AQA GCSE CHEMISTRY (4402)

CHEMISTRY



EXAM QUESTION PACK

UNIT C3 HIGHER TIER CH3HP PAPERS

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AQA

Please write clearly in block capitals.

Centre number | | | | | | Candidate number | | | | |

Surname _____

Forename(s) _____

Candidate signature _____

GCSE
Chemistry

H

Higher Tier Unit Chemistry C3

Wednesday 15 June 2016 Afternoon Time allowed: 1 hour

Materials
For this paper you must have:
- a ruler
- the Chemistry Data Sheet (enclosed).

You may use a calculator.

Instructions
- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information
- The marks for questions are shown in brackets.
- The maximum mark for this paper is 60.
- You are expected to use a calculator where appropriate.
- You are reminded of the need for good English and clear presentation in your answers.
- Question 2 should be answered in continuous prose.
  In this question you will be marked on your ability to:
  – use good English
  – organise information clearly
  – use specialist vocabulary where appropriate.

Advice
- In all calculations, show clearly how you work out your answer.

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Do not write outside the box

There are no questions printed on this page

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ANSWER IN THE SPACES PROVIDED

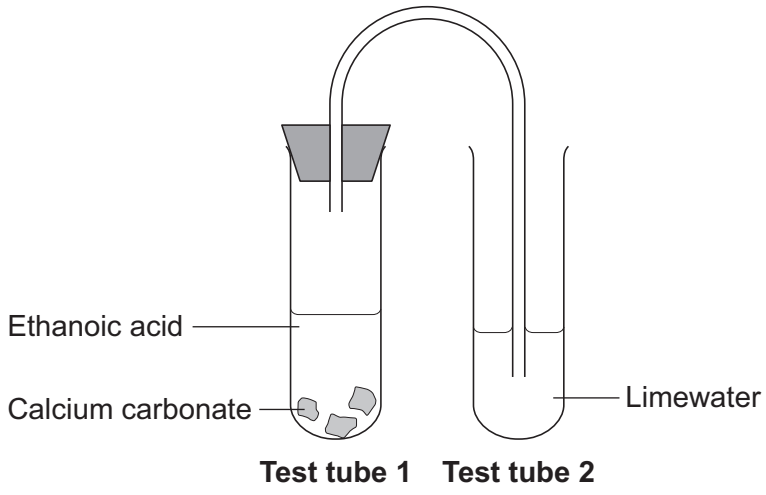
Do not write outside the box

Answer **all** questions in the spaces provided.

1 This question is about reactions of ethanoic acid and the analysis of salts.

1 (a) **Figure 1** shows the apparatus used to investigate the reaction of ethanoic acid with calcium carbonate.

Figure 1



1 (a) (i) Describe a change that would be seen in each test tube.

Give a reason for each change.

[4 marks]

Test tube 1 _____

_____

_____

_____

Test tube 2 _____

_____

_____

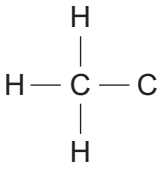
_____

Question 1 continues on the next page

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1 (a) (ii) Complete the displayed structure of ethanoic acid.

[1 mark]



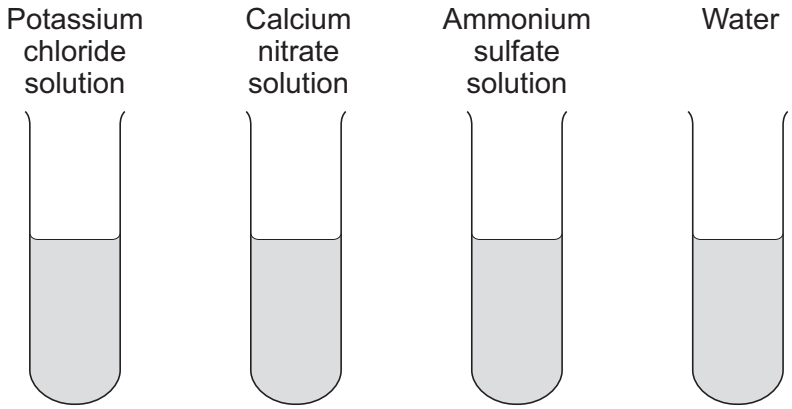
1 (a) (iii) Ethanoic acid is a carboxylic acid.
Complete the sentence.

[2 marks]

Carboxylic acids react with alcohols in the presence of an _____ catalyst to produce pleasant-smelling compounds called _____ .

1 (b) **Figure 2** shows four test tubes containing three different salt solutions and water.

