Pearson Edexcel

Additional Assessment Materials Summer 2021

Pearson Edexcel GCSE in Chemistry (1CH0) Higher

Resource Set Topic O: Hydrocarbons, polymers, alcohols and carboxylic acids

Questions

(Public release version)

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Additional Assessment Materials, Summer 2021

General guidance to Additional Assessment Materials for use in 2021

Context

- Additional Assessment Materials are being produced for GCSE, AS and A levels (with the exception of Art and Design).
- The Additional Assessment Materials presented in this booklet are an **optional** part of the range of evidence teachers may use when deciding on a candidate's grade.
- 2021 Additional Assessment Materials have been drawn from previous examination materials, namely past papers.
- Additional Assessment Materials have come from past papers both published (those materials available publicly) and unpublished (those currently under padlock to our centres) presented in a different format to allow teachers to adapt them for use with candidate.

Purpose

- The purpose of this resource to provide qualification-specific sets/groups of questions covering the knowledge, skills and understanding relevant to this Pearson qualification.
- This document should be used in conjunction with the mapping guidance which will map content and/or skills covered within each set of questions.
- These materials are only intended to support the summer 2021 series.

4 Ethanol can be used as a liquid fuel.

A student investigates how much heat energy is released when a known mass of ethanol is burned.

The apparatus is set up as shown in Figure 3.

A known volume of water is placed in a metal can.
The temperature of the water is measured.
The ethanol is ignited and placed under the beaker so that the flame is touching the beaker.
The water is heated by the flame.
The flame is extinguished.
The final temperature of the water is measured.

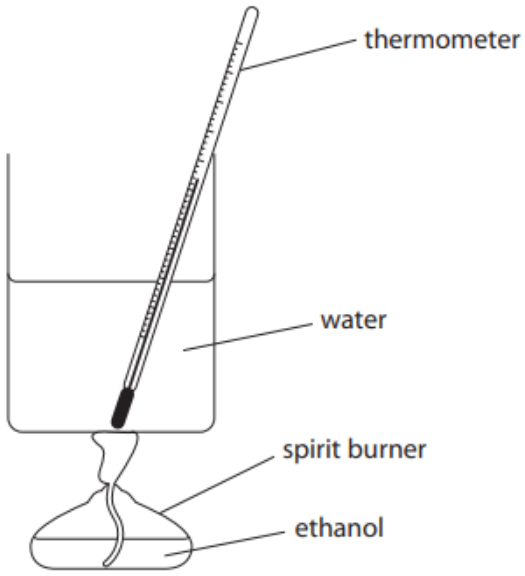


Figure 3

(a) The theoretical temperature rise for burning a given mass of ethanol is 82.4 °C.

In the experiment the actual temperature rise for burning this mass of ethanol was only 34.8 °C.
One reason why the temperature rise is less than expected is that the ethanol does not burn completely.

(i) Give a reason why, even if the ethanol burns completely, the actual temperature rise is much less than the theoretical value.

(1)

some heat is lost to the surroundings

(ii) Explain how the method described above could be improved to give a temperature rise closer to the theoretical value.

(2)

Cover the beaker with a lid to reduce heat lost to the environment

(iii) The amount of heat energy used to raise the temperature of the water by 34.8 °C can be calculated using

heat energy = 210 × temperature rise

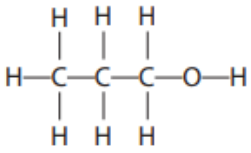
Calculate the amount of heat energy used.

(2)

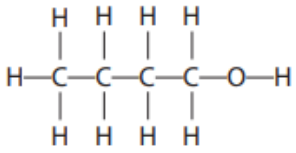
210 x 34.8 = 175.2

heat energy = 175.2 (energy units)

(b) Propanol and butanol are both members of the same homologous series as ethanol.



propanol



butanol

Propanol and butanol can also be burned in the apparatus shown in Figure 3.

Give **three** reasons why ethanol, propanol and butanol are members of the same homologous series.

(3)

reason 1 they have the same functional group

reason 2 same general formula, $C_nH_{2n+2}O$

reason 3 similar chemical properties

(c) Ethanol can oxidise when exposed to air to produce ethanoic acid and water. Propanol can also oxidise in a similar reaction when it is exposed to air.

