of various chemicals, including polymers like polyvinyl chloride (PVC). PVC is widely used as a building material in construction, providing durable and versatile solutions for pipes, window frames, flooring, and other applications in the construction industry.

<u>**Alcohols, Carboxylic Acids & Esters**</u>

Distinguish between alcohols, carboxylic acids and esters

Alcohols	Carboxylic Acids	Esters
$C_nH_{2n+1}OH$	$C_{n-1}H_{2n-1}COOH$	The general formula for esters is R[COO]R', where R may be a hydrogen atom, an alkyl group, or an aryl group, and R' may be an alkyl group or an aryl group but not a hydrogen atom.
Formed through a process called hydration where alkenes are reacted with water to produce alcohols Alkenes + Steam - Alcohol	Carboxylic acids are formed through the oxidation of primary alcohols and aldehydes.	Esters are formed by reacting alcohols with carboxylic acids.

Identify typical functional groups in alkanes, alkenes, alcohols, carboxylic acids and esters

	Functional Group
Alkanes	Single bonded Carbon atoms C—C
Alkenes	Double bonded Carbon atoms C=C
Alcohols	Single bonded Carbon and Hydroxide atoms C−O−H
Carboxylic Acids	Double bonded Carbon and Oxygen atom and a single bonded hydroxide atom 
Esters	Single bonded Carbon and Oxygen. Double bonded Carbon and Oxygen. Single bonded oxygen bonded to another carbon.  
Alkynes	Triple bonded Carbon atoms ·C≡C

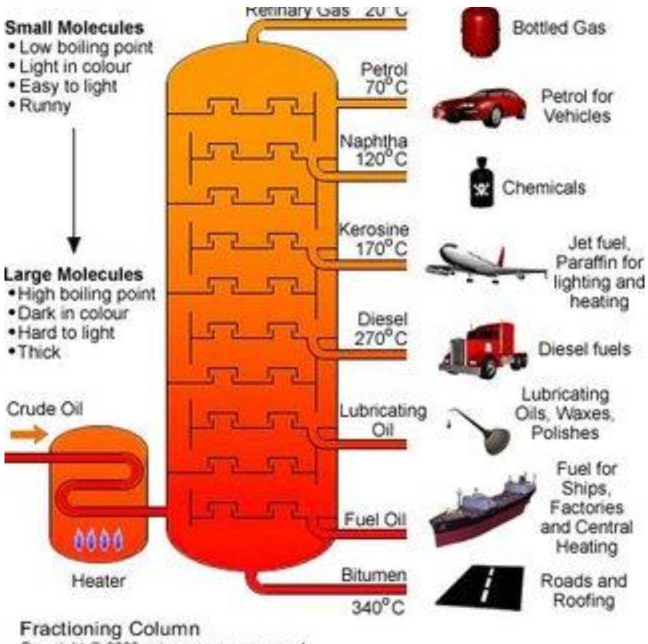
<u>Crude Oil</u>

Describe the process of refining crude oil including cracking and fractional distillation

Fractional distillation is a separation technique used to separate crude oil based on differences in boiling points through a fractionating column.

1. Crude oil is heated in a furnace at extremely high temperatures
2. There is a temperature gradient, where the top of the column is cooler than the bottom

3. As the crude oil is heated, the mixture evaporates and then condenses at different heights based on their boiling point due to the temperature gradient
4. As mentioned before, hydrocarbons with longer carbon chains have higher boiling points, therefore they condense at the bottom of the column, and vice versa for hydrocarbons with short carbon chains.
5. The separated hydrocarbons are piped out of the fractions at different heights and then used for different purposes:



<u>Reactions</u>

Substitution

A reaction where a functional group is broken downw to form a different functional group when an element is replaced

e.g. Methane + Chlorine -> Chloromethane Hydrochloric Acid

Esterification

A reaction between an alcohol and a carboxylic acid, producing an ester and water

e.g. Carboxylic acid + alcohol -> Ester + Water

Methanoic Acid + Ethanol -> Ethyl Methanoate + Water

Addition Reaction

The reaction between a substance and an alkene, breaking the double bond to accommodate the additional atoms

