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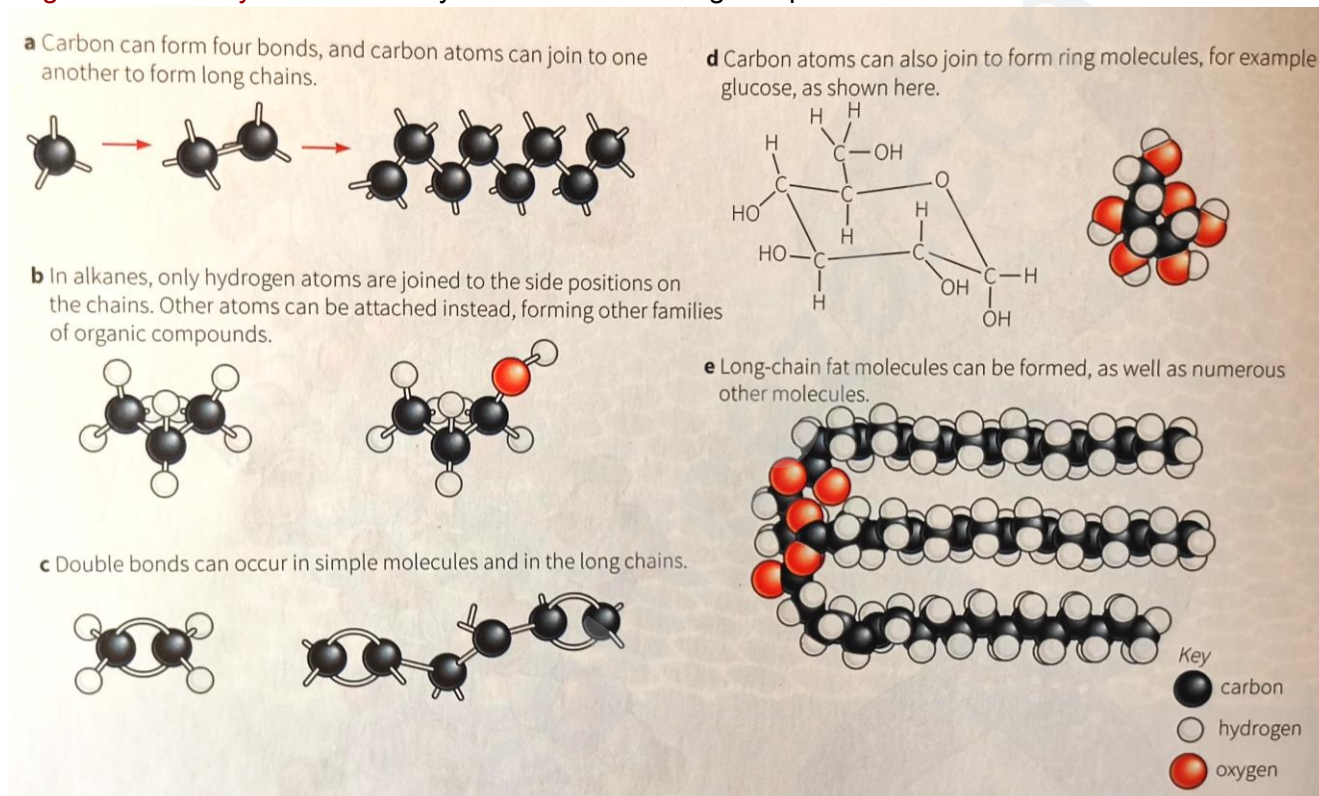
C10. Organic Chemistry

C10.01 the unique properties of carbon

Carbon

1. non metal in group 4
2. forms covalent compounds
 - a. carbon atoms can join each other to form long chains
 - b. carbon atoms in a chain can be linked by single, double, or triple
 - c. can arrange themselves in rings

Organic Chemistry - the chemistry of carbon containing compounds



C10.02 Alkanes

1. What is hydrocarbon?

hydrocarbon: a compound that contains carbon and hydrogen carbon

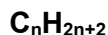
- the most simplest way
- **saturated hydrocarbon** - molecules contain only single covalent bonds between carbon atoms
 - no further atoms can be added => alkane

2. Formula

- **Molecular formula** - represents actual number of atoms
- **Structural formula** - shows how they are bonded together
 - chain increases - strength of the seak forces increased (intermolecular forces)
 - m.p and b.p gradually increases
 - carbon 1~4 = gases
 - carbon 5~16 = liquids

