OCR
RECOGNISING ACHIEVEMENT

SPECIMEN H

GENERAL CERTIFICATE OF SECONDARY EDUCATION

TWENTY FIRST CENTURY SCIENCE **A173/02**

CHEMISTRY A

Unit A173: Module C7 (Higher Tier)

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

OCR Supplied Materials:
None

Other Materials Required:
- Pencil
- Ruler (cm/mm)

Duration: 1 hour

Candidate Forename		Candidate Surname	

Centre Number						Candidate Number				

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.
- Write your answer to each question in the space provided, however additional paper may be used if necessary.

INFORMATION FOR CANDIDATES

- Your quality of written communication is assessed in questions marked with a pencil (✎).
- The Periodic Table is printed on the back page.
- The number of marks for each question is given in brackets **[ ]** at the end of the question or part question.
- The total number of marks for this paper is **60**.
- This document consists of **20** pages. Any blank pages are indicated.

For Examiner's Use		
	Max	**Mark**
1	**11**	
2	**5**	
3	**8**	
4	**8**	
5	**8**	
6	**10**	
7	**10**	
TOTAL	**60**	

Answer **all** the questions.

1 Methanoic acid, HCOOH, is a carboxylic acid that is present 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 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	→	calcium chloride	+	water	+	carbon dioxide
$CaCO_3$	+	$2HCl$	→	$CaCl_2$	+	H_2O	+	CO_2

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

..... + ... → $Ca(HCOO)_2$ + ... + ...

[2]

(ii) Calcium carbonate is insoluble so it stays inside the kettle.

When calcium carbonate in limescale reacts with methanoic acid, calcium methanoate forms.

The reaction with methanoic acid removes the calcium carbonate in limescale. Suggest a property of calcium methanoate that can explain why this happens.

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

(iii) Methanoic acid is a weak acid and hydrochloric acid is a strong acid.

Describe a reaction, other than with carbonates, that shows that methanoic acid is an acid.

Compare this with a similar reaction of hydrochloric acid to demonstrate why one is a weak acid and the other a strong acid.

Include relevant balanced equations in your answer.

The quality of written communication will be assessed in your answer to this question.

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..... **[6]**

(c) Butanoic acid, $C_4H_8O_2$, is responsible for the unpleasant taste in rancid butter.

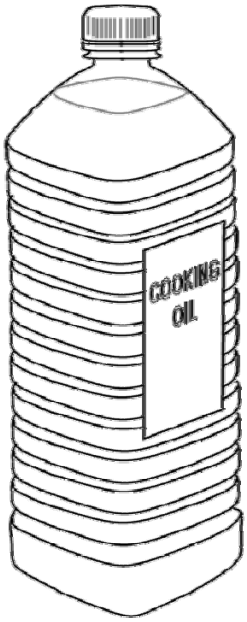
Draw a diagram to show the structural formula for butanoic acid.

[1]

[Total: 11]

2 Sunflower oil is an example of a vegetable oil. The oil comes from the seeds of the sunflower plant.

The chemicals in the oil are esters.



(a) When an ester is hydrolysed it forms an alcohol and a carboxylic acid.

This reaction is the reverse of the reaction that makes the ester.

Oils and fats are esters.

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

oil + water $\rightleftharpoons$ ..... + ... **[1]**

(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 in an upright position. Evaporated liquid is allowed to run back into the flask.
- In the **distillation** stage, the mixture is placed in a flask connected to a sloping condenser and heated. The product is collected at its boiling point.

Describe the stages of **purification** and **drying**.

