

**GENERAL CERTIFICATE OF SECONDARY EDUCATION**

**TWENTY FIRST CENTURY SCIENCE**

**A173/01**

**CHEMISTRY A**

Unit A173: Module C7 (Foundation 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	
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Centre Number						Candidate Number				
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**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**

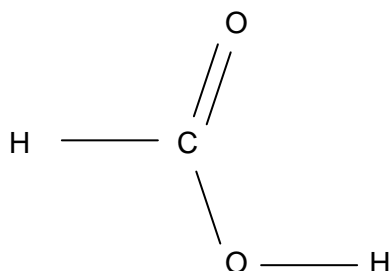
- Your quality of written communication is assessed in questions marked with a pencil (✎).
- The Periodic Table is printed on the back page.
- The number of marks for each question is given in brackets [ ] at the end of the question or part question.
- The total number of marks for this paper is **60**.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

For Examiner's Use		
	Max	Mark
<b>1</b>	<b>11</b>	
<b>2</b>	<b>3</b>	
<b>3</b>	<b>11</b>	
<b>4</b>	<b>11</b>	
<b>5</b>	<b>8</b>	
<b>6</b>	<b>9</b>	
<b>7</b>	<b>7</b>	
<b>TOTAL</b>	<b>60</b>	

Answer **all** the questions.

1 Methanoic acid is a carboxylic acid that is present in bee stings.

(a) The diagram shows the structural formula of methanoic acid.



On the diagram, draw a circle around the functional group that is responsible for the characteristic properties of carboxylic acids.

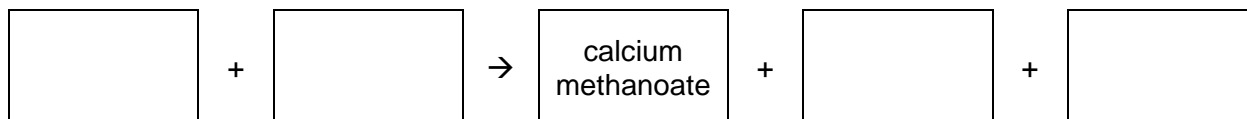
[1]

(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.

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




[2]

**(ii)** Some kettles have metal bodies, and all have metal heating elements.

Hydrochloric acid is not used for removing limescale from kettles.

Explain why methanoic acid is used to remove limescale but hydrochloric acid is not.

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

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

**(c)** Propanoic acid,  $\text{CH}_3\text{CH}_2\text{COOH}$ , is another carboxylic acid. It is found in some foods.

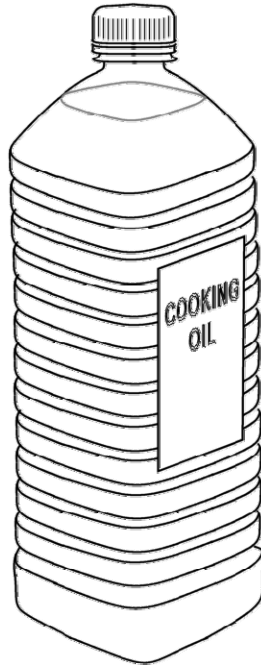
Draw a diagram to show the structural formula for propanoic acid.

**[2]**

**[Total: 11]**

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

The chemicals in the oil are esters.



- (a) Green plants get energy from sunlight.

Sunflower seeds cannot get energy from sunlight when they are in the soil.

Sunflower seeds contain oil.

Complete the sentence to describe how sunflower seeds use this oil.

Sunflower seeds use oil as a store of ..... [1]

- (b) 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]

(c) Esters are often added to processed foods.

How does adding esters most commonly improve food?

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

It can improve the taste.

It can improve the appearance.

It can stop bacteria growing.

It can prevent reaction with oxygen.

It can improve the smell.

It can make the food last longer.

[1]

[Total: 3]

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 <sub>4</sub>	1.7
ethane	C <sub>2</sub> H <sub>6</sub>	2.2
propane	C <sub>3</sub> H <sub>8</sub>	3.5
butane	C <sub>4</sub> H <sub>10</sub>	4.0
pentane	C <sub>5</sub> H <sub>12</sub>	7.4

(a) (i) Explain what is meant by retention time.

.....

