

GENERAL CERTIFICATE OF SECONDARY EDUCATION
TWENTY FIRST CENTURY SCIENCE
CHEMISTRY A

Unit 3: Ideas in Context plus C7
 (Higher Tier)

A323/02



Candidates answer on the question paper
 A calculator may be used for this paper

OCR Supplied Materials:

- Insert (inserted)

Other Materials Required:

- Pencil
- Ruler (cm/mm)

Thursday 4 June 2009
Morning

Duration: 60 minutes



A 3 2 3 0 2 *

Candidate Forename						Candidate Surname					
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Centre Number						Candidate Number					
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MODIFIED LANGUAGE

INSTRUCTIONS TO CANDIDATES

- Write your name clearly in capital letters, your Centre Number and Candidate Number in the boxes above.
- Use black ink. Pencil may be used for graphs and diagrams only.
- Read each question carefully and make sure that you know what you have to do before starting your answer.
- Answer **all** the questions.
- Do **not** write in the bar codes.
- Write your answer to each question in the space provided, however additional paper may be used if necessary.

INFORMATION FOR CANDIDATES

- The number of marks is given in brackets [] at the end of each question or part question.
- The total number of marks for this paper is **55**.
-  Where you see this icon you will be awarded a mark for the quality of written communication in your answer.
- The Periodic Table is printed on the back page.
- This document consists of **16** pages. Any blank pages are indicated.

Answer **all** the questions.

1 This question is based on the article 'The bioethanol dilemma'.

(a) Burning bioethanol gives a 70% carbon dioxide reduction compared to petrol.

However, some scientists think that the overall effect of using bioethanol instead of petrol would reduce total carbon dioxide emissions by only about 13%.

Use information from the article to explain why a figure of 13% for overall reduction in carbon dioxide emissions may be more realistic than 70%.

.....
.....
.....
.....

[2]

(b) It is technically feasible to produce enough bioethanol from crops grown in the UK to satisfy all of our transport needs.

Suggest **two** disadvantages of this.

.....
.....
.....

[2]

(c) It is reasonable to suggest that enough bioethanol can be made from UK crops to use as a 5% blend with petrol.

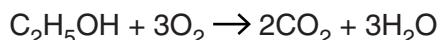
It is less reasonable to suggest that developing countries in Africa should do the same.

Explain why.

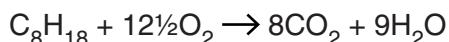
.....
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.....

[2]

(d) The combustion of bioethanol can be represented by this equation.



Octane, C_8H_{18} , is one of the hydrocarbons in petrol. The combustion of octane can be represented by this equation.



Burning 1.0 g of bioethanol produces 1.9 g of carbon dioxide.

Burning octane produces about 60% more carbon dioxide than the same mass of bioethanol.

Show that this is true by calculating the mass of carbon dioxide produced when 1.0 g of octane burns, and the percentage increase in carbon dioxide produced compared to bioethanol.

(relative atomic masses: C = 12, H = 1, O = 16)

mass of carbon dioxide = g

percentage increase = [3]

(e) (i) List **two** factors mentioned in the article that are involved in the Life Cycle Assessment for bioethanol that do not apply to petrol.

1

2

[2]

(ii) Explain how bioethanol may be a more sustainable fuel than petrol.

.....
.....
.....
.....
.....

[2]

[Total: 13]

2 Methanoic acid, HCOOH, is a carboxylic acid that is released in bee stings.

(a) What is the formula of the functional group that is responsible for the characteristic properties of carboxylic acids?

..... [1]

(b) Methanoic acid is used to remove the limescale that can build up in kettles.
Limescale is made of calcium carbonate, which is insoluble in water.

Carboxylic acids react with carbonates in a similar way to other acids, such as hydrochloric acid.

calcium carbonate + hydrochloric acid \rightarrow calcium chloride + carbon dioxide + water



(i) Complete and balance this symbol equation for the reaction between calcium carbonate and methanoic acid.

..... + \rightarrow Ca(HCOO)₂ + + [2]

(ii) Suggest a property of Ca(HCOO)₂ (calcium methanoate) that explains how this reaction removes limescale.

.....
..... [1]

(iii) Hydrochloric acid is not used to remove limescale from kettles because it is a strong acid.

Methanoic acid is used to remove limescale from kettles because it is a weak acid.

Explain the difference between a strong acid and a weak acid in terms of dynamic equilibrium.



One mark is for correct spelling.

.....
.....
.....
.....
..... [3+1]

5

(c) Butanoic acid, $C_4H_8O_2$, is responsible for the unpleasant taste in butter that is 'going off'.

Draw a diagram to show the structural formula for butanoic acid.

[1]

[Total: 9]

3 Vegetable oils are commonly used in cooking. Examples are rape seed oil and sunflower seed oil.



(a) (i) When an ester is hydrolysed it forms an alcohol and a carboxylic acid. This reaction is the reverse of that used to make the ester.

Oils and fats are esters. Write the **name** of the alcohol and of the **type** of carboxylic acid to complete this word equation for the hydrolysis of an oil.



