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ORGANIC CHEMISTRY

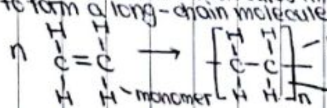
Chemistry of carbon compounds.
Note: All organic compounds can react with oxygen/combust.

complete: sufficient O_2, gives $CO_2 + H_2O$
incomplete: insufficient O_2, gives $CO/C + H_2O$

Structural Formula: Diagram showing complete spatial arrangement of atoms.
Condensed SF: shown in one line.
eg. H–C–C–O–H vs. C_2H_5OH.

Always write out as a 'H' shape w/ C=C in the middle so it is easier to visualise.

n Alkene → poly(alkene)
Addition Polymerization:
many small alkene molecules link together to form a long-chain molecule.



Thermal: ~800°C, high pressure
Catalytic: ~500°C, alumina (Al_2O_3), silica (SiO_2) catalyst.

Cracking: breaking larger hydrocarbons into smaller molecules. Sum of C+H in reactants = products

Applications:
1) convert heavy fractions of low demand into lighter fractions of high demand.
2) produce alkenes
3) produce H_2 gas

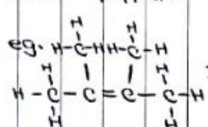
Hydration: Alkene + H_2O (steam) → Alcohol
300°C, 60atm, H_3PO_4 catalyst

Nomenclature:

number – additional branch/atom – [prefix] – number – [suffix]

- number: position of (smallest)
- additional branch/atom: eg. methyl, chloro, bromo
- prefix: no. of Carbons in longest chain. meth, eth, prop, but...
- number: position of functional group
- suffix: unique to each homologous series:
  - -ene – Alkene
  - -ane – Alkane
  - -anol – Alcohol
  - -oic acid – Carboxylic Acid.

eg.



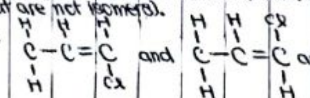
2,3-dimethylbut-2-ene.

Homologous series: A family of organic compounds which follow a regular structural pattern. Each homologous series also has a unique **functional group** (an atom, group of atoms, or a bond common to a homologous series that determines main chem. properties), as well as a **general formula**. (different from empirical → simplest ratio and molecular → actual composition).
Similar chem. properties, gradation in physical properties. As Mr increases, mp and bp increase — IMFOA stronger, viscosity increases, solubility and flammability decrease — larger molecule that is harder to dissolve and completely combust as more O_2 is required. (with the same no. of C atoms, alkenes are likelier to undergo incomplete combustion: higher % by mass of C than alkanes)

Isomers: Molecules with the same molecular formula but different spatial arrangement of atoms (structural formula)
1) Chain isomerism: branching in carbon chain
2) Position isomerism: longest carbon chain remains but position of impt. atoms/groups change
3) Functional isomerism: different functional group.

Note that because bonds can rotate, identical molecules can be drawn differently (but are not isomers).

eg.



are identical

Alkanes
No functional group (only C–C)
C_nH_{2n+2}

Saturated hydrocarbons.
Generally unreactive.
Simple molecules.
First 4 alkanes (g)

CSC
Substitution:
w/ chlorine in UV light giving a mixture of products as multiple H atoms can be substituted.

Alkenes
C=C double bond
C_nH_{2n} where n≥2

Unsaturated hydrocarbons
More reactive due to C=C bond.
Mostly (g) or (l).
Undergoes addition reactions over C=C bond to give a single molecule.

CHBHAP

Hydrogenation:
Alkene + H_2 → Alkane
400°C, Nickel catalyst.
Used for saturation of veg. oils (l) → margarine (s).

Bromination: (differentiate alkenes vs. alkanes)
no need UV.
brown colour of Br → colourless.
Br on each side of C=C.

Alcohols
–OH Hydroxyl functional group
$C_nH_{2n+1}OH$

Colourless liquids
Prepared by hydration or fermentation of glucose:
$C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$
yeast, water, ~37°C, anaerobic.

CODE

Dehydration:
Alcohol → Alkene + H_2O
heat with conc. H_2SO_4

Carboxylic Acids
–COOH Carboxyl functional group
$C_nH_{2n+1}COOH$

weak acids that dissociate partially in water. (⇌)
Reacts with bases, carbonates, metals.

oxidation: gain of O / loss of H.
alcohol + 2[O] → carboxylic acid + H_2O
[O] represents an oxidising agent like O_2 gas or acidified $KMnO_4$ (purple → colourless)

Note that compounds have the alkanoate ion in front, metal ion behind.
eg. C_2H_5COONa

Esters
–COO– Ester linkage
R_1COOR_2

sweet-smelling liquids.
Used for food flavourings and solvents for perfumes/glues.

Esterification:
alcohol + carboxylic acid ⇌ alkyl alkanoate + H_2O
conc. H_2SO_4 catalyst.
Alcohol loses 'H', Carboxylic acid loses 'OH', Ester linkage formed
"Alkyl" — Alcohol
"Alkanoate" — Carboxylic Acid.

Issues with use of organic molecules:

With insufficient oxygen, incomplete combustion of carbon compounds can produce carbon monoxide, a poisonous, colourless and odourless gas that reduces the ability of blood to carry oxygen.

The ozone layer absorbs the sun's UV radiation, which causes skin cancer. Chlorofluorocarbons (CFCs) can deplete the ozone layer.

Carbon dioxide and methane are greenhouse gases that contribute to global warming, and originate from human activities such as burning fossil fuels. GW leads to rising sea levels and extreme weather conditions.
(note that CO_2 ≠ pollutant!)

The carbon cycle includes combustion, respiration, photosynthesis. It regulates the amount of CO_2 in the atmosphere.

A'ZONE