



Unit 2 - The World of Carbon

Fuels

1. Petrol can be produced by the reforming of naphtha.
2. Reforming alters the arrangement of atoms in molecules without necessarily changing the number of carbon atoms per molecule.
3. As a result of the reforming process, petrol contains branched chain alkanes, cycloalkanes and aromatic hydrocarbons as well as straight chain alkanes.
4. Any petrol is a blend of hydrocarbons of different volatilities which takes account of prevailing temperatures.
5. In a petrol engine, the petrol-air mixture is ignited by a spark.
6. “Knocking” is caused by auto-ignition.
7. The tendency of alkanes to auto-ignite is reduced by the addition of lead compounds.
8. Unleaded petrol uses components which have a high degree of molecular branching and/or aromatics to improve the efficiency of burning.
9. Sugar cane is a renewable source of ethanol for mixing with petrol.
10. There are both advantages and disadvantages associated with the use of methanol as an alternative fuel to petrol.
11. Some biological materials, under anaerobic conditions, ferment to produce methane.
12. In the future a “hydrogen economy” could see the use of hydrogen as a means of storing and distributing energy.
13. Hydrogen could be produced by the electrolysis of water using solar energy, a renewable energy source.
14. The use of hydrogen in the internal combustion engine instead of petrol would reduce the build up of carbon dioxide in the atmosphere.

Nomenclature and Structural Formulae

1. Systematic names, full and shortened structural formulae can be used for straight and branched chain alkanes, alkenes and alkynes (C₁-C₈).
2. The functional group in an alkene is the carbon to carbon double bond.
3. The functional group in an alkyne is the carbon to carbon triple bond.
4. An alcohol can be identified from the hydroxyl functional group and the “-ol” name ending.

5. Alkanols are a homologous series of alcohols based on the corresponding parent alkane.
6. Systematic names, full and shortened structural formulae can be used for straight and branched chain alkanols (C_1 - C_8).
7. An aldehyde and a ketone can be identified from the carbonyl functional group.
8. Alkanals are a homologous series of aldehydes based on the corresponding parent alkane.
9. Alkanones are a homologous series of ketones based on the corresponding parent alkane.
10. Alkanals and alkanones can be identified from the “-al” and “-one” name endings.
11. Systematic names, full and shortened structural formulae can be used for straight and branched chain alkanals and alkanones (C_1 - C_8).
12. A carboxylic acid can be identified from the carboxyl functional group and the “-oic acid” name ending.
13. Alkanoic acids are a homologous series of carboxylic acids based on the corresponding parent alkane.
14. Systematic names, full and shortened structural formulae can be used for straight and branched chain carboxylic acids (C_1 - C_8).
15. An ester can be identified from the functional group and the “-oate” ending.
16. An ester can be named given the names of the parent alkanol and alkanoic acid or from full and shortened structural formulae.
17. Shortened and full structural formulae for esters can be drawn given the names of parent alkanol and alkanoic acid or the names of esters.
18. The products of the breakdown of an ester can be named, or shortened and full structural formulae can be drawn, given the name of the ester or the shortened or full structural formula of the ester.
19. Benzene is the simplest member of the class of aromatic hydrocarbons.
20. The benzene ring has a distinctive structural formula.
21. A benzene ring in which one hydrogen atom has been substituted by another group is known as the phenyl group.
22. The phenyl group has the formula C_6H_5 .

Reactions of carbon compounds

1. The characteristic reaction of an alkene is the addition reaction.
2. Alkenes can undergo the addition of hydrogen, hydrogen halides, halogens and water to form saturated products.
3. Ethyne can also undergo addition of hydrogen, hydrogen halides, halogens and water to form saturated products in two stages.
4. To meet market demand ethanol is made by means other than fermentation.

5. Direct catalytic hydration of alkenes is another way of making alkanols.
6. Alkanols can be converted to alkenes by dehydration.
7. The benzene ring resists addition reactions.
8. Alcohols burn in air to produce carbon dioxide and water.
9. Alcohols can be classified as primary, secondary or tertiary.
10. Primary and secondary alcohols can be oxidised by a variety of oxidising agents including copper (ii) oxide and acidified potassium dichromate solution.
11. Primary alcohols are oxidised first to aldehydes and then to carboxylic acids.
12. Secondary alcohols are oxidised to ketones.
13. Aldehydes, but not ketones, can be oxidised by a number of oxidising agents, including Benedicts' solution, to carboxylic acids.
14. When applied to carbon compounds, oxidation results in an increase in the oxygen to hydrogen ratio.
15. When applied to carbon compounds, reduction results in a decrease in the oxygen to hydrogen ratio.
16. Esters are formed by the condensation reaction between a carboxylic acid and an alcohol.
17. The ester link is formed by the reaction of a hydroxyl group with a carbonyl group
18. The parent carboxylic acid and the parent alcohol can be obtained by the hydrolysis of an ester.
19. The formation of an ester is a reversible reaction.
20. Percentage yields can be calculated from mass of reactant(s) and product(s) using balanced equations.