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..... **[4]**

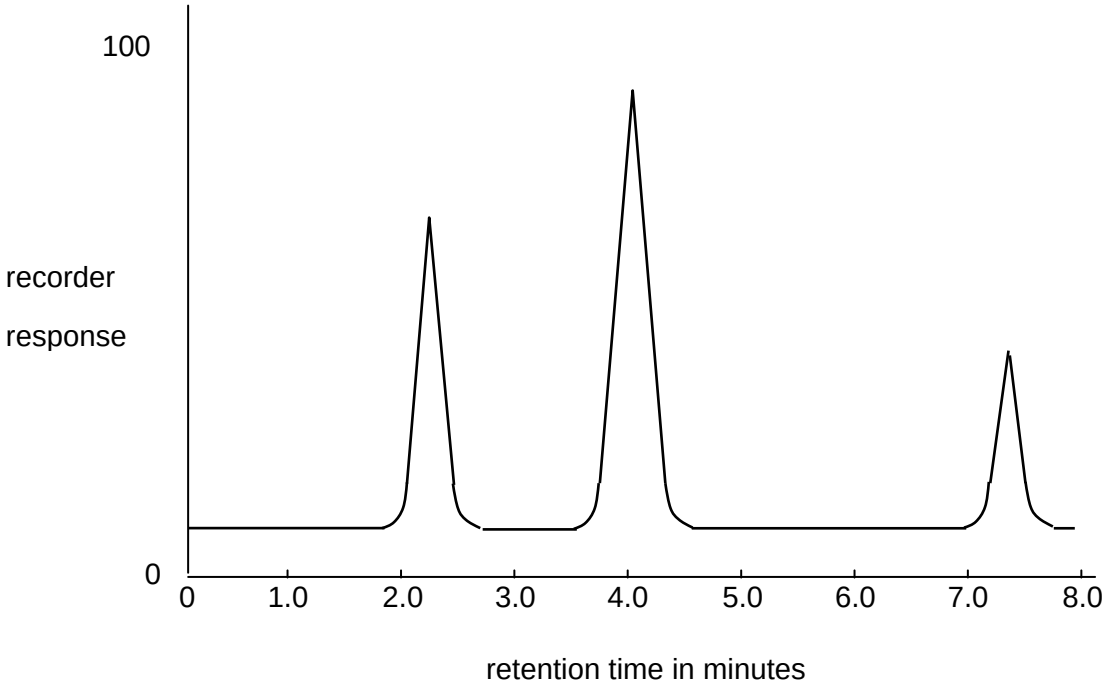
[Total: 5]

3 A technician analyses a mixture of hydrocarbons using gas chromatography.

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

hydrocarbon	formula	retention time in minutes
methane	CH_4	1.7
ethane	C_2H_6	2.2
propane	C_3H_8	3.5
butane	C_4H_{10}	4.0
pentane	C_5H_{12}	7.4

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



(a) (i) How does the recorder print out show that butane has the highest concentration?

.....

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

(ii) Use data in the table to draw a conclusion relating the formula of each hydrocarbon to its retention time.

.....

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

(b) During gas chromatography, each component of a mixture is involved in a dynamic equilibrium.

Explain how this separates the components in a mixture.

The quality of written communication will be assessed in your answer to this question.

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..... **[6]**

[Total: 8]

4 A company makes indigestion tablets that 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 analyses samples from each batch of indigestion tablets that the company makes.

He uses quantitative analysis to find the mass of active ingredient in each tablet.

He tests 5 tablets from one batch.

He makes a suspension of each of the five tablets and titrates these with a solution containing hydrochloric acid. The concentration of this acid is 40.0 g/dm^3.

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) Work out the relative formula mass (RFM) of magnesium hydroxide, $Mg(OH)_2$.

Relative atomic masses are given in the Periodic Table on the back page.

Show your working.

relative formula mass (RFM) = ... **[1]**

(ii) Work out the mass of hydrochloric acid in 23.5 cm^3 of the hydrochloric acid solution used in the titrations.

mass = ... g **[1]**

(iii) Use the neutralisation 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.

The relative formula mass of hydrochloric acid, HCl, is 36.5.

$$Mg(OH)_2 + 2HCl \rightarrow MgCl_2 + 2H_2O$$

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

(iv) The company makes batches of 100 000 tablets. The chemist samples and tests some tablets from each batch to obtain data about the mass of magnesium hydroxide in the tablets.

Look at his results.

	batch 1	**batch 2**	**batch 3**
number of tablets sampled	2	8	6
average mass of magnesium hydroxide in one tablet, in grams	0.64	0.77	0.72

Suggest what changes the chemist should make to the testing procedure.

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..... **[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.

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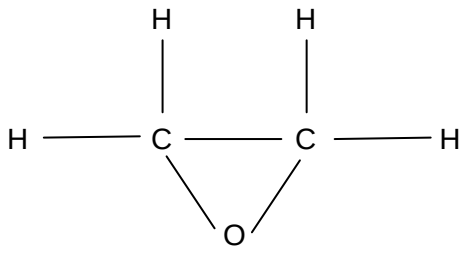
..... **[2]**

[Total: 8]

5 Epoxyethane is an intermediate in the production of car anti-freeze. It is also used to sterilise medical supplies.



epoxyethane

Epoxyethane is poisonous, carcinogenic and highly flammable.