.....

.....

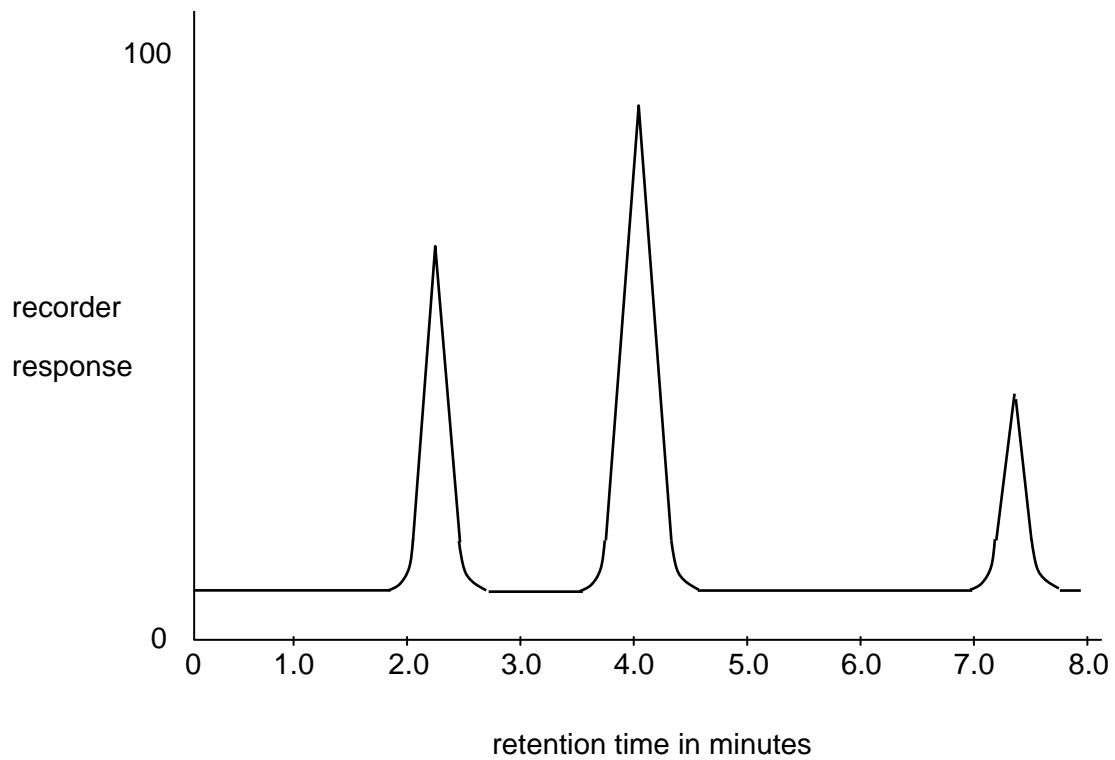
..... [2]

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

.....

..... [1]

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



**(b) (i)** Which three hydrocarbons are present in the mixture?

1 .....

2 .....

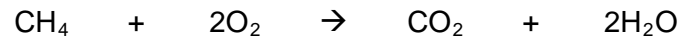
3 ..... [1]

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

..... [1]


(c) Natural gas is used as a fuel. It contains the hydrocarbon methane.

Methane burns in air according to this equation.



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

Use ideas about the energy involved to explain why the 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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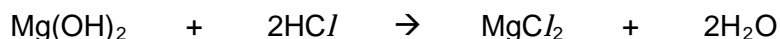
.....

[6]

[Total: 11]



- 4 A company makes indigestion tablets that contain the active ingredient magnesium hydroxide. This reacts with 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.

- (a) The statements describe the main stages of this analysis. They are in the wrong order.

- A Crush the tablet and stir it into approximately 25 cm<sup>3</sup> distilled water.
- B Use the average titration result to calculate the mass of magnesium hydroxide in each tablet.
- C Titrate the mixture against hydrochloric acid of concentration 40 g/dm<sup>3</sup>.
- D Measure accurately the mass of one indigestion tablet.
- E Estimate the degree of uncertainty in the result.
- F Repeat the procedure using several more tablets.

Write the letters in the boxes to show the correct order of the stages. The first one has been done for you.