(ii) What **two** things does the \rightleftharpoons sign tell you about this reaction?

.....
.....
..... [2]

(b) An ester can be made by reacting an alcohol with a carboxylic acid. The technique used involves four stages: **reflux**, **distillation**, **purification** and **drying**.

In the **reflux** stage the alcohol and ester are heated with a little concentrated sulfuric acid in a flask with a condenser attached. The condenser prevents evaporation of the mixture.

In the **distillation** stage the mixture is heated, and the product collected at its boiling point. This separates the product from most of the impurities.

Describe and explain the other two stages.

purification
.....

drying
..... [4]

[Total: 8]

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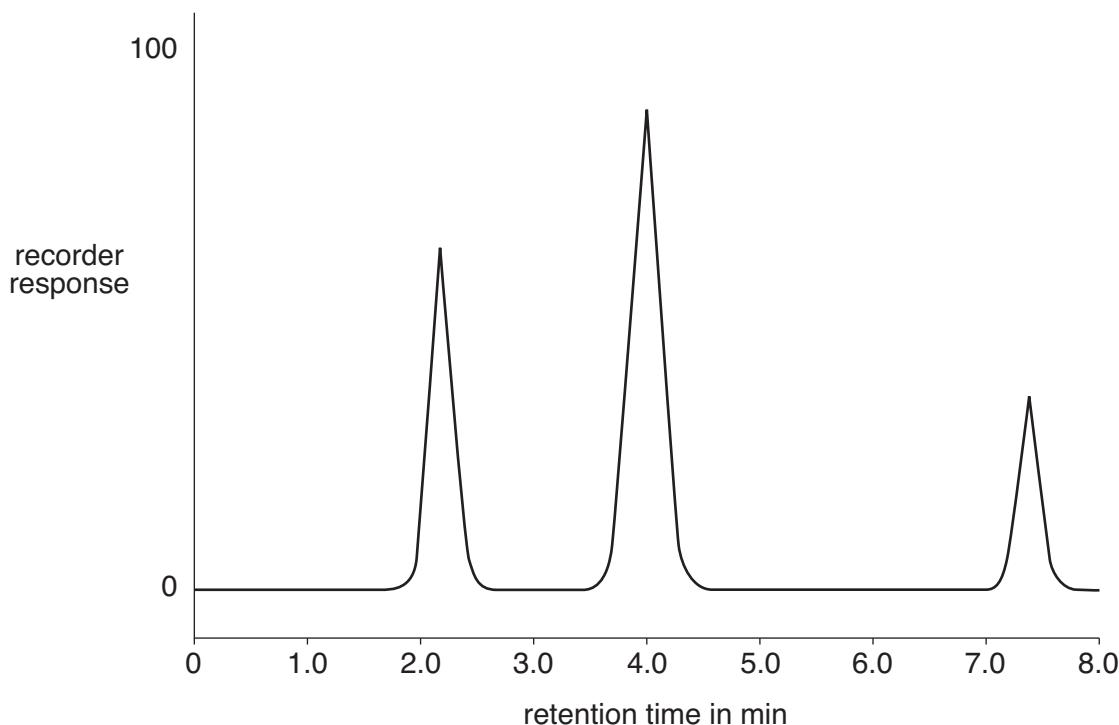
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4 A technician uses gas chromatography to analyse a mixture of hydrocarbons.

She first calibrates the equipment using standard hydrocarbons. The retention times for these hydrocarbons are shown in the table.

hydrocarbon	retention time in min
methane	1.7
ethane	2.2
propane	3.5
propene	4.0
butane	7.4

The technician then analyses the mixture of hydrocarbons. The recorder print-out from this analysis is shown below.



(a) The mixture contained ethane, propene and butane

(i) Name the hydrocarbon that has the highest concentration in the mixture.

..... [1]

(ii) Explain how the recorder print-out shows that this gas has the highest concentration.

.....

..... [1]

(b) Explain how this gas chromatography separated the components of the mixture.

Use ideas about the following in your answer:

- stationary phase
- mobile phase
- dynamic equilibrium.

.....
.....
.....
.....
.....
.....
.....

[4]

(c) Two of the hydrocarbons in the mixture are alkanes.

Alkanes burn but they do not react with solutions of other chemicals, for example bromine water.

(i) Explain why alkanes do not react with bromine water.

Use ideas about the bonds in alkanes in your answer.

.....
.....
.....

[2]

(ii) The burning of alkanes gives out energy.

Use ideas about bond making and breaking to explain why.

.....
.....
.....

[2]

[Total: 10]

10

5 Some indigestion tablets contain the active ingredient, magnesium hydroxide. This neutralises excess stomach acid to relieve the symptoms of acid indigestion. The tablets also contain starch.

A chemist uses quantitative analysis to find the mass of active ingredient in each tablet. He makes a suspension of each of five tablets and titrates these with a solution containing hydrochloric acid. The concentration of this acid is 40.0 g/dm³.