The raw material used to make epoxyethane is ethene. This 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.

$$C_2H_4 + Cl_2 + H_2O \rightarrow CH_2ClCH_2OH + HCl$$

2 The reaction mixture was treated with calcium hydroxide.

$$HCl + CH_2ClCH_2OH + Ca(OH)_2 \rightarrow (CH_2)_2O + CaCl_2 + H_2O$$

The modern method involves only one step. Ethene and oxygen are passed over a silver catalyst at 250 – 350 ^{o}C.

ethene + oxygen → expoxyethane

(a) The sustainability of the two processes can be compared.

(i) Which two statements, when taken together, explain why the two methods are equally unsustainable?

Put ticks (✓) in the boxes next to the **two** correct answers.

Oxygen can be obtained from the air.	☐
Ethene is obtained from crude oil.	☐
Deforestation is reducing the amount of oxygen in the air.	☐
Chlorine is obtained by electrolysis of brine.	☐
Our supply of crude oil is finite.	☐
The sea contains a very large reserve of sodium chloride.	☐

[2]

(ii) Which two statements explain why the original method is less sustainable in terms of by-products?

Put ticks (✓) in the boxes next to the **two** correct answers.

Chlorine is a poisonous gas.	☐
Hydrochloric acid is corrosive and its disposal can cause environmental problems.	☐
There is little use for calcium chloride.	☐
The original method produces water as a by-product.	☐
Calcium hydroxide is an alkaline solid.	☐
The new process has no by-products.	☐

[2]

(b) The catalyst speeds up the reaction.

Which two statements explain how a catalyst carries out this function.

Put ticks (✓) in the boxes next to the **two** correct answers.

The catalyst does not get used up during the reaction.	☐
The catalyst has to be replaced frequently.	☐
The catalyst lowers the activation energy for the reaction.	☐
The catalyst provides an alternative route for the reaction.	☐
The catalyst makes the reaction exothermic.	☐
The catalyst raises the temperature of the reaction mixture.	☐

[2]

(c) Complete and balance this symbol equation for the new method.

……..C_2H_4 + ……..O_2 → .....

[2]

[Total: 8]

6 Natural gas is used as a fuel. It contains the hydrocarbon methane.

(a) Methane burns in air according to this equation.

$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$$

Energy changes are involved in the breaking and making of bonds when methane burns.

Use ideas about the energy involved to explain why this reaction of methane with oxygen is exothermic.

The quality of written communication will be assessed in your answer to this question.

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..... **[6]**

(b) The table shows the energy involved in the making or breaking of some bonds.

bond	energy in kJ/mol
C – H	435
O = O	498
C = O	805
H – O	464

The energy change involved in the **breaking** of bonds in this reaction can be calculated as follows.

4 x C – H = 4 x 435 = 1740 kJ/mol

2 x O = O = 2 x 498 = 996 kJ/mol

energy involved = 1740 + 996 = 2736 kJ/mol

(i) Calculate the energy change involved in **making** bonds in this reaction.

energy involved = ... kJ/mol **[3]**

(ii) Calculate the overall energy change for the reaction.

overall energy change = ... kJ/mol **[1]**

[Total: 10]

7 Gemma works for a company making vinegar.

Each day she measures the amount of ethanoic acid in 25.0 cm^3 samples of the vinegar made.

She carries out a titration using a standard solution of sodium hydroxide and an indicator.

(a) Gemma makes her standard solution of sodium hydroxide to use for her titration.

The statements describe how she makes up this solution, but they are in the wrong order.

A Rinse all of the solution from the beaker using more distilled water.

B Place a stopper in the graduated flask and shake it.

C Dissolve the sodium hydroxide in a small volume of distilled water in a beaker.

D Accurately weigh 1.0 g of sodium hydroxide.

E Transfer the solution to a 250 cm^3 graduated flask.

F Add more distilled water up to the 250 cm^3 volume mark on the graduated flask.

(i) Write the letters of these statements in the boxes to show the correct order.

The first and last have been done for you.

D					**B**

[3]

(ii) Calculate the concentration of her sodium hydroxide solution in g/dm^3.

concentration of sodium hydroxide solution = ... g/dm^3 **[1]**

(b) Gemma carries out two sets of six titrations.

All of the samples she tests are from the same vinegar.

