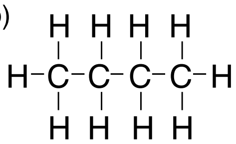
EDEXCEL INTERNATIONAL GCSE CHEMISTRY
EDEXCEL CERTIFICATE IN CHEMISTRY
ANSWERS

SECTION D

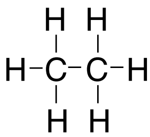
Chapter 18

1. a) (i) methane
(ii) propane
(iii) pentane
(iv) propene
(v) ethene
(vi) but-1-ene

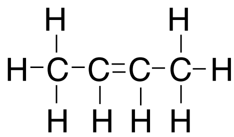
b)



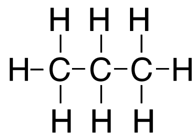
(I) butane



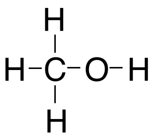
(ii) ethane



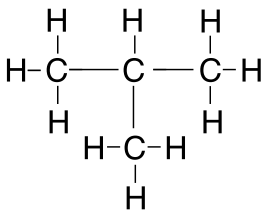
(iii) but-2-ene



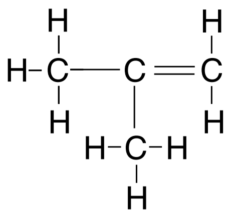
(iv) propane



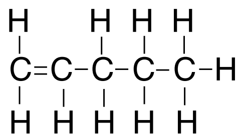
(v) methanol



(vi) 2-methylpropane



(vii) 2-methylpropene



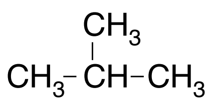
(viii) pent-1-ene

2. a) The existence of molecules with the same molecular formula but different structural formulae.

b)

$CH_3-CH_2-CH_2-CH_3$

butane



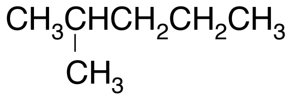
2-methylpropane

(In these and subsequent formulae, if you aren't asked specifically for displayed formulae, these quicker forms are acceptable.)

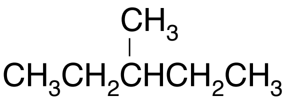
c)

$CH_3CH_2CH_2CH_2CH_2CH_3$

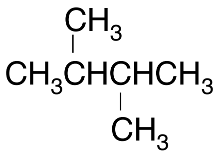
hexane



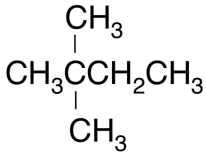
2-methylpentane



3-methylpentane



2,3-dimethylbutane



2,2-dimethylbutane

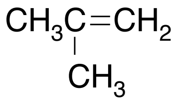
(If you are a home-schooling parent, this is going to be a bit of a nightmare to sort out. Anything else is just a twisted form of one of these. The trick is to make sure that you always draw the longest chain horizontally. Duplicates usually arise from breaking that rule.)

d) $CH_3CH_2CH{=}CH_2$

but-1-ene

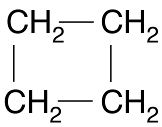
$CH_3CH{=}CHCH_3$

but-2-ene

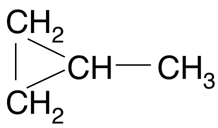


2-methylpropene

Also:



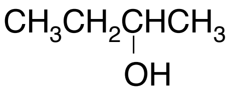
cyclobutane

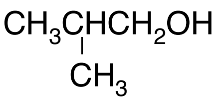


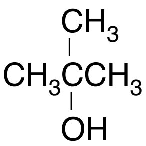
methylcyclopropane

(Few students would find these last two, particularly methylcyclopropane. Give praise if they do find them.)