Figure 2



Each solution and the water was tested with:

- silver nitrate in the presence of dilute nitric acid
- barium chloride in the presence of dilute hydrochloric acid.

Do not write outside the box

Complete the table of results.

[2 marks]

	Potassium chloride solution	**Calcium nitrate solution**	**Ammonium sulfate solution**	**Water**
Test with silver nitrate in the presence of dilute nitric acid			no change	no change
Test with barium chloride in the presence of dilute hydrochloric acid		no change	white precipitate	

1 (c) Flame tests can be used to identify metal ions.

1 (c) (i) Complete the following sentences.

[2 marks]

The flame colour for potassium ions is _____ .

The flame colour for calcium ions is _____ .

1 (c) (ii) Give **one** reason why a flame test would **not** show the presence of both potassium ions and calcium ions in a mixture.

[1 mark]

_____

_____

_____

12

Turn over for the next question

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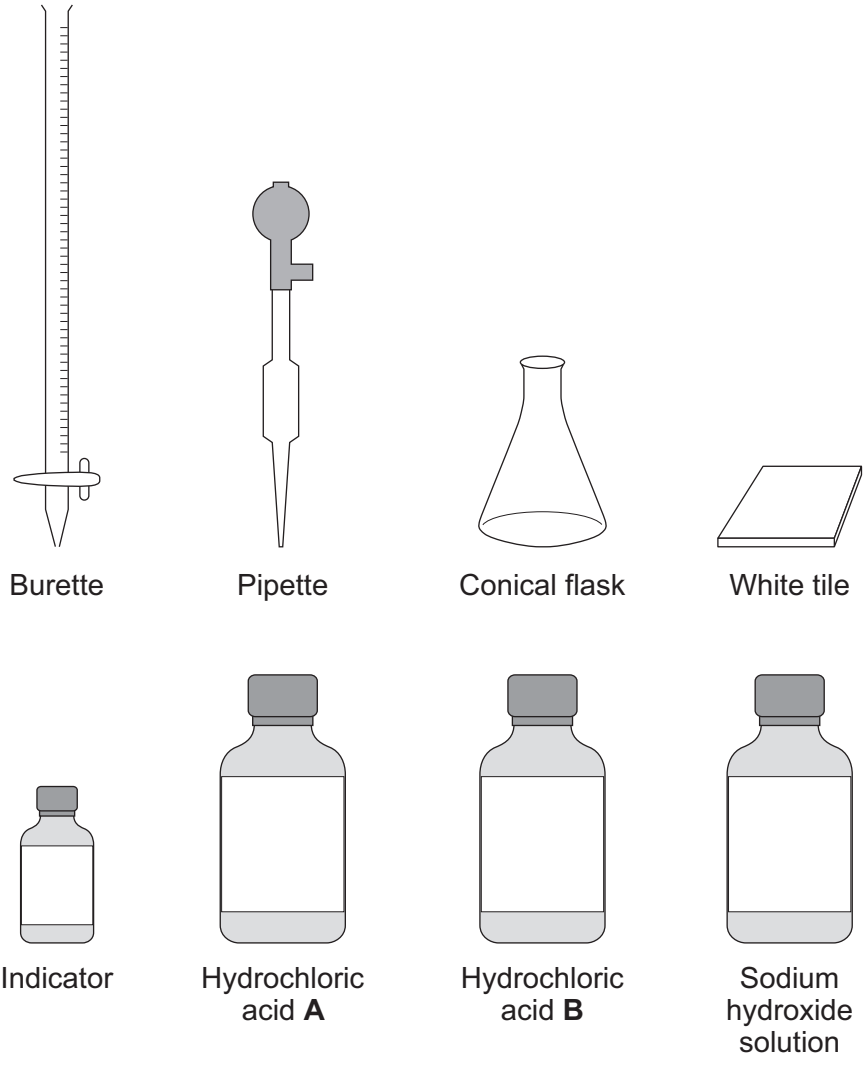
2 **In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.**

A student has to check if two samples of hydrochloric acid, **A** and **B**, are the same concentration.

Describe how the student could use the apparatus and the solutions in **Figure 3** to carry out titrations.

[6 marks]

Figure 3



Do not write outside the box

Extra space

6

Turn over for the next question

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3 This question is about elements and the periodic table.

3 (a) Newlands and Mendeleev both produced early versions of the periodic table.

3 (a) (i) Complete the sentence.