Her results are shown in the table.

	volume of sodium hydroxide solution in cm^3					
set 1 morning	12.9	12.2	12.5	12.8	12.9	12.1
set 2 afternoon	12.4	12.6	12.5	12.5	12.4	12.6

(i) Which set of results should Gemma use to get a best estimate for the concentration of ethanoic acid in the vinegar?

Explain why she should use this set of results.

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.....

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

(ii) There is not a significant difference between the morning and afternoon sets of results.

How does the data show this?

.....

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

(iii) Gemma works out the average (mean) value for her afternoon results and finds that 12.5 cm^3 of the sodium hydroxide solution neutralises 25 cm^3 of the vinegar.

Vinegar contains ethanoic acid that reacts with sodium hydroxide in this equation.

$$CH_3COOH + NaOH \rightarrow CH_3COONa + H_2O$$

Calculate the best estimate for the concentration of ethanoic acid in the vinegar.

Relative atomic masses are given in the Periodic Table on the back page.

You will also need to use your answer to part **(a) (ii)**.

Show your working.

concentration of ethanoic acid = ... g/dm^3 **[2]**

(iv) Quality control requires the ethanoic acid in the vinegar to be of concentration 2.8 g/dm^3 plus or minus 10 %.

Explain whether the sample of vinegar that Gemma tested would have passed the quality test.

.....

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

[Total: 10]

[Paper Total: 60]

END OF QUESTION PAPER

PLEASE DO NOT WRITE ON THIS PAGE

Periodic Table

1	2											3	4	5	6	7	0
							1 **H** hydrogen 1										4 **He** helium 2
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** aluminium 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	59 **Co** cobalt 27	59 **Ni** nickel 28	63.5 **Cu** copper 29	65 **Zn** zinc 30	70 **Ga** gallium 31	73 **Ge** germanium 32	75 **As** arsenic 33	79 **Se** selenium 34	80 **Br** bromine 35	84 **Kr** krypton 36
85 **Rb** rubidium 37	88 **Sr** strontium 38	89 **Y** yttrium 39	91 **Zr** zirconium 40	93 **Nb** niobium 41	96 **Mo** molybdenum 42	[98] **Tc** technetium 43	101 **Ru** ruthenium 44	103 **Rh** rhodium 45	106 **Pd** palladium 46	108 **Ag** silver 47	112 **Cd** cadmium 48	115 **In** indium 49	119 **Sn** tin 50	122 **Sb** antimony 51	128 **Te** tellurium 52	127 **I** iodine 53	131 **Xe** xenon 54
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	192 **Ir** iridium 77	195 **Pt** platinum 78	197 **Au** gold 79	201 **Hg** mercury 80	204 **Tl** thallium 81	207 **Pb** lead 82	209 **Bi** bismuth 83	[209] **Po** polonium 84	[210] **At** astatine 85	[222] **Rn** radon 86
[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	[277] **Hs** hassium 108	[268] **Mt** meitnerium 109	[271] **Ds** darmstadtium 110	[272] **Rg** roentgenium 111	Elements with atomic numbers 112-116 have been reported but not fully authenticated						

Key

relative atomic mass
atomic symbol
name
atomic (proton) number

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

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SPECIMEN H

GENERAL CERTIFICATE OF SECONDARY EDUCATION

TWENTY FIRST CENTURY SCIENCE

CHEMISTRY A **A173/02**

Unit A173: Module C7 (Higher Tier)

MARK SCHEME

MAXIMUM MARK 60

This document consists of 16 pages

Guidance for Examiners

Additional guidance within any mark scheme takes precedence over the following guidance.

1. Mark strictly to the mark scheme.
2. Make no deductions for wrong work after an acceptable answer unless the mark scheme says otherwise.
3. Accept any clear, unambiguous response which is correct, eg mis-spellings if phonetically correct (but check additional guidance).
4. Abbreviations, annotations and conventions used in the detailed mark scheme:

   / = alternative and acceptable answers for the same marking point
   (1) = separates marking points
   not/reject = answers which are not worthy of credit
   ignore = statements which are irrelevant - applies to neutral answers
   allow/accept = answers that can be accepted
   (words) = words which are not essential to gain credit
   <u>words</u> = underlined words must be present in answer to score a mark
   ecf = error carried forward
   AW/owtte = alternative wording
   ORA = or reverse argument

   Eg mark scheme shows 'work done in lifting / (change in) gravitational potential energy' (1)
   work done = 0 marks
   work done lifting = 1 mark
   change in potential energy = 0 marks
   gravitational potential energy = 1 mark

5. Annotations:
   The following annotations are available on SCORIS.

   ✓ = correct response
   ✗ = incorrect response
   bod = benefit of the doubt
   nbod = benefit of the doubt **<u>not</u>** given
   ECF = error carried forward
   ^ = information omitted
   I = ignore
   R = reject

6. If a candidate alters his/her response, examiners should accept the alteration.

7. Crossed out answers should be considered only if no other response has been made. When marking crossed out responses, accept correct answers which are clear and unambiguous.