His results are shown in the table.

tablet number	1	2	3	4	5	average
volume of hydrochloric acid in cm ³	23.6	23.5	23.4	23.5	23.5	23.5

(a) Use the average of his results to work out the average mass of magnesium hydroxide in each tablet in the following way.

(i) The relative formula mass of hydrochloric acid is 36.5.

Work out the relative formula mass (RFM) of magnesium hydroxide, Mg(OH)₂.

You should show your working.

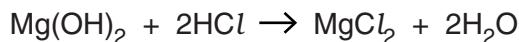
(relative atomic masses: H = 1, Mg = 24, O = 16)

relative formula mass (RFM) of magnesium hydroxide = [2]

(ii) Work out the mass of hydrochloric acid in 23.5 cm³ of the hydrochloric acid solution used in the titrations.

mass of hydrochloric acid = g [1]

(iii) Use the neutralization equation below to work out the mass of magnesium hydroxide that reacts with this mass of hydrochloric acid.



This is the average mass of magnesium hydroxide in each tablet.

mass of magnesium hydroxide in each tablet = g [2]

(b) Use the table of titration results to assess the degree of uncertainty in your calculated value of the mass of magnesium hydroxide in each tablet.

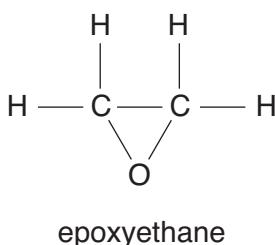
Explain your answer.

.....
.....
.....

[Total: 7]

12

6 Epoxyethane, $(\text{CH}_2)_2\text{O}$, is an intermediate in the production of car anti-freeze, and is used to sterilize medical supplies.



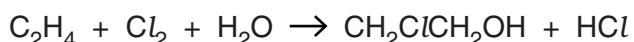
Epoxyethane is poisonous, carcinogenic and highly flammable.

Ethene is the raw material used to make epoxyethane. Ethene is obtained by the cracking of hydrocarbons from petroleum.

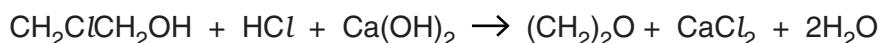
Two different methods have been used to make epoxyethane.

In the original method epoxyethane was manufactured in a two stage process.

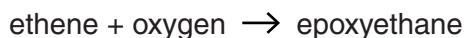
- 1 Ethene was passed into an aqueous solution of chlorine.



- 2 The reaction mixture was treated with calcium hydroxide.



The modern method involves only one step. Ethene and oxygen are passed over a silver catalyst at 250-350 °C.



(a) Compare the sustainability of the two methods in terms of the following:

(i) obtaining the hydrocarbon feedstock used for manufacture,

.....
.....
.....

[2]

(ii) disposing of the by-products of manufacture.

.....
.....
.....

[2]

13

(b) The catalyst speeds up the reaction.

Explain how a catalyst carries out this function.

.....
.....
.....

[2]

(c) Write a balanced symbol equation for the reaction that produces epoxyethane in the modern method.

.....

[Total: 8]

END OF QUESTION PAPER

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The Periodic Table of the Elements

1	2	3	4	5	6	7	0
7 Li lithium 3	9 Be beryllium 4	11 B boron 5	12 C carbon 6	14 N nitrogen 7	16 O oxygen 8	19 F fluorine 9	20 Ne neon 10
23 Na sodium 11	24 Mg magnesium 12	27 Al aluminum 13	28 Si silicon 14	31 P phosphorus 15	32 S sulfur 16	35.5 Cl chlorine 17	40 Ar argon 18
39 K potassium 19	40 Ca calcium 20	45 Sc scandium 21	48 Ti titanium 22	51 V vanadium 23	52 Cr chromium 24	55 Mn manganese 25	56 Fe iron 26
85 Rb rubidium 37	88 Sr strontium 38	89 Y yttrium 39	91 Nb niobium 40	93 Zr zirconium 40	96 Mo molybdenum 42	[98] Tc technetium 43	101 Ru ruthenium 44
133 Cs caesium 55	137 Ba barium 56	139 La* lanthanum 57	178 Hf hafnium 72	181 Ta tantalum 73	184 W tungsten 74	186 Re rhenium 75	190 Os osmium 76
[223] Fr francium 87	[226] Ra radium 88	[227] Ac* actinium 89	[261] Rf rutherfordium 104	[262] Db dubnium 105	[266] Sg seaborgium 106	[264] Bh bohrium 107	[268] Mt meitnerium 108
				[277] Hs hassium 109	[271] Ds darmstadtium 110	[272] Rg roentgenium 111	

Key

relative atomic mass
atomic symbol
atomic name (proton) number

1 H hydrogen 1
4 He helium 2
16

* The lanthanoids (atomic numbers 58-71) and the actinoids (atomic numbers 90-103) have been omitted.

The relative atomic masses of copper and chlorine have not been rounded to the nearest whole number.

Elements with atomic numbers 112-116 have been reported but not fully authenticated