[1 mark]

In their periodic tables, Newlands and Mendeleev arranged the elements in order of

_____ .

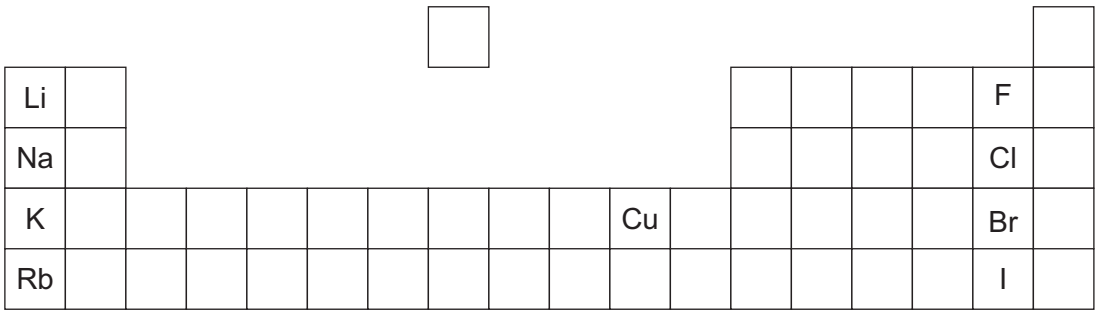
3 (a) (ii) Name the particle that allowed the elements to be arranged in order of their atomic number in the modern periodic table.

[1 mark]

_____

3 (b) **Figure 4** shows the position of nine elements in the modern periodic table.

Figure 4



3 (b) (i) Which **one** of the nine elements shown in **Figure 4** has the lowest boiling point?

[1 mark]

_____

3 (b) (ii) Copper and potassium have different melting points and boiling points.
Give **one other** difference between the properties of copper and potassium.

[1 mark]

_____

_____

Do not write outside the box

3 (b) (iii) Explain why the reactivity of the elements increases going down Group 1 from lithium to rubidium but decreases going down Group 7 from fluorine to iodine.

[4 marks]

8

Turn over for the next question

Do not write outside the box

4 This question is about water.

4 (a) Hard water contains dissolved compounds.
Explain **one** benefit of drinking hard water.

[2 marks]

4 (b) What is the name of the solid formed when hard water reacts with soap?

[1 mark]

4 (c) Using temporary hard water in an electric kettle reduces the efficiency of the kettle.
Describe how this happens.

[4 marks]

Do not write outside the box

4 (d) Water filters used in homes contain ion exchange resins.
Explain how an ion exchange resin changes the dissolved compounds in tap water to improve the water.

[3 marks]

10

Turn over for the next question

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5 This question is about energy changes in chemical reactions.

5 (a) Balance the chemical equation for the combustion of methane.

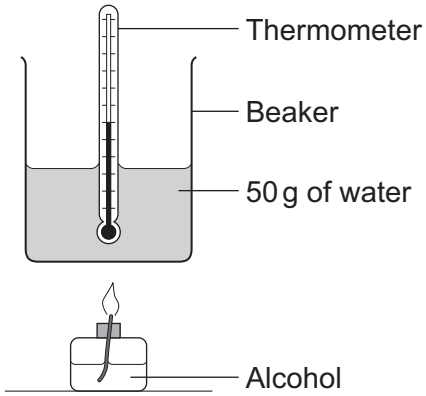
[1 mark]

$$CH_4 \quad + \quad O_2 \quad \longrightarrow \quad CO_2 \quad + \quad H_2O$$

5 (b) Alcohols are used as fuels.

A group of students investigated the amount of energy released when an alcohol was burned. The students used the apparatus shown in **Figure 5**.

Figure 5



In one experiment the temperature of 50 g of water increased from 22.0 °C to 38.4 °C. The mass of alcohol burned was 0.8 g.

Calculate the heat energy (Q) in joules, released by burning 0.8 g of the alcohol.
Use the equation:

$$Q = m \times c \times \Delta T$$

Specific heat capacity (c) = 4.2 J/g/°C

[3 marks]

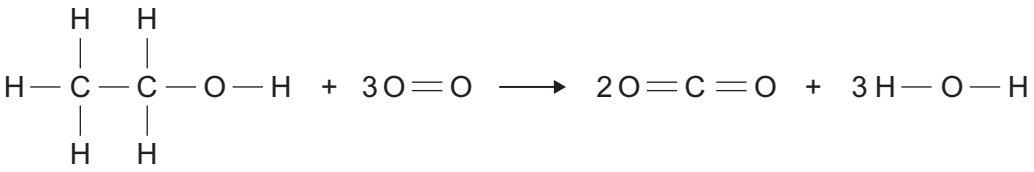
Heat energy (Q) = _____ J

Do not write outside the box

5 (c) The chemical equation for the combustion of ethanol is:

$$C_2H_5OH + 3O_2 \longrightarrow 2CO_2 + 3H_2O$$

5 (c) (i) The equation for the reaction can be shown as:



Bond	Bond energy in kJ per mole
C — H	413
C — C	347
C — O	358
C = O	799
O — H	467
O = O	495

Use the bond energies to calculate the overall energy change for this reaction.