   Eg
   For a one mark question, where ticks in boxes 3 and 4 are required for the mark:

Put ticks (✓) in the two correct boxes.	Put ticks (✓) in the two correct boxes.	Put ticks (✓) in the two correct boxes.
☐	☐	✓
☐	☐	✓
✓	✓	☐
✓	✓	☐
☐	☐	☐
This would be worth 0 marks.	This would be worth one mark.	This would be worth one mark.

8. The list principle:
   If a list of responses greater than the number requested is given, work through the list from the beginning. Award one mark for each correct response, ignore any neutral response, and deduct one mark for any incorrect response, eg one which has an error of science. If the number of incorrect responses is equal to or greater than the number of correct responses, no marks are awarded. A neutral response is correct but irrelevant to the question.

9. Marking method for tick boxes:

   Always check the additional guidance.

   If there is a set of boxes, some of which should be ticked and others left empty, then judge the entire set of boxes.
   If there is at least one tick, ignore crosses. If there are no ticks, accept clear, unambiguous indications, eg shading or crosses.
   Credit should be given for each box correctly ticked. If more boxes are ticked than there are correct answers, then deduct one mark for each additional tick. Candidates cannot score less than zero marks.

   Eg If a question requires candidates to identify a city in England, then in the boxes

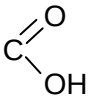
Edinburgh	
Manchester	
Paris	
Southampton	

   the second and fourth boxes should have ticks (or other clear indication of choice) and the first and third <u>should be blank</u> (or have indication of choice crossed out).

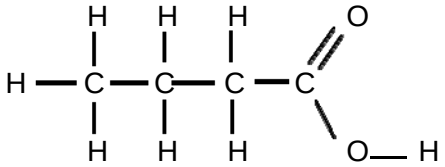
Edinburgh			✓			✓	✓	✓	✓	
Manchester	✓	×	✓	✓	✓				✓	
Paris				✓	✓		✓	✓	✓	
Southampton	✓	×		✓		✓	✓		✓	
Score:	2	2	1	1	1	1	0	0	0	NR

10. Three questions in this paper are marked using a Level of Response (LoR) mark scheme with embedded assessment of the Quality of Written Communication (QWC). When marking with a Level of Response mark scheme:

- Read the question in the question paper, and then the list of relevant points in the 'Additional guidance' column of the mark scheme, to familiarise yourself with the expected science. The relevant points are not to be taken as marking points, but as a summary of the relevant science from the specification.
- Read the level descriptors in the 'Expected answers' column of the mark scheme, starting with Level 3 and working down, to familiarise yourself with the expected levels of response.
- *For a general correlation between quality of science and QWC*: determine the level based upon which level descriptor best describes the answer; you may award either the higher or lower mark within the level depending on the quality of the science and/or the QWC.
- *For high-level science but very poor QWC*: the candidate will be limited to Level 2 by the bad QWC no matter how good the science is; if the QWC is so bad that it prevents communication of the science the candidate cannot score above Level 1.
- *For very poor or totally irrelevant science but perfect QWC*: credit cannot be awarded for QWC alone, no matter how perfect it is; if the science is very poor the candidate will be limited to Level 1; if there is insufficient or no relevant science the answer will be Level 0.