(i) Write the word equation for the reaction when **propanol** oxidises when it is exposed to air.

(2)

propanol + [O] → propanoic acid + water

(ii) What is the formula of the functional group in carboxylic acids?

(1)

- ☒ **A** –OH
- ☒ **B** $-CH_3$
- ☒ **C** –COOH
- ☒ **D** $-CO_2$

5

(b) Poly(propene) is an example of a polymer.

The structure of a poly(propene) molecule is shown in Figure 5.

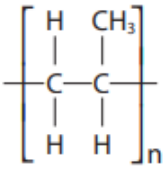
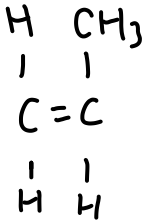


Figure 5

This polymer is made from a monomer.

Draw the structure of the monomer molecule showing all covalent bonds.

(2)



5

(c) A layer of poly(chloroethene) (PVC) is used to surround the copper in electrical cables.

Explain why poly(chloroethene) is a suitable material for this purpose.

(2)

it is an electrical insulator and can be made flexible so can be shaped to surround the copper

(d) Some polymers are polyesters.

What type of reaction takes place when polyesters are formed?

(1)

- ☒ **A** addition
- ☒ **B** condensation
- ☒ **C** neutralisation
- ☒ **D** precipitation

5

(e) The repeating unit in a polyester molecule is shown in Figure 6.

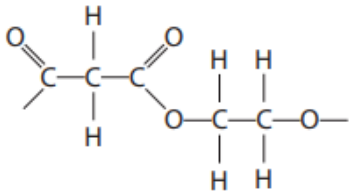
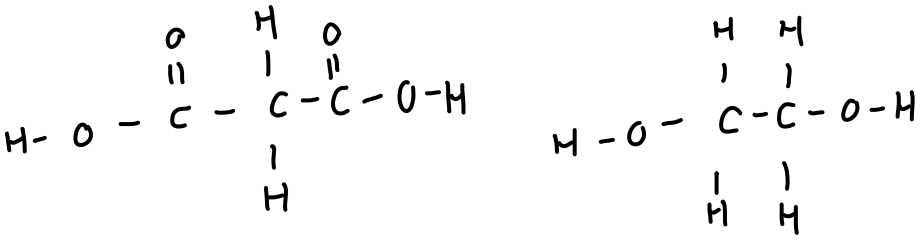


Figure 6

(i) This polymer is made from two different monomers.

Draw a molecule of each monomer showing all covalent bonds.

(2)



(ii) Give the name or formula of the small molecule formed when the monomer molecules react to form an ester link.

(1)

water / H_2O

10

*(b) A student is provided with unlabelled samples of three liquids.
The three liquids are known to be
hexane, C_6H_{14}, a liquid alkane
hexene, C_6H_{12}, a liquid alkene
butanoic acid, $C_4H_8O_2$, a carboxylic acid, in aqueous solution

Aqueous solutions of carboxylic acids contain hydrogen ions and undergo reactions typical of acids with indicators and carbonates.

Describe, in detail, using the information given and your knowledge of the reactions of these liquids, tests the student should carry out to identify each of the three liquids.

You should include balanced equations for any chemical reactions described.

(6)

1. Add bromine water to each of the sample. The sample containing C_6H_{12} will decolourise bromine water.

reaction: $C_6H_{12} + Br_2 \rightarrow C_6H_{10}Br_2$

2. add universal indicator to the samples. The sample containing carboxylic acid will turn universal indicator yellow.

The sample which gives a negative result for both tests is hexane.

4 (a) Ethanol is made by fermentation of a carbohydrate dissolved in water, in the presence of yeast.

The reaction is carried out at 30 °C.

Explain why the reaction is carried out at a temperature of 30 °C rather than at a temperature of 80 °C.

(2)

Yeast will be killed by the high temperature and fermentation cannot take place without the yeast.

(b) Ethanol, C_2H_5OH, can be converted into ethanoic acid, CH_3COOH.