Uses of carbon compounds

1. There are competing demands for the use of crude oil for fuel and the manufacture of petroleum based consumer products.
2. Many consumer products are compounds of carbon.
3. Uses of esters include flavourings, perfumes and solvents.
4. Carboxylic acids are used in a variety of ways.
5. Halogenoalkanes have properties which make them useful in a variety of consumer products.
6. In the atmosphere, ozone, O₃, forms a protective layer which absorbs UV radiation from the sun.
7. The depletion of the ozone layer is believed to have been caused by the extensive use of certain CFCs.
8. Benzene and its related compounds are important as feedstocks.

9. One or more hydrogen atoms of a benzene molecule can be substituted to form a range of consumer products.

Polymers

1. Ethene is a starting material of major importance in the petrochemical industry especially for the manufacture of plastics.
2. Ethene can be formed from the cracking of ethane from the gas fraction or the naptha fraction of crude oil.
3. Propene can be formed from the cracking of propane from the gas fraction or the naptha fraction of crude oil.
4. Condensation polymers are made from monomers with 2 functional groups per molecule.
5. The repeating unit or the structure of a condensation polymer can be drawn given the monomer structures and vice-versa.
6. Polyesters are examples of condensation polymers.
7. Polyesters are manufactured for use as textile fibres and resins.
8. Polyesters used for textile fibres have a linear structure whereas cured polyester resins have a 3-dimensional structure.
9. An amine can be identified from the functional group.
10. Polyamides are examples of condensation polymers.
11. The amide link is formed by the reaction of an amine group with a carboxyl group.
12. An example of a polyamide is nylon which is a very important engineering plastic.
13. The strength of nylon is related to the hydrogen bonding between polymer chains.
14. Methanal is an important feedstock in the manufacture of thermosetting plastics.
15. Methanol, a feedstock for methanal, is made industrially from synthesis gas, a mixture of carbon monoxide and hydrogen.
16. Synthesis gas can be obtained by steam reforming of methane from natural gas or by steam reforming of coal.
17. Kevlar is an aromatic polyamide which is extremely strong because of the way in which the rigid, linear molecules are packed together.
18. Kevlar has many important uses.
19. Poly(ethenol) is a plastic which readily dissolves in water.
20. Poly(ethenol) is made from another plastic by a process known as ester exchange.
21. The percentage of acid groups which have been removed in the production process influences the strengths of the intermolecular forces upon which the solubility depends.
22. Poly(ethenol) has many important uses.

23. Poly(ethyne) can be treated to make a polymer which conducts electricity.
24. The conductivity depends on the delocalised electrons along the polymer chain.
25. Poly(ethyne) is used to make the membrane for high-performance loud speakers.
26. Poly(vinyl carbazole) is a polymer which exhibits photoconductivity and is used in photocopiers.
27. Biopol is an example of a biodegradable polymer. The structure of low density polythene can be modified during manufacture to produce a photodegradable polymer.

Natural Products

1. Natural fats and oils can be classified according to their origin as animal, vegetable or marine.
2. The lower melting points of oils compared to those of fats is related to higher unsaturation of oil molecules.
3. The low melting points of oils is a result of the effect that the shapes of the molecules have on close packing, hence on Van der Waals' forces of attraction.
4. The conversion of oils into hardened fats involves the partial removal of unsaturation by the addition of hydrogen.
5. Fats and oils in the diet supply the body with energy and are a more concentrated source of energy than carbohydrates.
6. Fats and oils are esters.
7. The hydrolysis of fats and oils produces fatty acids and glycerol in the ratio of 3 moles of fatty acid to 1 mole of glycerol.
8. Glycerol (propan-1,2,3-triol) is a trihydric alcohol.
9. Fatty acids are saturated or unsaturated straight chain carboxylic acids containing even numbers of carbon atoms ranging from C_4 to C_{24} , primarily C_{16} and C_{18} .
10. Fats and oils consist largely of mixtures of triglycerides in which the 3 fatty acid molecules which are combined with each molecule of glycerol may or may not be identical.
11. Soaps are produced by the hydrolysis of fats and oils.
12. Nitrogen is essential for protein formation by plants and animals.
13. Proteins are condensation polymers made up of many amino acid molecules linked together.
14. The structure of a section of protein is based on the constituent amino acids.
15. Condensation of amino acids produces the peptide (amide) link.
16. Proteins specific to the body's needs are built up within the body.
17. The body cannot make all the amino acids required for body proteins and is dependant on dietary protein for supply of certain amino acids known as essential amino acids.
18. During digestion, the hydrolysis of proteins produces amino acids.

19. The structural formulae of amino acids obtained from the hydrolysis of proteins can be identified from the structure of a section of the protein.
20. Proteins can be classified as fibrous or globular.
21. Fibrous proteins are long and thin and are the major structural materials of animal tissue.
22. Globular proteins have the spiral chains folded into compact units.
23. Globular proteins are involved in the maintenance and regulation of life processes and include enzymes, many hormones eg insulin and haemoglobin.
24. Enzyme function is related to the molecular shapes of proteins.
25. Denaturing of an enzyme involves physical alteration of the molecules as a result of temperature or pH change.
26. The ease with which an enzyme is denatured is related to its susceptibility to changes in temperature and pH.
27. Enzymes are most efficient within a narrow range of temperature and pH.