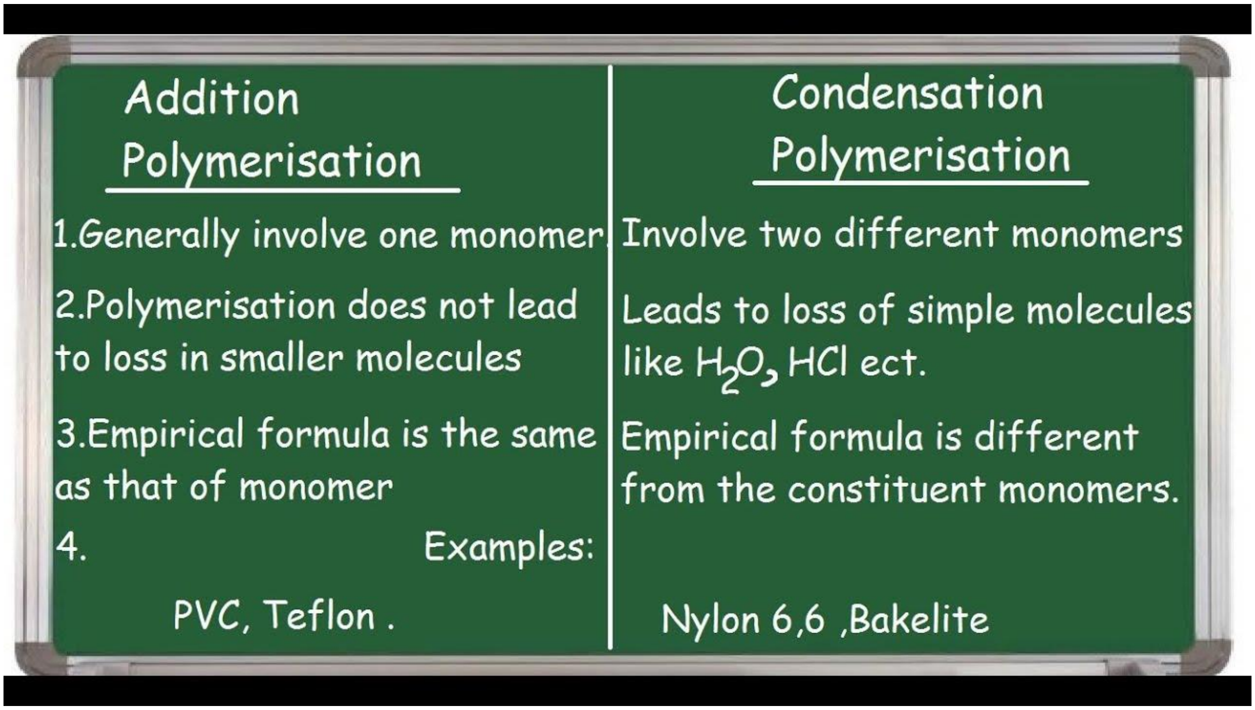
e.g. Ethene + Bromine -> 1,2-dibromoethane