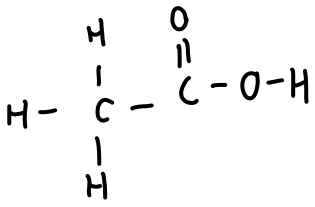
(i) In this reaction ethanol is

(1)

- ☒ **A** hydrated
- ☒ **B** oxidised
- ☒ **C** polymerised
- ☒ **D** reduced

(ii) Draw the structure of a molecule of ethanoic acid, CH_3COOH, showing all covalent bonds.

(2)



(c) (i) The apparatus in Figure 3 can be used to investigate the temperature rise produced in a known mass of water when a sample of ethanol is burned.

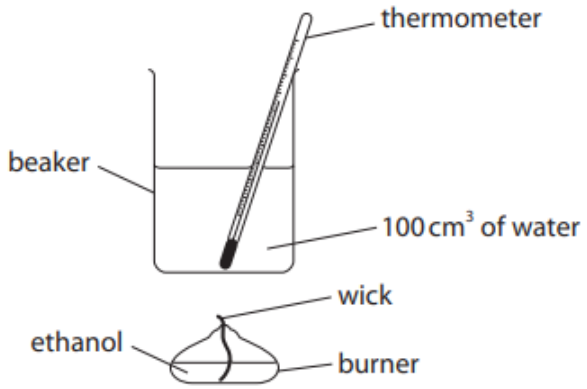


Figure 3

The first steps of the method are

1. put 100 cm^3 of water into a beaker
2. determine the mass of the burner containing ethanol
3. measure the initial temperature of the water
4. place the burner under the beaker of water
5. light the wick

Describe the remaining steps of the method that are needed to determine the mass of ethanol required to raise the temperature of the water by 30 °C.

(3)

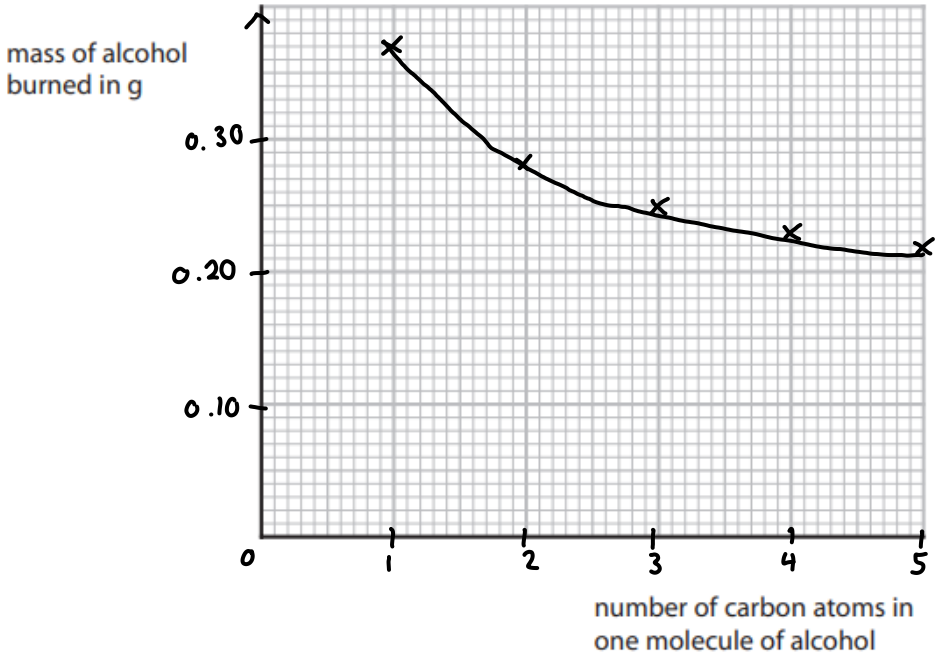
When the temperature has rised by 30°C , extinguish the flame. Determine the mass of the burner containing the remaining ethanol. Deduct the final mass from the initial mass.

(ii) In a different experiment, separate samples of the alcohols methanol, ethanol, propanol, butanol and pentanol were burned to determine the mass of each alcohol that needs to be burned to raise the temperature of 100 cm^3 water by 10 °C.

alcohol	number of carbon atoms in one molecule of alcohol	mass of alcohol burned in g
methanol	1	0.37
ethanol	2	0.28
propanol	3	0.25
butanol	4	0.23
pentanol	5	0.22

Draw a graph of the mass of each alcohol required to raise the temperature of 100 cm^3 of water by 10 °C against the number of carbon atoms in one molecule of that alcohol.