[3 marks]

Overall energy change = _____ kJ per mole

Question 5 continues on the next page

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5 (c) (ii) The reaction is exothermic.
Explain why, in terms of bonds broken and bonds formed.

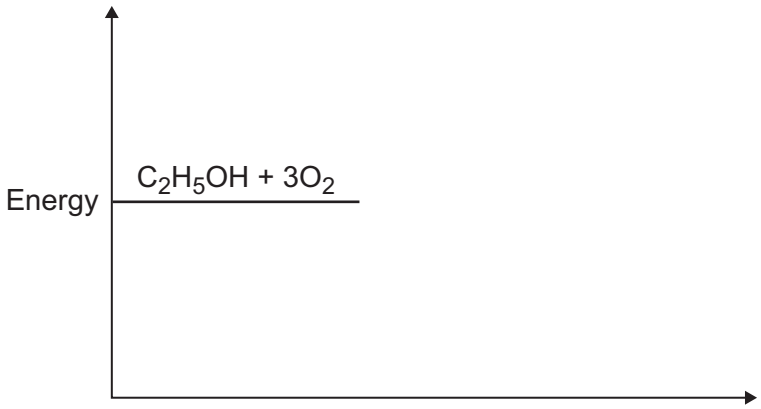
[2 marks]

5 (c) (iii) Complete the energy level diagram for the combustion of ethanol.

[3 marks]

On the completed diagram, label:

- activation energy
- overall energy change.

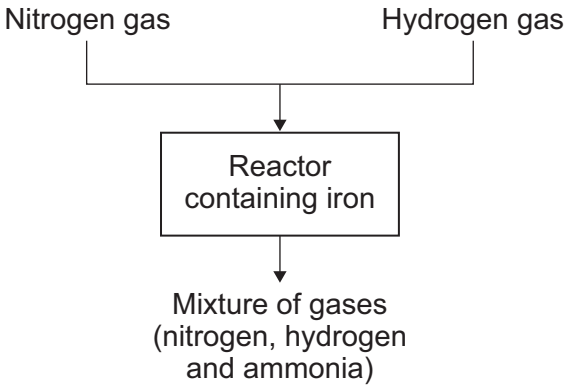


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6 **Figure 6** shows a flow diagram for the Haber process.

Figure 6



6 (a) (i) Hydrogen gas is obtained from methane.
Name **one** source of methane.

[1 mark]

6 (a) (ii) Air is the source used to produce nitrogen for the Haber process.
Suggest why air must **not** get into the reactor.

[2 marks]

6 (a) (iii) Describe what happens to the mixture of gases from the reactor.