Question			Expected answers	Marks	Additional guidance
1	(a)		COOH	[1]	**allow** CO_2H **allow** 
	(b)	(i)	$CaCO_3 + 2HCOOH \rightarrow Ca(HCOO)_2 + CO_2 + H_2O$	[2]	one mark for formulae one mark for balanced equation
		(ii)	it is soluble / it dissolves	[1]	

Question			Expected answers	Mark	Additional guidance
		(iii) ✎	**[Level 3]** Answer identifies an appropriate reaction, clearly identifies correct reagents and products of the chosen reaction, and gives a balanced equation for the chosen reaction. Comparison is made with similar hydrochloric acid reaction to show why this is a strong acid but methanoic a weak acid. All information in the answer is relevant, clear, organised and presented in a structured and coherent format. Specialist terms are used appropriately. Few, if any, errors in grammar, punctuation and spelling. (5-6 marks) **[Level 2]** Answer identifies an appropriate reaction with correct reagents and products, and gives an equation for the chosen reaction. Reaction with hydrochloric acid is included but not compared. Distinction between strong and weak acid is not fully made. For the most part the information is relevant and presented in a structured and coherent format. Specialist terms are used for the most part appropriately. There are occasional errors in grammar, punctuation and spelling. (3-4 marks) **[Level 1]** Answer identifies an appropriate reaction, with correct reagents and/or products. Hydrochoric acid is not mentioned. Answer may be simplistic. There may be limited use of specialist terms. Errors of grammar, punctuation and spelling prevent communication of the science. (1-2 marks) **[Level 0]** Insufficient or irrelevant science. Answer not worthy of credit. (0 marks)	**[6]**	**relevant points include:** • appropriate reaction (eg with an alkali, an oxide or a hydroxide) • correct reagents for the reaction • correct products of the reaction • balanced equation for the reaction • details of similar reaction with hydrochloric acid • comparison of two reactions to show difference between a weak acid and a strong acid

Question			Expected answers	Mark	Additional guidance
	(c)			[1]	**allow** $CH_3CH_2CH_2COOH$
			Total	[11]	

Question			Expected answers	Mark	Additional guidance
2	(a)		glycerol + fatty acids	[1]	either order
	(b)		in the purification stage, the product is shaken with reagent in a tap funnel and then the layer containing impurities is run off in the drying stage, solid drying agent is added to the product and then the mixture is filtered to remove the drying agent	[4]	**allow** a named reagent eg distilled water **allow** a named drying agent eg calcium chloride
			Total	[5]	

Question			Expected answers	Mark	Additional guidance
3	(a)	(i)	the peak at 4.1 is higher than the other peaks	[1]	
		(ii)	as the size of the molecule increases, the retention time increases	[1]	
	(b)	✎	**[Level 3]** Answer shows a full and detailed understanding of how the idea of a dynamic equilibrium explains the separation. All information in the answer is relevant, clear, organised and presented in a structured and coherent format. Specialist terms are used appropriately. Few, if any, errors in grammar, punctuation and spelling. (5-6 marks) **[Level 2]** Answer explains how components are separated but does not relate this to dynamic equilibrium. For the most part the information is relevant and presented in a structured and coherent format. Specialist terms are used for the most part appropriately. There are occasional errors in grammar, punctuation and spelling. (3-4 marks) **[Level 1]** Answer refers to the phases but does not adequately explain how the components are separated. Answer may be simplistic. There may be limited use of specialist terms. Errors of grammar, punctuation and spelling prevent communication of the science. (1-2 marks) **[Level 0]** Insufficient or irrelevant science. Answer not worthy of credit. (0 marks)	[6]	**relevant points include:** • mobile phase moves through stationary phase • mobile phase carries some components further than others • components are separated by moving at different speeds • each component of the mixture is in a dynamic equilibrium between the two phases • for each component the equilibrium will lie more towards the one phase than the other • each component will be more soluble/more attracted/spend more time in one phase than the other • the speed of movement of a component depends on its equilibrium position in / solubility in / attraction to each phase **accept** ideas of position of dynamic equilibrium or solubility in each phase or time spent in each phase with equal merit **ignore** irrelevant detail
			Total	[8]	

Question			Expected answers	Mark	Additional guidance
4	(a)	(i)	58	[1]	
		(ii)	0.94 g	[1]	
		(iii)	0.94 x 58/(36.5 x 2) = 0.75 g	[2]	**allow** both marks for correct answer without working **allow** answer 0.747 g or 0.746 g **allow** ecf from (i) and (ii) only if working shown
		(iv)	take a larger sample/more tablets to test from each batch / idea of a larger proportion of the total number of tablets take the same number of tablets to test in each batch / idea of consistent method	[2]	
	(b)		there is only a small degree of uncertainty because all of the titration values are very close / because all of the titration values are within 0.1 of the average	[2]	
			Total	[8]	

Question			Expected answers	Mark	Additional guidance
5	(a)	(i)	☐ Ethene is obtained from crude oil. ✓ ☐ ☐ Our supply of crude oil is finite. ✓ ☐	[2]	