D					
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[3]

- (b) State and explain what piece of apparatus the chemist should use to measure the volume of hydrochloric acid used in each titration.

.....

.....

.....

..... [2]

- (c) The chemist finds that the average volume of hydrochloric acid to react with the magnesium chloride in a tablet is  $23.5 \text{ cm}^3$ .

The formula shown below can be used to work out the mass of magnesium hydroxide in each indigestion tablet.

$$\text{mass of magnesium hydroxide in g} = \frac{\text{volume HCl} \times 40 \times \text{RFM Mg(OH)}_2}{2000 \times 36.5}$$

- (i) Work out the relative formula mass (RFM) of magnesium hydroxide,  $\text{Mg(OH)}_2$ .

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

Show your working.

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

- (ii) Use the formula to work out the mass of magnesium hydroxide in each indigestion tablet.

Give your answer to 2 decimal places.

mass = ..... g [2]

- (d) 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

(i) Should the company be concerned about these results?

Explain your answer.

.....

.....

..... [1]

(ii) Suggest what changes the chemist should make to the testing procedure.

.....

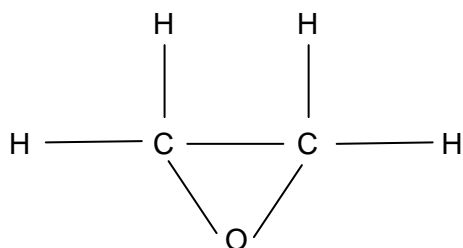
.....

.....

..... [2]

[Total: 11]

- 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.

- (a) (i) Epoxyethane is a bulk chemical.

What is a bulk chemical?

Put a tick (✓) in the box next to the correct answer.

A chemical that costs a lot to make.

A chemical that is rarely used.

A chemical made in large quantities.

A chemical that is only made when it is needed.

[1]

- (ii) It may not be sustainable to make epoxyethane from ethene.

Which statements suggest why not?

Put ticks (✓) in the boxes next to the **two** statements, when taken together, that give the correct answer.

Making epoxyethane uses oxygen from the air.

This will reduce the oxygen supply to people.

Chlorine is used to make epoxyethane.

Chlorine is a poisonous gas.

Ethene is obtained from crude oil.

One day we will run out of crude oil.

[2]

(b) Two methods have been used to make epoxyethane

- original method – from ethene, chlorine and calcium hydroxide
- modern method – ethene and oxygen are passed over a silver catalyst at 250 – 350 °C.

(i) The original method produces solid calcium chloride as a by-product, but the modern method does not.

There is not much use for this calcium chloride and the company cannot sell it.

Why may this mean that the original method is less sustainable than the modern method?

Put a tick (✓) in the box next to the correct answer.

The company has to dispose of the calcium chloride.

Chlorine is used in the original process.

Corrosive hydrochloric acid is produced.

Epoxyethane is poisonous.

[1]

(ii) The modern method uses a catalyst.

Complete the sentence to explain what the catalyst does in this reaction.

Use words from this list.

- |                          |                         |                  |                      |
|--------------------------|-------------------------|------------------|----------------------|
| <b>activation energy</b> | <b>boiling point</b>    | <b>feedstock</b> | <b>melting point</b> |
| <b>product</b>           | <b>rate of reaction</b> | <b>reactant</b>  | <b>route</b>         |

The silver catalyst lowers the ..... by allowing

the reaction to take place using an alternative ..... [2]

(c) The Government has strict regulations that control the way that epoxyethane is transported.

Explain the purpose of these regulations.

.....

.....

.....

..... [2]

[Total: 8]

- 6 Manufacturers are trying to find alternative fuels to petrol and diesel, because drivers are using up the world's fossil fuels.

One alternative is bio-ethanol. This is made by the fermentation of wheat or beet sugar.

Bio-ethanol can be mixed with petrol. When it is burned, this produces less carbon dioxide and other pollutants. Bio-ethanol also provides more energy and is a renewable energy source.

- (a) Fermentation of carbohydrates by yeast produces a solution. This solution is distilled to produce bio-ethanol.

Why is the solution distilled?

Put a tick (✓) in the box next to the best answer.

To remove the yeast.

To turn the ethanol into ethanoic acid.