3. a) (i) (done in question as an example)

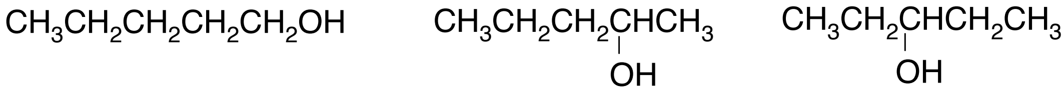
(ii) 

(iii) 

(iv) 

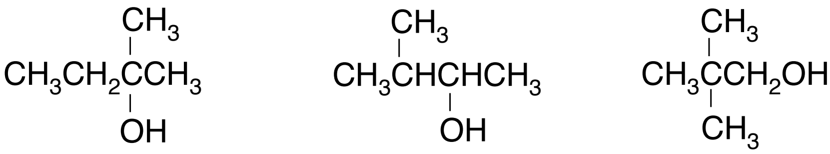
(For home schooling parents: It doesn't matter exactly how you have written the molecule as long as everything is joined up in the right way. For example, in part (iv), as long as the central carbon has 3 methyl groups and an -OH group attached, it doesn't matter about their relative orientation - N, S, E or W.)

b) There are 8 of these.



pentan-1-ol — pentan-2-ol — pentan-3-ol

2-methylbutan-1-ol — 3-methylbutan-1-ol



2-methylbutan-2-ol — 3-methylbutan-2-ol — 2,2-dimethylpropan-1-ol

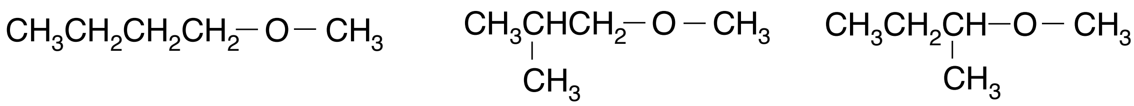
(If you are a home-schooling parent, it is important that you understand how to find all these systematically. In the top row, there are 5-carbon chains, and the -OH group is just moved along them. If you move it one more place to the left, so that it is on the next-to-the-end carbon, that is the same as the second structure, flipped over.

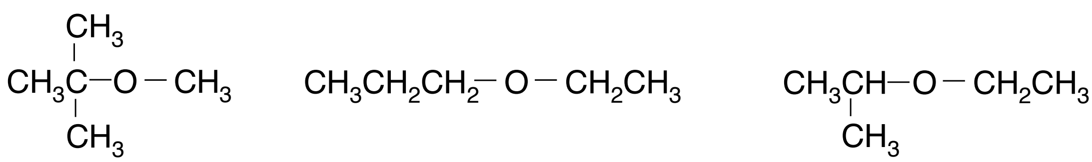
In the second row, there are 4-carbon chains, with an -OH on the end, and the methyl group moved along the chain. It can't be on the same carbon as the -OH group, because the longest chain would then have 5 carbons, and it would be the same as the middle structure in the top row, just bent a bit.

In the bottom row, the first two are 4-carbon chains with an -OH on the second carbon, and the methyl group moved around. The last structure is the only one with a 3-carbon chain as the longest chain.

As far as naming is concerned, there are some cases where the chain could perhaps be numbered from either end. The rule is to keep the numbers as small as possible - particularly, in these compounds, the numbering of the -OH group. This is way beyond GCSE!)

c) (For home-schooling parents: This next sequence involves oxygen atoms joined to two different carbon atoms, rather than a carbon atom and a hydrogen atom as in the previous structures. These compounds are known as ethers.)





This isn't easy stuff! Anyone who gets more than a couple of them deserves a lot of credit.

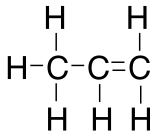
Chapter 19

1. a) Contains as many hydrogen atoms as possible for the given number of carbons. Only carbon-carbon single bonds.

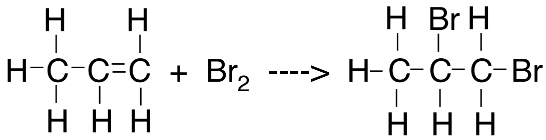
   b) (i) $C_{11}H_{24}$
   (ii) liquid
   (iii) $C_{11}H_{24}(l) + 17O_2(g) \longrightarrow 11CO_2(g) + 12H_2O(l)$

2. a) a carbon-carbon double bond

   b)



   c)



   (Home schooling parents: It doesn't matter what position you draw the bromine in on the right-hand carbon - N, S or E (with hydrogens in the other two positions). All that matters is that one bromine becomes attached to each of the carbons either side of the original double bond.)

   d) (i) $CH_4(g) + Br_2(g) \longrightarrow CH_3Br(g) + HBr(g)$

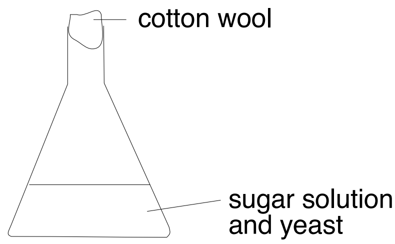
   (ii) In this (substitution) reaction, one of the hydrogens has been replaced by a bromine during the reaction. In the previous (addition) reaction, nothing was lost when the two molecules combined together.