Question			Expected answers	Mark	Additional guidance
		(ii)	There is little use for calcium chloride. ✓ The new process had no by-products. ✓	[2]	
	(b)		The catalyst lowers the activation … … provides an alternative route … ✓	[2]	
	(c)		$2C_2H_4 + O_2 \rightarrow 2(CH_2)_2O$	[2]	one mark for correct product one mark for correct balancing
			Total	[8]	

Question			Expected answers	Mark	Additional guidance
6	(a)	✎	**[Level 3]** Answer clearly shows a good understanding of exothermic reactions. All information in the answer is relevant, clear, organised and presented in a structured and coherent format. Specialist terms are used appropriately. Few, if any, errors in grammar, punctuation and spelling. (5-6 marks) **[Level 2]** Answer shows a partial understanding of exothermic reactions. For the most part the information is relevant and presented in a structured and coherent format. Specialist terms are used for the most part appropriately. There may be occasional errors in grammar, punctuation and spelling. (3-4 marks) **[Level 1]** Answer shows a limited understanding of exothermic reactions. Answer may be simplistic. There may be limited use of specialist terms. Errors of grammar, punctuation and spelling prevent communication of the science. (1-2 mark) **[Level 0]** Insufficient or irrelevant science. Answer not worthy of credit. (0 marks)	**[6]**	**relevant points include:** • in an exothermic reaction energy is released / given out, as heat • during a reaction bonds are broken in the reactants and new bonds formed in the products • breaking bonds, requires / uses / takes in, energy • forming bonds, releases / gives out, energy • energy change for a reaction is the sum of these two energy changes • idea that if the energy, released / given out, (when forming bonds) is greater than the energy, used / taken in , (when breaking bonds) the reaction is exothermic **accept** the idea that the reaction heats up its surroundings for a low-level mark

Question			Expected answers	Mark	Additional guidance
	(b)	**(i)**	2 x 805 = 1610 4 x 464 = 1856 energy involved = 3466	**[3]**	**ignore** if go on to calculate -730 here
		(ii)	-730	**[1]**	only credit with minus sign
			Total	**[10]**	

Question			Expected answers	Mark	Additional guidance
7	**(a)**	**(i)**	(**D**) **C** **E** **A** **F** (**B**)	**[3]**	one mark per correct order: **C** before **E** **E** before **A** **A** before **F**
		(ii)	4.0	**[1]**	**allow** 4
	(b)	**(i)**	*she should use set 2 (afternoon) because:* the data in set 2 have a smaller range / are closer together which means they are more consistent / will give a more accurate best estimate / closer to the true value	**[2]**	no marks for the choice of set 1 or set 2 **do not allow** "more accurate" without qualification
		(ii)	the mean of one set of data lies in range of the other set of data / the ranges overlap	**[1]**	
		(iii)	RAM CH_3COOH = 60 RAM NaOH = 40 conc. = 4.0 x (12.5/1000) x (60/40) X (1000/25) = 3.0	**[2]**	**allow** ecf from (a)(ii) and from incorrect RAMs
		(iv)	vinegar concentration is within quality control limits and reference to being in range of 2.52 – 3.02 g/dm^3	**[1]**	**allow** answer that agrees with candidate's incorrect calculation from part (iii)
			Total	**[10]**	

Assessment Objectives (AO) Grid

(includes quality of written communication ✎)

Question	AO1	AO2	AO3	Total
1(a)	1			**1**
1(b)(i)	1	1		**2**
1(b)(ii)		1		**1**
1(b)(iii)✎	3	3		**6**
1(c)		1		**1**
2(a)	1			**1**
2(b)	4			**4**
3(a)(i)		1		**1**
3(a)(ii)			1	**1**
3(b)✎	6			**6**
4(a)(i)		1		**1**
4(a)(ii)		1		**1**
4(a)(iii)		2		**2**
4a(iv)			2	**2**
4(b)			2	**2**
5(a)(i)		2		**2**
5(a)(ii)		2		**2**
5(b)	2			**2**
5(c)		2		**2**
6(a)✎	3	3		**6**
6(b)(i)		3		**3**
6(b)(ii)		1		**1**
7(a)(i)	3			**3**
7(a)(ii)		1		**1**
7(b)(i)			2	**2**
7(b)(ii)			1	**1**
7(b)(iii)		2		**2**
7(b)(iv)			1	**1**
Totals	**24**	**27**	**9**	**60**

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