To increase the concentration of ethanol.

To mix ethanol with petrol.

[1]

- (b) Ethanol can also be made from ethane. Ethane is obtained from natural gas.

- (i) Outline the industrial method used to make ethanol from ethane.

.....

.....

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..... [2]

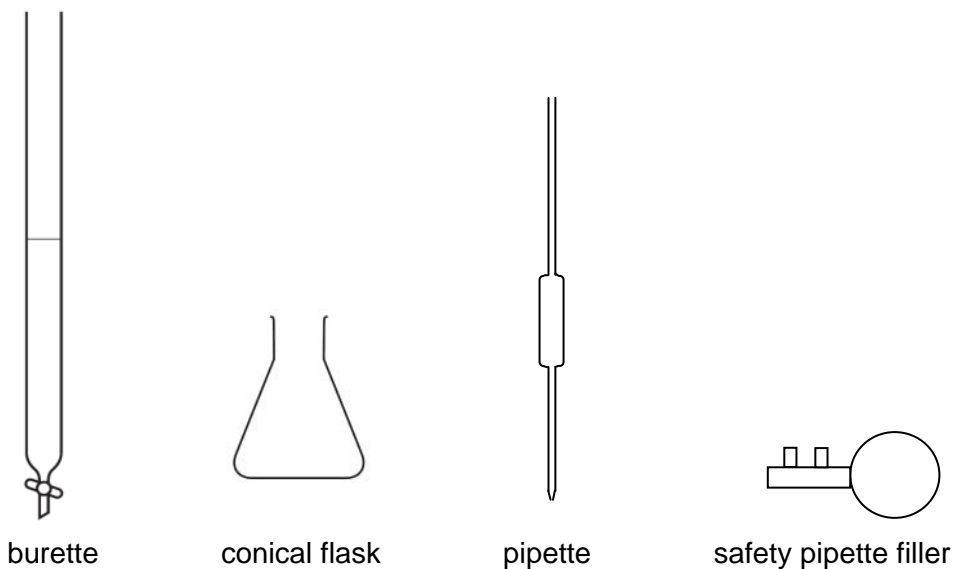


7 Gemma works for a company making vinegar.

She measures the amount of ethanoic acid in  $25.0 \text{ cm}^3$  samples of the vinegar made each day.

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

(a) Gemma uses this apparatus.



(i) What does Gemma measure out using the pipette?

..... [1]

(ii) Gemma uses a few drops of an indicator.

Where does she add these drops of indicator?

..... [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 <sup>3</sup>					
<b>set 1</b>	12.9	12.2	12.5	12.8	12.9	12.1
<b>set 2</b>	12.4	12.6	12.5	12.5	12.4	12.6

(i) What are the ranges of the two sets of results?

range of set 1 results = ..... to ..... cm<sup>3</sup>

range of set 2 results = ..... to ..... cm<sup>3</sup> [1]

(ii) Work out the mean for the set 2 results.

Show your working.

mean = ..... cm<sup>3</sup> [2]

(iii) 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.

.....

.....

.....

..... [2]

[Total: 7]

[Paper Total: 60]