3. a) Ethene is passed with steam at 300°C and 60 - 70 atmospheres over a phosphoric acid catalyst.

   b) e.g. two of: continuous flow process, therefore faster; rapid reaction; purer product.

   c) uses renewal resources; gentle conditions.

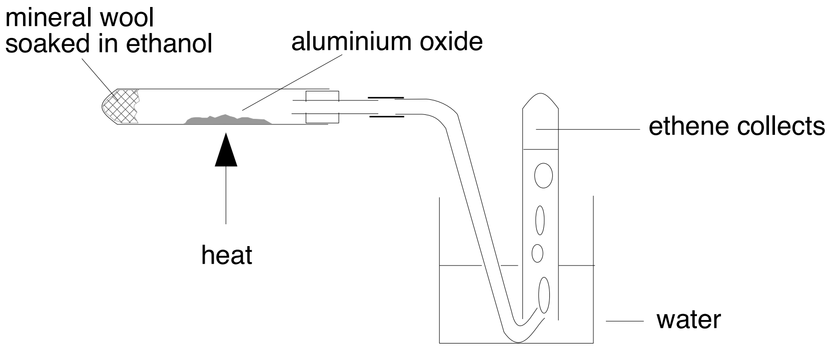
4. Dissolve the sugar in water in a conical flask (or similar) and add yeast. You now need some means of keeping the air out while allowing carbon dioxide to escape. You could use a commercial home-winemaking airlock of some sort, but a plug of cotton wool works just as well. Leave the mixture in the warm for a few days until bubbling stops.



   Allow the yeast to settle, and pour off the solution so that it can be fractionally distilled, collecting the fraction which boils at 78°C. (See the diagram for the fractional distillation of an alcohol/water mixture in Chapter 11 of the book.)

   continued . . .

Finally, pass ethanol vapour over hot aluminium oxide using the apparatus on the right, and collect several tubes of ethene.



5. A Google search on *biofuels disadvantages* will produce lots of useful information. Some of the points you will find include:

   Increases in food prices:

   Crops such as maize (US: corn) used to produce ethanol can't at the same time be used for human consumption. If the supply of these crops going for food falls, but demand stays the same (or, more likely, increases due to increasing population), prices are bound to rise.

   Subsidies going to biofuel crops (whether they are food crops or not) cause farmers to divert land away from food production. Again food supply falls, and so prices rise.

   Carbon dioxide balance:

   Some biofuel crops are being grown on previously undisturbed land, including rain forests. Cutting down and burning rain forests to make space for biofuel crops adds lots of carbon dioxide to the atmosphere. Forests are also much more efficient at removing carbon dioxide from the atmosphere than crops are.

   (There are several other disadvantages of current biofuels, but they don't directly address the question.)

Chapter 20

1. petroleum gases, gasoline, kerosine, diesel oil (gas oil), fuel oil, bitumen. Use for each (see text)

2. a) Compound of carbon and hydrogen only.

   b) $C_7H_{16}(l) + 11O_2(g) \text{ ----> } 7CO_2(g) + 8H_2O(l)$

   c) (i) turns to vapour easily / at a low temperature
   (ii) C_8H_{18}. Smaller molecules aren't as strongly attracted to their neighbours as bigger ones (weaker intermolecular attractions). It takes less energy to separate them and so they vaporise at lower temperatures.

   d) Incomplete combustion leads to formation of carbon monoxide which is very poisonous. It combines with haemoglobin preventing transport of oxygen around the blood.

