OCR B GCSE Chemistry

Topic 3: Chemicals of the natural environment

Why is crude oil important as a source of new materials?

Notes

1. Recall that crude oil is a main source of hydrocarbons and is a feedstock for the petrochemical industry

2. Explain how modern life is crucially dependent upon hydrocarbons and recognise that crude oil is a finite resource

- There are many uses of each fraction obtained from the fractional distillation of crude oil, such as...
  - Refinery gas for bottled gas for heating and cooking
  - Gasoline fraction for fuel (petrol) in cars
  - Naphtha fraction for making chemicals
  - Kerosene/paraffin fraction for jet fuel
  - Diesel oil/gas oil for fuel in diesel engines
  - Fuel oil fraction for fuel for ships and home heating systems
  - Lubricating fraction for lubricants, waxes and polishes
  - Bitumen for making roads

3. Describe and explain the separation of crude oil by fractional distillation

- The oil is heated in the fractionating column and the oil evaporates and condenses at a number of different temperatures.
- The many hydrocarbons in crude oil can be separated into fractions each of which contains molecules with a similar number of carbon atoms
- The fractionating column works continuously, heated crude oil is piped in at the bottom. The vaporised oil rises up the column and the various fractions are constantly tapped off at the different levels where they condense.
- The fractions can be processed to produce fuels and feedstock for the petrochemical industry.
- Longer chained alkanes are boiled towards the bottom, due to their high boiling points – since they have more and stronger intermolecular forces

4. Describe the fractions of crude oil as largely a mixture of compounds of formula C_nH_{2n+2} which are members of the alkane homologous series

5. Use ideas about energy transfers and the relative strength of chemical bonds and intermolecular forces to explain the different temperatures at which changes of state occur

- longer chained hydrocarbons have higher boiling points. All hydrocarbons have covalent bonds, which are very strong, but it is the intermolecular forces not these bonds that are overcome when they melt/boil
- longer chained hydrocarbons have more intermolecular forces, making them stronger and meaning that they need more energy to be overcome

6. Deduce the empirical formula of a compound from the relative numbers of atoms present or from a model or diagram and vice versa

- if given the formula of molecule: if you have a common multiple e.g. Fe_4O_6, the empirical formula is the simplest whole number ratio, which would be Fe_2O_3
- if given a diagram, just look to see the ratio of the number of one element compared to another

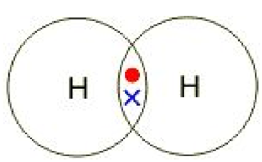
7. Use arithmetic computation and ratio when determining empirical formulae
- see above

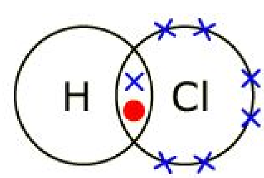
8. Describe the arrangement of chemical bonds in simple molecules

- simple molecules are made of non metals and have covalent bonds
- e.g. H_2 O_2 CH_4 NH_3

9. Explain covalent bonding in terms of the sharing of electrons
- a covalent bond is formed when outer shell electrons are shared between atoms
- each atom should form a full outer shell

10. Construct dot and cross diagrams for simple covalent substances
examples:





11. Represent three dimensional shapes in two dimensions and vice versa when looking at chemical structures for simple molecules

12. Describe the limitations of dot and cross diagrams, ball and stick models and two and three dimensional representations when used to represent simple molecules

- dot and cross diagrams: shows how atoms are bonded and electrons, but doesn't show the 3D arrangement of molecules
- ball and stick models: show how atoms are bonded and the 3D shape, but doesn't show the electrons or the chemical symbols
- 2D/3D: generally, 2D models don't show the 3D arrangement and 3D models don't give details of bonding or electrons
- All: do not include intermolecular forces, which are the ones that are broken when boiling and melting simple molecules

13. Translate information between diagrammatic and numerical forms

14. Explain how the bulk properties of simple molecules are related to the covalent bonds they contain and their bond strengths in relation to intermolecular forces

- Substances that consist of simple molecules have weak intermolecular forces between the molecules. These are broken in boiling or melting, not the covalent bonds.
    - The intermolecular forces increase with the size of the molecules, so larger molecules have higher melting and boiling points.
- simple molecules can't conduct electricity because there are no charged particles within their structure