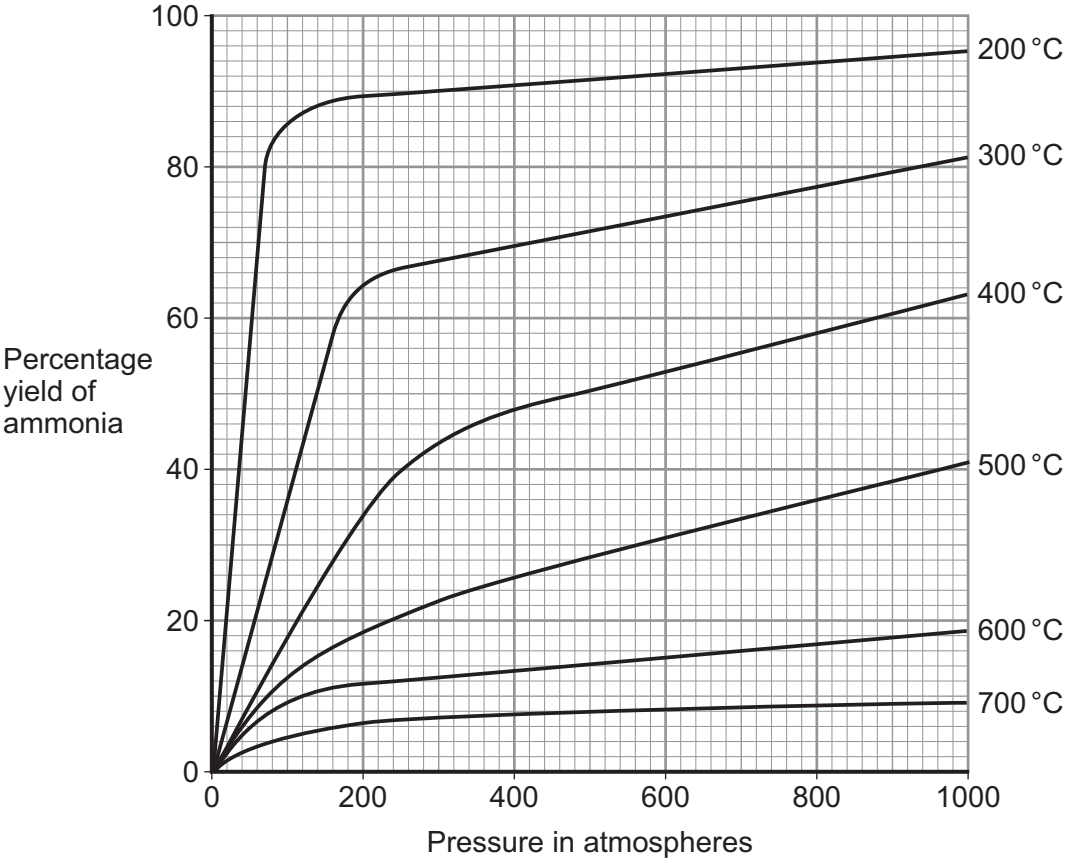
[3 marks]

Question 6 continues on the next page

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6 (b) The graph in **Figure 7** shows the percentage yield of ammonia using different conditions.

Figure 7



6 (b) (i) Use **Figure 7** to suggest the conditions that produce the greatest yield of ammonia.

[1 mark]

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6 (b) (ii) Use **Figure 7** to suggest and explain why the conditions used to produce ammonia in the Haber process are a temperature of 450 °C and a pressure of 200 atmospheres.

[5 marks]

12

END OF QUESTIONS

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AQA

GCSE

Chemistry

CH3HP

Mark scheme

4402

June 2016

Version/Stage: 1.0 Final

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Mark schemes are prepared by the Lead Assessment Writer and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation events which all associates participate in and is the scheme which was used by them in this examination. The standardisation process ensures that the mark scheme covers the students' responses to questions and that every associate understands and applies it in the same correct way. As preparation for standardisation each associate analyses a number of students' scripts. Alternative answers not already covered by the mark scheme are discussed and legislated for. If, after the standardisation process, associates encounter unusual answers which have not been raised they are required to refer these to the Lead Assessment Writer.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of students' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

Further copies of this mark scheme are available from aqa.org.uk

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Information to Examiners

1. General

The mark scheme for each question shows:

- the marks available for each part of the question
- the total marks available for the question
- the typical answer or answers which are expected
- extra information to help the Examiner make his or her judgement and help to delineate what is acceptable or not worthy of credit or, in discursive answers, to give an overview of the area in which a mark or marks may be awarded.
- the Assessment Objectives and specification content that each question is intended to cover.

The extra information is aligned to the appropriate answer in the left-hand part of the mark scheme and should only be applied to that item in the mark scheme.
At the beginning of a part of a question a reminder may be given, for example: where consequential marking needs to be considered in a calculation; or the answer may be on the diagram or at a different place on the script.
In general the right-hand side of the mark scheme is there to provide those extra details which confuse the main part of the mark scheme yet may be helpful in ensuring that marking is straightforward and consistent.

2. Emboldening and underlining

2.1 In a list of acceptable answers where more than one mark is available 'any **two** from' is used, with the number of marks emboldened. Each of the following bullet points is a potential mark.

2.2 A bold **and** is used to indicate that both parts of the answer are required to award the mark.

2.3 Alternative answers acceptable for a mark are indicated by the use of **or**.
Different terms in the mark scheme are shown by a / ; eg allow smooth / free movement.

2.4 Any wording that is underlined is essential for the marking point to be awarded.

3. Marking points

3.1 Marking of lists

This applies to questions requiring a set number of responses, but for which students have provided extra responses. The general principle to be followed in such a situation is that 'right + wrong = wrong'.

Each error / contradiction negates each correct response. So, if the number of error / contradictions equals or exceeds the number of marks available for the question, no marks can be awarded.