3. a) Crude oil produces too many larger hydrocarbons / not enough of the desirable smaller ones. Cracking introduces C=C double bonds which are more reactive and therefore more useful.

   b) Heat the vaporised fraction in the presence of a silicon dioxide + aluminium oxide catalyst at high temperature. (I quote 600 - 700°C in the book, but in an exam, “high temperature” would almost certainly be acceptable.)

   c) $C_{11}H_{24} \text{ ----> } 2C_2H_4 + C_7H_{16}$

   d) Any other valid cracking equation starting with $C_{11}H_{24}$. For example:

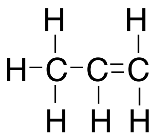
   $C_{11}H_{24} \text{ ----> } C_2H_4 + C_9H_{20}$
   or $C_{11}H_{24} \text{ ----> } C_2H_4 + C_3H_6 + C_6H_{14}$
   or lots of other variants. In each case, at least one hydrocarbon should be an alkane (C_nH_{2n+2}), and at least one an alkene (C_nH_{2n}).

4. This is entirely open to the student’s imagination and ability to think both logically and laterally. It is impossible to suggest "right" answers.

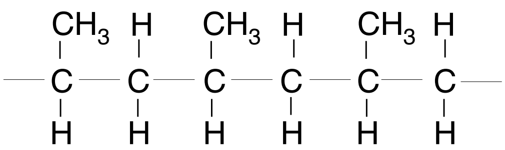
Chapter 21

1. a) Joining up of lots of little molecules (the monomers) to make one big one (a polymer).

   b)



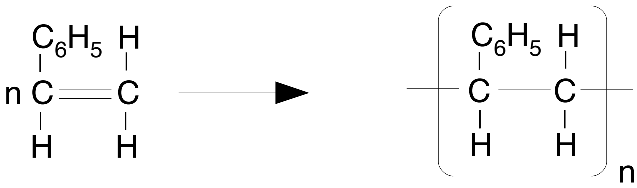
   c)



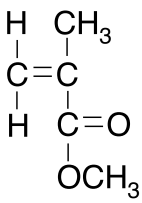
(The “continuation” bonds at each end are an important part of this structure. Marks will be lost in an exam if they are omitted.)

   d) Joining two or more molecules together without anything being lost in the process.

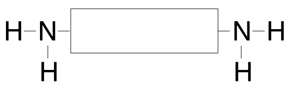
   e)



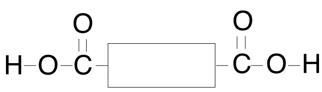
   f) Drawing the molecule to show its relationship with the structure of the polymer as drawn in the question:



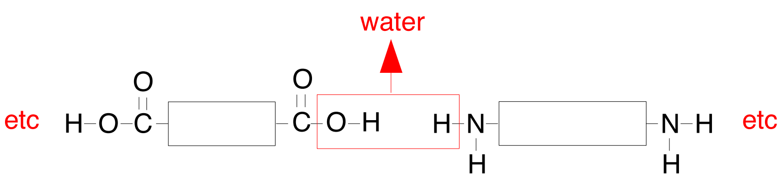
2. a) Drawing 1,6-diaminohexane as



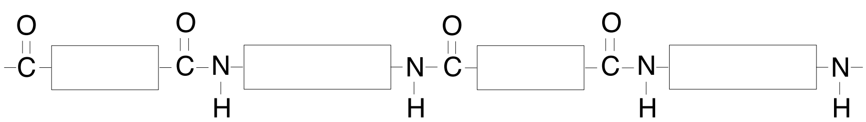
   and hexandioic acid as



   (i) In a condensation reaction, when two molecules join together a small molecule is lost in the process. When the two molecules above join together, a molecule of water is lost every time they come together. In a condensation polymerisation reaction, this happens repeatedly.



   (ii)



   The “continuation” bonds at each end of the structure *must* be included.

b) (i) There will be four more CH_2 groups in the "box" in the part of the diagram which comes from the dioic acid. This time, the box from the dioic acid will be longer than the one from the diamine.

(ii) The bonding between the two monomers will be identical, as will the size of the diamine.