(3)



7 Ethene, C_2H_4, is an unsaturated hydrocarbon.

(a) Explain why ethene is an **unsaturated hydrocarbon**.

(2)

Ethene only contains hydrogen and carbon so it is a hydrocarbon, there is a double bond so it is unsaturated.

(b) A sample of ethene is burned completely in oxygen.

Write the balanced equation for this reaction.

(3)

$C_2H_4 + 3O_2 \rightarrow 2CO_2 + 2H_2O$

(c) Ethene can be polymerised to form poly(ethene).

Describe what you would **see** when a sample of ethene and a sample of poly(ethene) are shaken with separate, small volumes of bromine water.

(3)

Bromine water decolourise when added to ethene but not with polyethene.

(d) A different hydrocarbon has a relative formula mass of 84.
It has an empirical formula of CH_2.

Deduce the molecular formula of this hydrocarbon.

You must show your working.

(relative atomic masses : H=1, C=12)

(3)

$(12+2)n = 84$

$n = 6$

molecular formula : C_6H_{12}

molecular formula = C_6H_{12}

4 Figure 2 shows the structure of a molecule of dichloroethene.

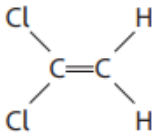


Figure 2

(a) (i) Describe how dichloroethene monomers form a polymer.

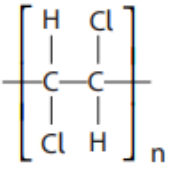
(2)

The C=C double bond breaks and each carbon atom forms a single bond with neighbouring carbons.

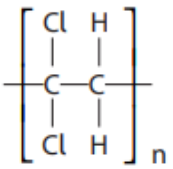
(ii) Which of these represents the structure of the polymer formed from the monomer in Figure 2?

(1)

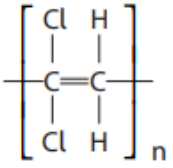
☒ **A**



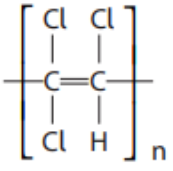
☒ **B**



☒ **C**



☒ **D**



(iii) Separate samples of dichloroethene and poly(dichloroethene) are shaken with a few drops of bromine water.

What would be **seen**?

(1)

☒ **A** both mixtures remain orange

☒ **B** only the dichloroethene and bromine water goes colourless

☒ **C** only the poly(dichloroethene) and bromine water goes colourless

☒ **D** both mixtures go colourless

(b) Dichloroethene is produced from ethene and chlorine.

In the overall reaction, ethene reacts with chlorine and forms dichloroethene and hydrogen chloride.

Complete the balanced equation for the overall reaction.

(2)

$$C_2H_4 + 2Cl_2 \rightarrow C_2H_2Cl_2 + 2HCl$$

(c) Poly(dichloroethene) was used to wrap food to keep it fresh.

Explain **one** property that a plastic food wrapping must have.

(2)

Flexible so it can be shaped to wrap around the food.

(d) An industrial process uses 500 tonnes of dichloroethene.
In the process only 96.5% of the dichloroethene molecules react.

Calculate the mass of dichloroethene that has **not** reacted.

Give your answer to two significant figures.

(3)

$\frac{(100 - 96.5)}{100} \times 500 = 17.5$

mass = 17.5 tonnes

5 (a) Figure 3 shows the structure of two monomers.

monomer A	monomer B
HO—CH_2—CH_2—OH	HOOC—CH_2—CH_2—COOH

Figure 3

(i) Monomer **B** contains a carboxylic acid group.

Describe what you would **see** when a small amount of solid sodium carbonate is added to a solution of monomer **B**.

(2)

The solid disappears and bubbles of gases are observed.

(ii) When monomer **A** and monomer **B** react together they polymerise to form a polymer and one other product.

Name the type of polymerisation that takes place and name the other product.

(2)

type of polymerisation condensation

name of other product ester

(iii) A naturally occurring polymer is made by combining monomers called nucleotides.