However, responses considered to be neutral (indicated as * in example 1) are not penalised.

Example 1: What is the pH of an acidic solution?

[1 mark]

Student	Response	Marks awarded
1	green, 5	0
2	red*, 5	1
3	red*, 8	0

Example 2: Name two planets in the solar system.

[2 marks]

Student	Response	Marks awarded
1	Pluto, Mars, Moon	1
2	Pluto, Sun, Mars, Moon	0

3.2 Use of chemical symbols / formulae

If a student writes a chemical symbol / formula instead of a required chemical name, full credit can be given if the symbol / formula is correct and if, in the context of the question, such action is appropriate.

3.3 Marking procedure for calculations

Full marks can be given for a correct numerical answer, without any working shown.

However, if the answer is incorrect, mark(s) can be gained by correct substitution / working and this is shown in the 'extra information' column or by each stage of a longer calculation.

3.4 Interpretation of 'it'

Answers using the word 'it' should be given credit only if it is clear that the 'it' refers to the correct subject.

3.5 Errors carried forward

Any error in the answers to a structured question should be penalised once only.

Papers should be constructed in such a way that the number of times errors can be carried forward are kept to a minimum. Allowances for errors carried forward are most likely to be restricted to calculation questions and should be shown by the abbreviation 'ecf' in the marking scheme.

3.6 Phonetic spelling

The phonetic spelling of correct scientific terminology should be credited **unless** there is a possible confusion with another technical term.

3.7 Brackets

(…..) are used to indicate information which is not essential for the mark to be awarded but is included to help the examiner identify the sense of the answer required.

3.8 Accept / allow

Accept is used to indicate an equivalent answer to that given on the left-hand side of the mark scheme. Allow is used to denote lower-level responses that just gain credit.

3.9 Ignore / Insufficient / Do not allow

Ignore or insufficient is used when the information given is irrelevant to the question or not enough to gain a marking point. Any further correct amplification could gain the marking point.

Do **not** allow means that this is a wrong answer which, even if the correct answer is given, will still mean that the mark is not awarded.

4. Quality of Written Communication and levels marking

In Question 2 students are required to produce extended written material in English, and will be assessed on the quality of their written communication as well as the standard of the scientific response.

Students will be required to:

- use good English
- organise information clearly
- use specialist vocabulary where appropriate.

The following general criteria should be used to assign marks to a level.

Level 1: Basic

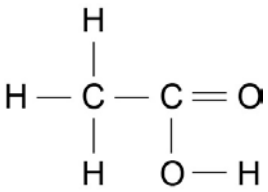
- Knowledge of basic information
- Simple understanding
- The answer is poorly organised, with almost no specialist terms and their use demonstrating a general lack of understanding of their meaning, little or no detail
- The spelling, punctuation and grammar are very weak.

Level 2: Clear

- Knowledge of accurate information
- Clear understanding
- The answer has some structure and organisation, use of specialist terms has been attempted but not always accurately, some detail is given
- There is reasonable accuracy in spelling, punctuation and grammar, although there may still be some errors.

Level 3: Detailed

- Knowledge of accurate information appropriately contextualised
- Detailed understanding, supported by relevant evidence and examples
- Answer is coherent and in an organised, logical sequence, containing a wide range of appropriate or relevant specialist terms used accurately
- The answer shows almost faultless spelling, punctuation and grammar.

Question	Answers	Extra information	Mark	AO / SpecRef
1(a)(i)	fizz / effervescence / bubbles	allow calcium carbonate decreases in size or dissolves	1	AO2/AO3 3.4.1d, 3.6.2b
	because carbon dioxide produced / released	allow because gas produced / released	1	
	limewater turns cloudy / milky / white		1	
	because (a precipitate of or solid) calcium carbonate forms	allow because of carbon dioxide if not already credited	1	
1(a)(ii)		allow –OH do not allow lower case 'h'	1	AO1 3.6.2a
1(a)(iii)	acid	must be in this order ignore any name of an acid	1	AO1 3.6.2b
	ester(s)		1	
1(b)	white (precipitate) no change no change no change	all four correct 2 marks any two correct 1 mark	2	AO2 3.4.1e,f
1(c)(i)	lilac red	must be in this order allow purple	1 1	AO1 3.4.1a
1(c)(ii)	colours are masked / changed by each flame colour		1	AO3 3.4.1a
Total			**12**	

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Question	Answers	Extra information	Mark	AO / SpecRef
2			6	2AO1 / 3AO2 / 1AO3 3.4.1g

Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should also refer to the information on page 5 and apply a 'best-fit' approach to the marking.