3.

$$-O-\overset{\overset{O}{||}}{C}-C_6H_4-\overset{\overset{O}{||}}{C}-O-CH_2CH_2-O-\overset{\overset{O}{||}}{C}-C_6H_4-\overset{\overset{O}{||}}{C}-O-CH_2CH_2-O-\overset{\overset{O}{||}}{C}-C_6H_4-\overset{\overset{O}{||}}{C}-O-CH_2CH_2-$$

(For home-schooling parents: Work this out by drawing the structures of the two monomers, as shown in the question, alternately in a row. Then remove water from -OH groups which find themselves next door to each other, and join up what is left.)

End of Section D Questions

1. a) Compound (1) of carbon and hydrogen only (1).

   b) The higher the number of carbons, the higher the boiling point (1).

   c) fractional distillation (1)

   d) any valid use (see text; “as a fuel” isn’t sufficient) (1)

   e) $C_{10}H_{22}$ (1)

   f) $C_{15}H_{32}(l) + 23O_2(g) \longrightarrow 15CO_2(g) + 16H_2O(l)$ (2 marks - deduct 1 for incorrect state symbol for the alkane)

   g) Pass through lime water (1). Turns milky (or alternative) (1).

   h) Incomplete combustion (1) produces carbon monoxide (1). Poisonous (1). Combines with haemoglobin preventing oxygen transport in blood (1).

2. a) Saturated: all carbon-carbon bonds are single (1). Unsaturated: contains at least one C=C bond (1).

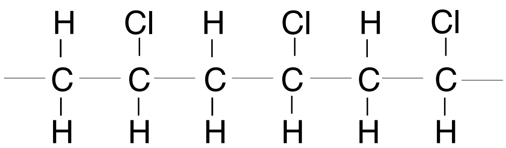
   b) cracking (1)

   c) (i) $C_{17}H_{36} \longrightarrow 2C_2H_4 + C_3H_6 + C_{10}H_{22}$ (2 marks - allow one for $C_{10}H_{22}$ even if equation is unbalanced. Ignore state symbols, even if they are wrong.)
   (ii) alkane (1)

   d) Pass through (or shake with) bromine water (1). Decolourisation (1) shows the presence of C=C.

3. a) Joining up lots of small molecules (1) to make a large molecule (1).

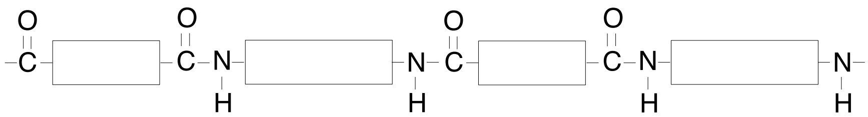
   b)



   (2 marks - must include “continuation” bonds for full marks)

   c) A reaction in which a small molecule is lost when two others join together. (1)

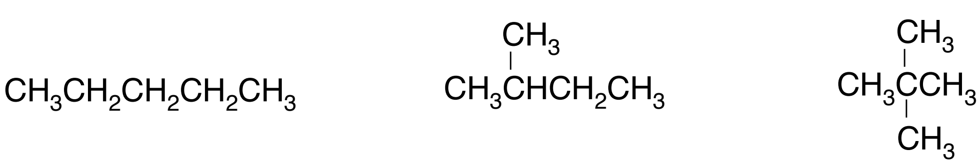
   d)



   (3 marks: alternating different sized or shaped blocks (1). CO and NH groups attached to the correct blocks - i.e. 2 x CO groups on one block, and 2 x NH groups on the other - and bonded correctly (1). “Continuation bonds” at either end of the chain (1).)

4. a) Molecules with the same molecular formula (1) but different structural formulae (1).

   b)



   (1 mark per structure)

   c) pentane (1)

5. a) Sugar (1) solution (1) plus yeast (1). Leave in warm place for several days (1). Some means of allowing CO_2 to escape without allowing air in (1).

   b) Water: 100°C (1); ethanol: 78°C (1)

   c) $CH_2{=}CH_2(g) + H_2O(g)$ ----> $CH_3CH_2OH(g)$ (1) (Don't penalise incorrect state symbols.)

   d) 2 of: 300°C. 60 - 70 atm. Phosphoric acid catalyst. (2 x 1 = 2)

   e) (i) fermentation (1). Renewable (1)
   (ii) fermentation (1). Gentle conditions (1)
   (iii) hydration (1). Fermentation is a batch process (1)