15. Describe the production of materials that are more useful by cracking

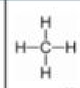
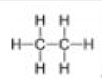
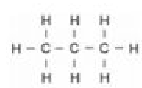
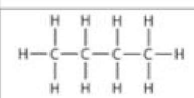
- Hydrocarbons can be cracked to produce smaller, more useful molecules. This process involved heating the hydrocarbons to vaporise them.
- The vapours are:
    - Either passed over a hot catalyst (silica or alumina)
    - Mixed with steam and heated to a very high temperature (temperature in the range of 600-700˚C) so that thermal decomposition reactions can occur.
- The products of cracking include alkanes and alkenes (or hydrogen)

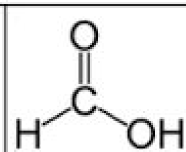
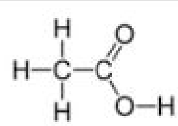
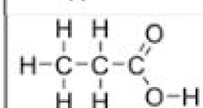
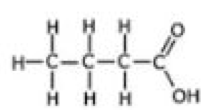
16. Recognise functional groups and identify members of the same homologous series (separate science only)

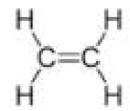
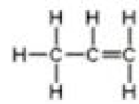
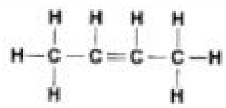
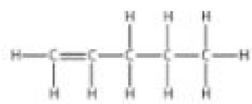
- Prefixes (beginning of the name)
    - remember the first 4 prefixes using MEPB Monkeys Eat Peanut Butter

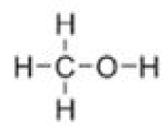
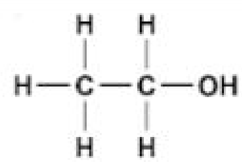
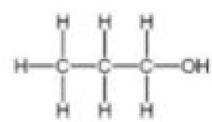
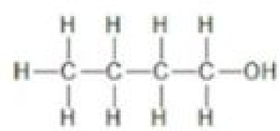
- Any compound with 1 carbon has the prefix of: Meth-
- 2 carbons: Eth-
- 3 carbons: Prop-
- 4 carbons: But-
- The suffix of any compound refers to the functional group
  - Alkanes – ane (C-C // C-H) e.g. ethane
  - Alkenes – ene (C=C) e.g. ethene
  - Alcohols – ol (OH) e.g. ethanol
  - Carboxylic acids – anoic acid (-COOH) e.g. ethanoic acid

17. Name and draw the structural formulae, using fully displayed formulae, of the first four members of the straight chain alkanes and alkenes, alcohols and carboxylic acids (separate science only)

alkane	structural formula	displayed formula
methane	CH_4	
ethane	CH_3CH_3	
propane	$CH_3CH_2CH_3$	
butane	$CH_3CH_2CH_2CH_3$	

methanoic acid	CHOOH	
ethanoic acid	CH_3COOH	
propanoic acid	C_2H_5COOH	
butanoic acid	C_3H_7COOH	

ethene	C_2H_4	
propene	C_3H_6	
butene	C_4H_8	
pentene	C_5H_{10}	

methanol	CH_3OH	
ethanol	C_2H_5OH	
propanol	C_3H_7OH	
butanol	C_4H_9OH	

18. Predict the formulae and structures of products of reactions (combustion, addition across a double bond and oxidation of alcohols to carboxylic acids) of the first four and other given members of these homologous series (separate science only)

- Combustion of alkanes – reaction of alkanes with oxygen to produce carbon dioxide and water
- addition reactions of alkenes
  - molecule added is split and added to the carbon either side of the C=C bond, which becomes a C-C bond
  - Addition of bromine –colour change from orange to colourless (can be used as a test for C=C double bond, since alkanes cannot react with bromine in this way so the colour remains orange)
  - Addition of hydrogen – alkenes form alkanes
- Oxidation of alcohols to carboxylic acids using potassium manganate(VII) (orange to green colour change) (reflux)

19. Recall that it is the generality of reactions of functional groups that determine the reactions of organic compounds (separate science only)