0 marks	Level 1 (1–2 marks)	Level 2 (3–4 marks)	Level 3 (5–6 marks)
No relevant content.	There is a simple description of using some of the apparatus.	There is a description of an experimental method including addition of acid to alkali which may include an indicator or colour change and may include a measurement of volume**.**	There is a description of titrations that would allow a comparison to be made between the two solutions of hydrochloric acid.

examples of chemistry points made in the response could include:

- acid in burette **or** flask
- alkali/sodium hydroxide **or** acid in burette or flask
- volume of acid **or** alkali measured using the pipette
- indicator in flask
- white tile under the flask
- slow addition
- swirling/mixing
- colour change of indicator
- burette volume measured

Total		6

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Question	Answers	Extra information	Mark	AO / SpecRef
3(a)(i)	atomic weights	allow atomic masses	1	AO1 3.1.1a
3(a)(ii)	proton	allow proton number	1	AO1 3.1.2a
3(b)(i)	F/fluorine	allow F_2	1	AO3 3.1.3a,b,f
3(b)(ii)	any **one** from: • copper has a higher density • copper is stronger • copper is harder • copper is less reactive	allow converse for potassium allow named property ignore colour, conductivity, melting point and boiling point	1	AO1 3.1.3c
3(b)(iii)	relative distance from nucleus relative attraction to nucleus relative ease of gain or loss of electron opposite explanation of ease of gain or loss of electron for other group	max 3 marks if 'outer' not mentioned allow more / fewer energy levels / shells or larger / smaller atom allow more / less shielding	1 1 1 1	2AO1 / 1AO2 / 1AO3 3.1.3b,f,h
Total			**8**	

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Question	Answers	Extra information	Mark	AO / SpecRef
4(a)	development / maintenance of teeth / bones	allow lowers risk of heart disease	1	AO1 3.2.1f
	because contains calcium ions / compounds	allow contains calcium	1	
4(b)	scum or calcium stearate		1	AO1 3.2.1a
4(c)	temporary hard water contains calcium hydrogencarbonate or hydrogencarbonate ions	allow hydrogencarbonate	1	1AO1 / 2AO2 / 1AO3 3.2.1c,d,e
	when heated / boiled these decompose	allow decompose (in the kettle)	1	
	to produce a precipitate / scale or to produce calcium carbonate		1	
	coats the heating element or coats the kettle	allow prevents heat / energy transfer to the water	1	
4(d)		ions must be mentioned once to gain both of the first two marking points		2AO1 / 1AO2 3.2.1g, 3.2.2b
	ion exchange resins contain sodium / hydrogen ions		1	
	which replace / remove the calcium / magnesium ions	allow displace, but do not allow references to reactivity series	1	
	so removing the hardness or producing soft water		1	
Total			**10**	

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Question	Answers	Extra information	Mark	AO / SpecRef
5(a)	CH_4 + $2O_2$ → CO_2 + $2H_2O$	allow multiples	1	AO2 3.3.1a
5(b)	3444 J	if answer incorrect: one mark for temperature increase = 16.4 °C one mark for mass of water = 50 g ecf for one incorrect value gains two marks for correct calculation no ecf for two incorrect values	3	AO2 3.3.1a
5(c)(i)	1276 (kJ per mole)	ignore + or - if answer incorrect: [(5 x 413) + 347 + 358 +467] + [(3 x 495)] = 4722 (1 mark) [(4 x 799) + (6 x 467)] = 5998 (1 mark) correct subtraction of calculated energy values (1 mark)	3	AO2 3.3.1f
5(c)(ii)	because energy released when bonds form is greater than energy used when bonds broken	allow converse if no mark awarded allow one mark for energy is used to break bonds or one mark for energy is released when bonds form	2	AO1 3.3.1e,f
5(c)(iii)	products line lower than reactants activation energy labelled overall energy change labelled		1 1 1	2AO2 / 1AO3 3.3.1d
Total			**12**	