**END OF QUESTION PAPER**

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# Periodic Table

1

2

3

4

5

6

7

0

1 <b>H</b> hydrogen 1
--------------------------------

## Key

relative atomic mass
<b>atomic symbol</b>
name
atomic (proton) number

7 <b>Li</b> lithium 3	9 <b>Be</b> beryllium 4											11 <b>B</b> boron 5	12 <b>C</b> carbon 6	14 <b>N</b> nitrogen 7	16 <b>O</b> oxygen 8	19 <b>F</b> fluorine 9	20 <b>Ne</b> neon 10
23 <b>Na</b> sodium 11	24 <b>Mg</b> magnesium 12											27 <b>Al</b> aluminium 13	28 <b>Si</b> silicon 14	31 <b>P</b> phosphorus 15	32 <b>S</b> sulfur 16	35.5 <b>Cl</b> chlorine 17	40 <b>Ar</b> argon 18
39 <b>K</b> potassium 19	40 <b>Ca</b> calcium 20	45 <b>Sc</b> scandium 21	48 <b>Ti</b> titanium 22	51 <b>V</b> vanadium 23	52 <b>Cr</b> chromium 24	55 <b>Mn</b> manganese 25	56 <b>Fe</b> iron 26	59 <b>Co</b> cobalt 27	59 <b>Ni</b> nickel 28	63.5 <b>Cu</b> copper 29	65 <b>Zn</b> zinc 30	70 <b>Ga</b> gallium 31	73 <b>Ge</b> germanium 32	75 <b>As</b> arsenic 33	79 <b>Se</b> selenium 34	80 <b>Br</b> bromine 35	84 <b>Kr</b> krypton 36
85 <b>Rb</b> rubidium 37	88 <b>Sr</b> strontium 38	89 <b>Y</b> yttrium 39	91 <b>Zr</b> zirconium 40	93 <b>Nb</b> niobium 41	96 <b>Mo</b> molybdenum 42	[98] <b>Tc</b> technetium 43	101 <b>Ru</b> ruthenium 44	103 <b>Rh</b> rhodium 45	106 <b>Pd</b> palladium 46	108 <b>Ag</b> silver 47	112 <b>Cd</b> cadmium 48	115 <b>In</b> indium 49	119 <b>Sn</b> tin 50	122 <b>Sb</b> antimony 51	128 <b>Te</b> tellurium 52	127 <b>I</b> iodine 53	131 <b>Xe</b> xenon 54
133 <b>Cs</b> caesium 55	137 <b>Ba</b> barium 56	139 <b>La*</b> lanthanum 57	178 <b>Hf</b> hafnium 72	181 <b>Ta</b> tantalum 73	184 <b>W</b> tungsten 74	186 <b>Re</b> rhenium 75	190 <b>Os</b> osmium 76	192 <b>Ir</b> iridium 77	195 <b>Pt</b> platinum 78	197 <b>Au</b> gold 79	201 <b>Hg</b> mercury 80	204 <b>Tl</b> thallium 81	207 <b>Pb</b> lead 82	209 <b>Bi</b> bismuth 83	[209] <b>Po</b> polonium 84	[210] <b>At</b> astatine 85	[222] <b>Rn</b> radon 86
[223] <b>Fr</b> francium 87	[226] <b>Ra</b> radium 88	[227] <b>Ac*</b> actinium 89	[261] <b>Rf</b> rutherfordium 104	[262] <b>Db</b> dubnium 105	[266] <b>Sg</b> seaborgium 106	[264] <b>Bh</b> bohrium 107	[277] <b>Hs</b> hassium 108	[268] <b>Mt</b> meitnerium 109	[271] <b>Ds</b> darmstadtium 110	[272] <b>Rg</b> roentgenium 111	Elements with atomic numbers 112-116 have been reported but not fully authenticated						

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

**GENERAL CERTIFICATE OF SECONDARY EDUCATION**

**TWENTY FIRST CENTURY SCIENCE**

**CHEMISTRY A**

**A173/01**

Unit A173: Module C7 (Foundation Tier)

**MARK SCHEME**

**MAXIMUM MARK 60**

## 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
  - words = 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 **not** 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.

<input type="checkbox"/>
<input type="checkbox"/>
<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/>
<input type="checkbox"/>

This would be worth 0 marks.

Put ticks (✓) in the two correct boxes.

<input type="checkbox"/>
<input type="checkbox"/>
<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/>
<input type="checkbox"/>

This would be worth one mark.

Put ticks (✓) in the two correct boxes.

<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/>
<input type="checkbox"/>

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

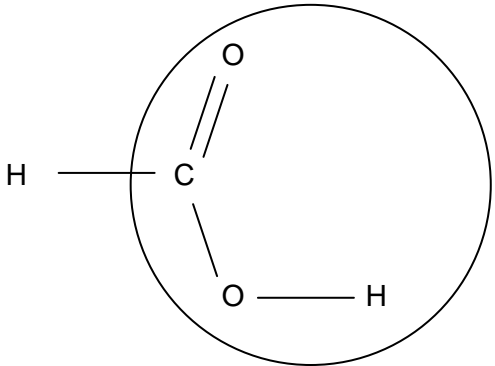
Edinburgh	
Manchester	
Paris	
Southampton	