Give the name of this natural polymer.

(1)

DNA

(b) Some polymerisation reactions produce ammonia as a waste product.

A student is given a sample of pure, dry ammonia gas.

The student suggests the following method to test for ammonia gas.

step 1 take some dry, blue litmus paper

step 2 place the dry litmus paper into the dry gas

step 3 observe any change in colour of the litmus paper

This test for ammonia will not work.

Give **two** changes that should be made to this test for it to work.

(2)

change 1 dampen the litmus paper

change 2 use red litmus paper

(c) Alcohols can be dehydrated.

Complete the balanced equation for the dehydration of butan-1-ol by drawing the structures of the two products in the boxes. Name the two products.

(3)

$CH_3—CH_2—CH_2—CH_2—OH \rightarrow$ [$CH_3-CH_2-CH=CH_2$] + [H-O-H]

butan-1-ol → but-1-ene + water

10 (a) Figure 10 shows a flask fitted with a cotton wool plug.
The flask contains an aqueous solution of a carbohydrate.

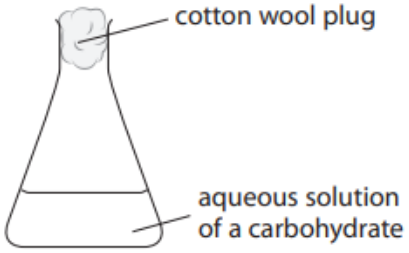


Figure 10

(i) State **two** steps that need to be taken to turn the solution of the carbohydrate in the flask into a solution of ethanol.

(2)

1 add enzymes to break down carbohydrate to glucose

2 add yeast for fermentation

(ii) The apparatus in Figure 11 is used to increase the concentration of the dilute solution of ethanol.

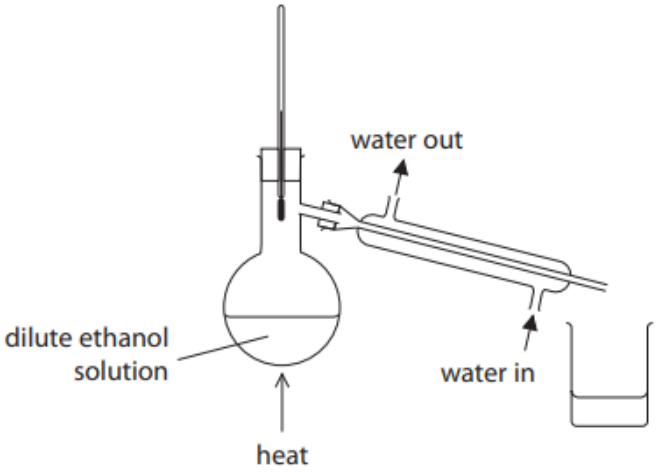


Figure 11

This apparatus did not produce a very concentrated solution of ethanol.

Describe how the apparatus can be altered to produce a more concentrated solution of ethanol.

(2)

water and ethanol has different boiling points so they can be separated by fractional distillation. Ethanol will vapourise and condense into the beaker.

*(c) Figure 12 shows information about some compounds in the same homologous series.

name	structural formula	formula mass	density in g cm^{-3}	boiling point in °C	does it react with an alcohol?	does it react with sodium hydroxide solution?
butanoic acid	$CH_3CH_2CH_2COOH$	88	0.96	164	yes	yes
ethanoic acid	CH_3COOH	60	1.05	118	yes	yes
hexanoic acid	$CH_3CH_2CH_2CH_2CH_2COOH$	116	0.93	205	yes	yes
pentanoic acid	$CH_3CH_2CH_2CH_2COOH$	102	0.94	186	yes	yes
propanoic acid	CH_3CH_2COOH	74	0.99	141	yes	yes

Figure 12

Explain, using the data in Figure 12, why these compounds belong together in the same homologous series.

(6)

They have the same functional group, -COOH and the same general formula $C_nH_{2n}O_2$. The formula mass increase by 14 for each subsequent compound of the homologous series. Density decreases as length of carbon chain increases. They all have high boiling point which increases with the length of carbon chain. They have similar chemical properties as they react with both alcohol and sodium hydroxide solution.

TOTAL FOR PAPER IS 78 MARKS