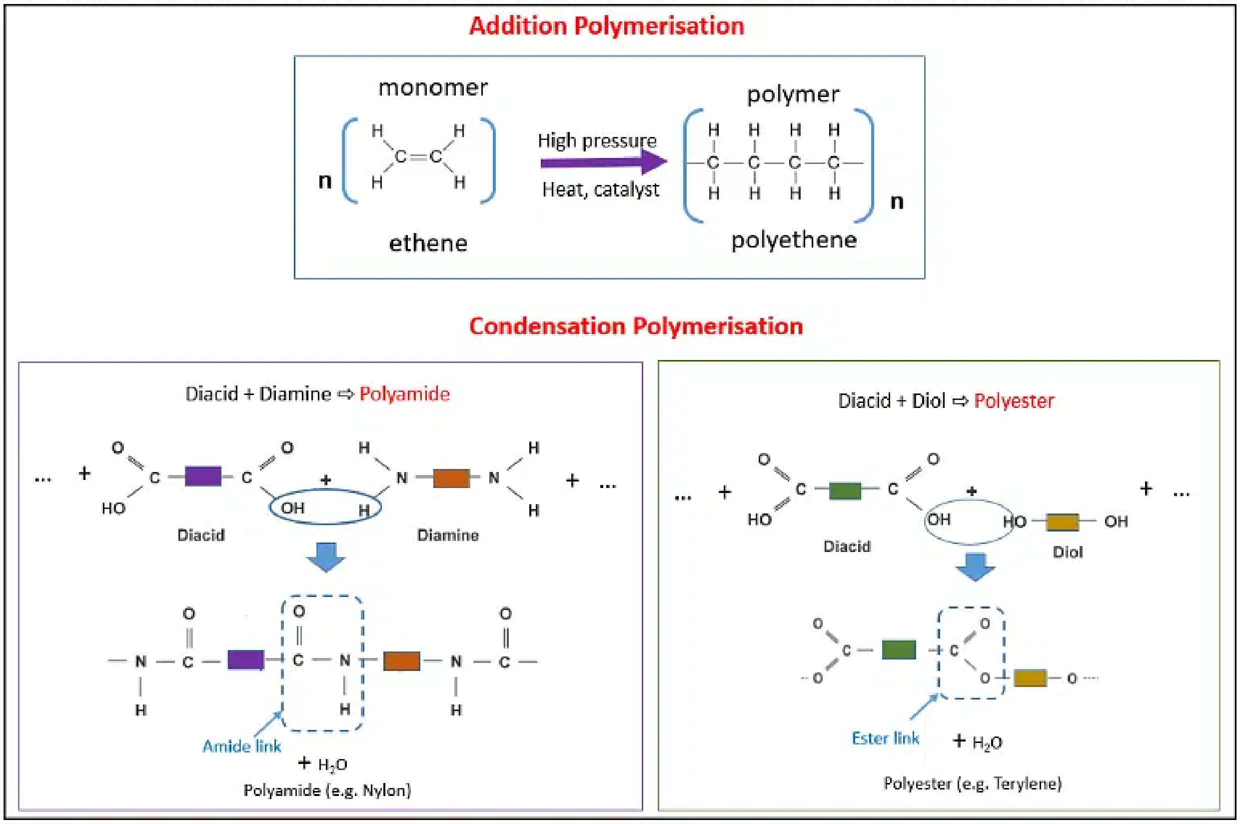
Hydrogenation

The reaction between an alkene and a hydrogen molecule, making it saturated and turning it into an alkene

$C_2H_4 + H_2 \rightarrow C_2H_6$

Polymerization





IUPAC

Functional group	Prefix	Suffix	Functional group	Prefix	Suffix
carboxylic acids	none	-oic acid	carboxylic acids	none	-oic acid
aldehydes	none	-al	aldehydes	none	-al
ketones	none	-one	ketones	none	-one
alchols	hydroxy-	-ol	alchols	hydroxy-	-ol
amines	amino-	-amine	amines	amino-	-amine
ethers	alkoxy-	-ether	ethers	alkoxy-	-ether
fluorine	fluoro-	none	fluorine	fluoro-	none
chlorine	chloro-	none	chlorine	chloro-	none
bromine	bromo-	none	bromine	bromo-	none
iodine	iodo-	none	iodine	iodo-	none

Rules: (Taken from IUPAC Rules (uiuc.edu))

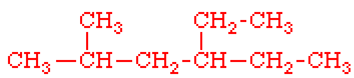
1. Identify the longest carbon chain. This chain is called the parent chain.
2. Identify all of the substituents (groups appending from the parent chain).
3. Number the carbons of the parent chain from the end that gives the substituents the lowest numbers. When comparing a series of numbers, the series that is the

"lowest" is the one which contains the lowest number at the occasion of the first difference. If two or more side chains are in equivalent positions, assign the lowest number to the one which will come first in the name.

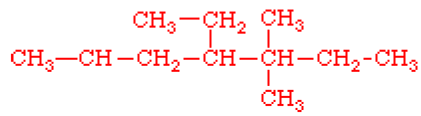
4. If the same substituent occurs more than once, the location of each point on which the substituent occurs is given. In addition, the number of times the substituent group occurs is indicated by a prefix (di, tri, tetra, etc.).
5. If there are two or more different substituents, they are listed in alphabetical order using the base name (ignore the prefixes). The only prefix which **is** used when putting the substituents in alphabetical order is **iso** as in isopropyl or isobutyl. The prefixes sec- and tert- are not used in determining alphabetical order except when compared with each other.
6. If chains of equal length are competing for selection as the parent chain, then the choice goes in series to:
   a) the chain which has the greatest number of side chains.
   b) the chain whose substituents have the lowest- numbers.
   c) the chain having the greatest number of carbon atoms in the smaller side chain.
   d)the chain having the least branched side chains.
7. A cyclic (ring) hydrocarbon is designated by the prefix **cyclo-** which appears directly in front of the base name.

In summary, the name of the compound is written out with the substituents in alphabetical order followed by the base name (derived from the number of carbons in the parent chain). Commas are used between numbers and dashes are used between letters and numbers. There are **no** spaces in the name.

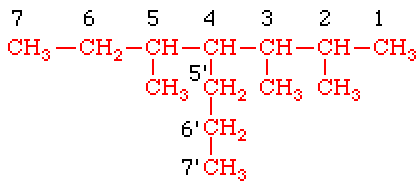
Here are some examples:



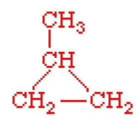
4-ethyl-2-methylhexane



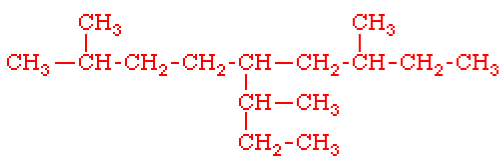
4-ethyl-3,3-dimethylheptane



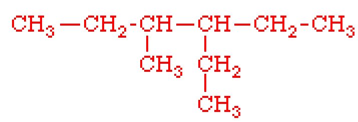
2,3,5-trimethyl-4-propylheptane
(NOT: 2,3-dimethyl-4-sec-butylheptane)



methylcyclopropane



5-sec-butyl-2,7-dimethylnonane



3-ethyl-4-methylhexane