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

Edinburgh			✓			✓	✓	✓	✓	
Manchester	✓	x	✓	✓	✓				✓	
Paris				✓	✓		✓	✓	✓	
Southampton	✓	x		✓		✓	✓		✓	
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)		[1]	circle around COOH group
	(b) (i)	methanoic acid and calcium carbonate in either order in reactant boxes carbon dioxide and water in either order in product boxes	[2]	

Question	Expected answers	Mark	Additional guidance
1 (b) (ii) 	<p><b>[Level 3]</b> Answer correctly identifies the strong acid and the weak acid, compares their reactivity and shows a clear understanding of why the strong acid is not used. 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)</p> <p><b>[Level 2]</b> Answer correctly identifies the strong acid and the weak acid, but does not clearly explain why the strong acid is not used. 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)</p> <p><b>[Level 1]</b> Answer correctly identifies either the strong acid or the weak acid without considering the other, and does not clearly explain why the strong acid is not used. 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)</p> <p><b>[Level 0]</b> Insufficient or irrelevant science. Answer not worthy of credit. (0 marks)</p>	[6]	<p><b>relevant points include:</b></p> <ul style="list-style-type: none"> <li>• methanoic acid is a weak acid</li> <li>• hydrochloric acid is a strong acid</li> <li>• strong acids are more reactive than weak acids</li> </ul> <p>Hydrochloric acid is not used because</p> <ul style="list-style-type: none"> <li>• it will, react with the metal / damage the kettle</li> <li>• idea of safety considerations when using strong acids</li> </ul>

Question		Expected answers	Mark	Additional guidance
1	(c)		[2]	no errors = 2 marks one error = 1 mark two or more errors = 0 marks
<b>Total</b>			<b>[11]</b>	

Question		Expected answers	Mark	Additional guidance
2	(a)	energy	[1]	
	(b)	glycerol + fatty acids	[1]	either order
	(c)	<p>It can improve the taste. <input checked="" type="checkbox"/></p> <p><input type="checkbox"/></p> <p><input type="checkbox"/></p> <p><input type="checkbox"/></p> <p>It can improve the smell. <input checked="" type="checkbox"/></p> <p><input type="checkbox"/></p>	[1]	
<b>Total</b>			<b>[3]</b>	


Question		Expected answers	Mark	Additional guidance
3	(a) (i)	retention time is the length of time from the injection of the sample until the chemical leaves the column / to the appearance of the peak	[2]	
	(ii)	as the size of the molecule increases, the retention time increases	[1]	
	(b) (i)	ethane butane pentane	[1]	any order
	(ii)	butane	[1]	
	(c) 	<p><b>[Level 3]</b> 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)</p> <p><b>[Level 2]</b> 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)</p> <p><b>[Level 1]</b> 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)</p> <p><b>[Level 0]</b> Insufficient or irrelevant science. Answer not worthy of credit. (0 marks)</p>	[6]	<p><b>relevant points include:</b></p> <ul style="list-style-type: none"> <li>in an exothermic reaction energy is released / given out , as heat</li> <li>during a reaction bonds are broken in the reactants and new bonds formed in the products</li> <li>breaking bonds, requires / uses / takes in , energy</li> <li>forming bonds, releases / gives out , energy</li> <li>energy change for a reaction is the sum of these two energy changes</li> <li>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</li> </ul> <p><b>accept</b> the idea that the reaction heats up its surroundings for a low-level mark</p>
<b>Total</b>			<b>[11]</b>	

Question		Expected answers	Mark	Additional guidance
4	(a)	A C F B E	[3]	all 5 in correct order for 3 marks 4 in correct order for 2 marks 3 in correct order for 1 mark
	(b)	he should use a burette because it allows accurate measurement of the volume	[2]	
	(c) (i)	58	[1]	
	(ii)	0.75	[2]	<b>allow</b> ecf from the candidate's answer to part (i) <b>credit</b> 1 mark max. for any number other than 0.75 that has been rounded correctly from 0.746849315
	(d) (i)	<i>they should be worried because:</i> there is too much variation in the amount of active ingredient/magnesium hydroxide / reference to the sample from batch 1 being lower / it is important that there is the correct/same amount of active ingredient in each tablet	[1]	no marks for saying they should be worried, only for the justification
	(ii)	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>Total</b>			<b>[11]</b>	