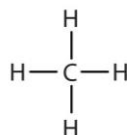
3. Nomenclature

methane - ethane - propane - butane - pentane - hexane

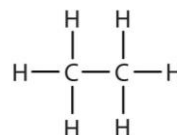


4. Burning alkanes

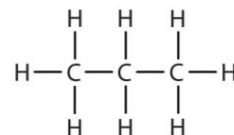
- very exothermically burns - good fuels
- burn with the supply of air, and produce carbon dioxide and water vapour
 - $CH_4 + 2O_2 \Rightarrow CO_2 + 2H_2O$
 - $2C_2H_6 + 7O_2 \Rightarrow 4CO_2 + 6H_2O$



Methane



Ethane



Propane

5. Homologous series

Homologous series: a family of organic compounds

- have same general formula
- similar chemical properties
- gradual increase in physical properties such as melting point and boiling point

C10.03 Alkenes

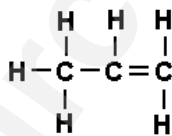
1. Unsaturated Hydrocarbons

alkene: unsaturated hydrocarbons

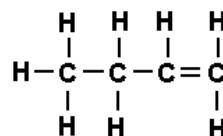
- molecules of these compounds contain C=C double bond somewhere
 - double bond - make them much more reactive
 - $C_2H_4 + 3O_2 \Rightarrow 2CO_2 + 2H_2O$
- unsaturated - possible to break this double bond and add extra atoms
- have general formula C_nH_{2n}



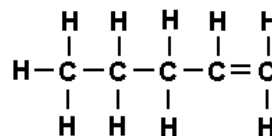
ethene



propene



butene



pentene

2. Nomenclature

ethene - propene - butene - pentene

3. Chemical tests for unsaturation

ethene + bromine(orange brown solution) $\Rightarrow$ 1,2-dibromoethane(colourless)



- Addition reaction:** double bond breaks and adds two new atoms

C10.04 Hydrocarbon structure

1. Naming organic compounds

Homologous series	Name ending	Example
alkane	-ane	propane
alkene	-ene	propene
alcohol	-ol	propanol

C10.05 Chemical reactions of alkanes

- unreactive compounds
- saturated - can't take part in addition reactions
- unaffected by acids or alkalis

1. Combustion



C10.06 Chemical reactions of the alkenes

- much more reactive
- bromine, hydrogen, water can be added across C=C bond

1. Bromination



- used as the chemical test for an unsaturated hydrocarbon
- discoloured when shaken with an alkene

2. Hydrogenation

ethene + hydrogen -- (150~300 °C + nickel) --> ethane



3. Hydration

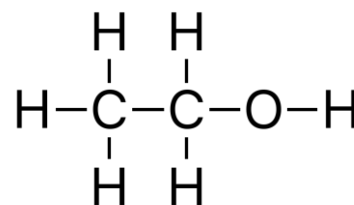
- manufacture of ethanol
 - ethanol: important industrial chemical and solvent

ethene + steam -- (300 °C 60 atmosphere pressure, phosphoric acid=7kel) --> ethanol



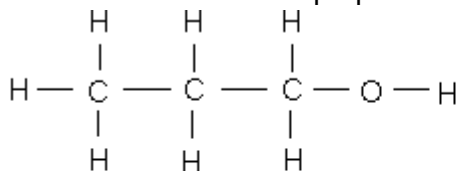
C10.07 Alcohols

- series of containing -OH
- general formula: $\text{C}_n\text{H}_{2n+1}\text{OH}$

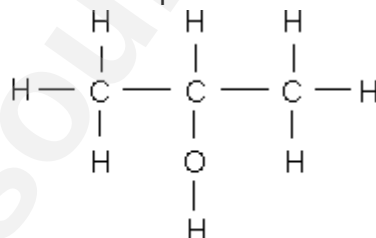


1. Nomenclature

methanol -> ethanol -> propan -1-ol -> butan-1-ol -> pentan -1-ol



propan-1-ol



propan-2-ol

2. Making ethanol

Hydration of ethene

ethene + steam -- (300 °C 60 atmosphere pressure, phosphoric acid=7kel) --> ethanol



Fermentation

- natural waste products of yeasts when they ferment sugar
- anaerobic reaction
- yeast provides enzymes for fermentation
- takes several days to finish
- conditions
 - sugars dissolved in water, mixed with yeast
 - yeast dies when ethanol concentration is about 15%
 - temperature 25 ~ 35C
 - temp too low - very slowly
 - temp too hot - enzymes denatured, fermentation stops

glucose --yeast→ ethanol + carbon dioxide



Ethanol by the hydration of ethene	Ethanol by fermentation
from a non-renewable source - petroleum	made from readily renewable resources
small scale equipment which withstands pressure	simple, large vessels
continuous process	batch process - need to start process each time
fast reaction rate	relatively slow process
yields highly pure ethanol	ethanol must be purified by subsequent distillation - though fermented product can be used as it is for some purposes
sophisticated, complex method	simple, straightforward method

C10.08 The reactions of ethanol

1. Ethanol as a fuel

ethanol + oxygen => carbon dioxide + water