Question			Expected answers	Mark	Additional guidance
5	(a)	(i)	<input type="checkbox"/> <input type="checkbox"/> A chemical made in large quantities. <input checked="" type="checkbox"/> <input type="checkbox"/>	[1]	
		(ii)	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> Ethene is obtained from crude oil. <input checked="" type="checkbox"/> One day we will run out of crude oil. <input checked="" type="checkbox"/>	[2]	

Question		Expected answers	Mark	Additional guidance
5	(b) (i)	The company has to dispose of ... <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	[1]	
	(ii)	activation energy route	[2]	
	(c)	to protect people and the environment	[2]	
<b>Total</b>			<b>[8]</b>	

Question		Expected answers	Mark	Additional guidance
6	(a)	 <input type="checkbox"/> <input type="checkbox"/> To increase the concentration ... <input checked="" type="checkbox"/> <input type="checkbox"/>	[1]	
	(b) (i)	ethane is converted to ethene ethene is reacted with steam to make ethanol	[2]	




Question	Expected answers	Mark	Additional guidance
6 (b) (ii) 	<p><b>[Level 3]</b> Answer shows a clear understanding of sustainability and applies it fully to both processes and indicates clearly why fermentation is the more sustainable method. 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)</p> <p><b>[Level 2]</b> Answer shows an understanding of sustainability but applies partially to both processes. For the most part the information is relevant and presented in a structured and coherent format, but the complete case for saying fermentation is more sustainable is not presented. Specialist terms are used for the most part appropriately. There are occasional errors in grammar, punctuation and spelling. (3-4 marks)</p> <p><b>[Level 1]</b> Answer has a valid comment on the sustainability of one or other of the two processes, but does not demonstrate why fermentation is more sustainable. 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)</p> <p><b>[Level 0]</b> Insufficient or irrelevant science. Answer not worthy of credit. (0 marks)</p>	[6]	<p><b>relevant points include:</b></p> <ul style="list-style-type: none"> <li>• making ethanol by fermentation is more sustainable than making ethanol from ethane</li> <li>• making ethanol by fermentation uses wheat/beet</li> <li>• more wheat/beet can be grown / wheat/beet is a renewable resource</li> <li>• making ethanol from ethane uses ethene</li> <li>• ethane is obtained from natural gas</li> <li>• natural gas is a finite/non-renewable resource</li> </ul> <p><b>accept</b> crude oil in place of natural gas</p> <p><b>ignore</b> technical details of either process</p>
	<b>Total</b>	<b>[9]</b>	



Question			Expected answers	Mark	Additional guidance
7	(a)	(i)	vinegar	[1]	
		(ii)	in the conical flask	[1]	
	(b)	(i)	12.1 to 12.9 12.4 to 12.6	[1]	
		(ii)	$(12.4+12.6+12.5+12.5+12.4+12.6)/6$ = 12.5	[2]	
	(c)		<i>she should use set 2 because:</i> 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 <b>do not allow</b> "more accurate" without qualification
<b>Total</b>				[7]	

## Assessment Objectives (AO) Grid

(includes quality of written communication )

Question	AO1	AO2	AO3	Total
1(a)		1		1
1(b)(i)		2		2
1(b)(ii) 	3	3		6
1(c)		2		2
2(a)	1			1
2(b)		1		1
2(c)	1			1
3(a)(i)	2			2
3(a)(ii)			1	1
3(b)(i)			1	1
3(b)(ii)			1	1
3(c) 	3	3		6
4(a)	2	1		3
4(b)	1	1		2
4(c)(i)		1		1
4(c)(ii)		2		2
4(d)(i)			1	1
4(d)(ii)			2	2
5(a)(i)	1			1
5(a)(ii)	1	1		2
5(b)(i)		1		1
5(b)(ii)	2			2
5(c)	2			2
6(a)	1			1
6(b)(i)	2			2
6(b)(ii) 	2	4		6
7(a)(i)		1		1
7(a)(ii)	1			1
7(b)(i)		1		1
7(b)(ii)		2		2
7(b)(iii)			2	2
<b>Totals</b>	<b>25</b>	<b>27</b>	<b>8</b>	<b>60</b>

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