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Question	Answers	Extra information	Mark	AO / SpecRef
6(a)(i)	natural gas	allow fossil fuels / biogas generator	1	AO1 3.5.1a
6(a)(ii)	air contains oxygen this would react with / oxidise the hydrogen	 allow this would react with / oxidise the iron ignore nitrogen	1 1	AO3 3.5.1b
6(a)(iii)	cooled ammonia condenses / liquefies (so can be separated) nitrogen and hydrogen (remain as gases and) are returned to the reactor	 allow recycled	1 1 1	AO1 3.5.1b
6(b)(i)	200 °C **and** 1000 atmospheres		1	AO3 3.5.1b
6(b)(ii)	the reaction is reversible forward reaction is exothermic so increased temperature lowers the yield of ammonia a lower temperature would decrease rate of reaction a higher pressure would increase the yield of ammonia because the forward reaction produces the least number of (gaseous) molecules / moles higher pressures would involve high cost / energy	allow stated as equilibrium or forward / backward reaction anywhere in answer allow converse allow converse allow converse ignore risk / explosion	1 1 1 1 1	3AO1 / 2AO3 3.5.1d,e,f,g,h
Total			**12**	

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Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										

For Examiner's Use	
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Question	Mark
1	
2	
3	
4	
5	
6	
7	
8	
TOTAL	

General Certificate of Secondary Education
Higher Tier
June 2015

Chemistry
Unit Chemistry C3

CH3HP

H

Thursday 14 May 2015 9.00 am to 10.00 am

For this paper you must have:
- a ruler
- the Chemistry Data Sheet (enclosed).

You may use a calculator.

Time allowed
- 1 hour

A

Instructions
- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information
- The marks for questions are shown in brackets.
- The maximum mark for this paper is 60.
- You are expected to use a calculator where appropriate.
- You are reminded of the need for good English and clear presentation in your answers.
- Question 4(b) should be answered in continuous prose.
  In this question you will be marked on your ability to:
  – use good English
  – organise information clearly
  – use specialist vocabulary where appropriate.

Advice
- In all calculations, show clearly how you work out your answer.

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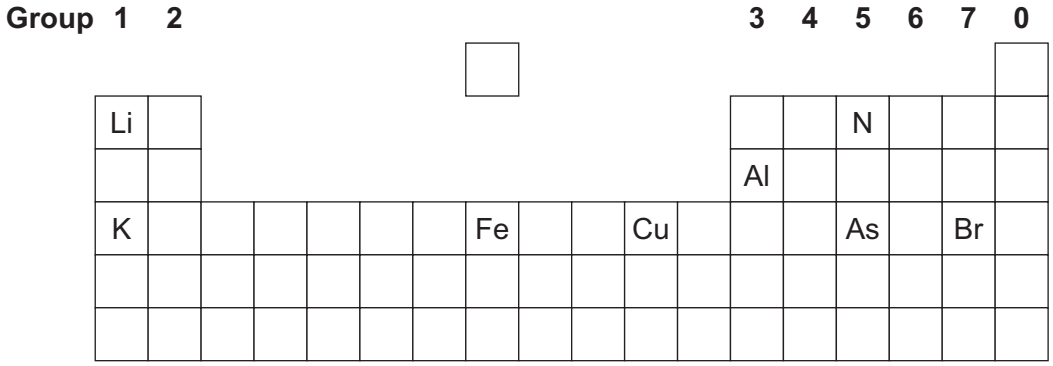
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ANSWER IN THE SPACES PROVIDED

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Answer **all** questions in the spaces provided.

1 **Figure 1** shows the positions of eight elements in the modern periodic table.

Figure 1



Choose the correct chemical symbols from **Figure 1** to complete each sentence.

1 (a) The **two** metals that react vigorously with water are ..... and ..... .

[1 mark]

1 (b) The element used as a catalyst in the Haber process is ..... .

[1 mark]

1 (c) The **two** elements with five electrons in their outer shell (highest energy level) are

..... and ..... .

[1 mark]

1 (d) Iron has ions with different charges.

The other metal that has ions with different charges is ..... .

[1 mark]

4

Turn over for the next question

Do not write outside the box

2 In 1866 John Newlands produced an early version of the periodic table.

Part of Newlands' periodic table is shown in **Figure 2**.

Figure 2

Column	1	2	3	4	5	6	7
	H	Li	Be	B	C	N	O
	F	Na	Mg	Al	Si	P	S
	Cl	K	Ca	Cr	Ti	Mn	Fe

Newlands' periodic table arranged all the known elements into columns in order of their atomic weight.

Newlands was trying to show a pattern by putting the elements into columns.

2 (a) Iron (Fe) does **not** fit the pattern in column 7.

Give a reason why.

[1 mark]

.....

.....

2 (b) In 1869 Dmitri Mendeleev produced his version of the periodic table.

Why did Mendeleev leave gaps for undiscovered elements in his periodic table?

[1 mark]

.....

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2 (c) Newlands and Mendeleev placed the elements in order of atomic weight.

Complete the sentence.

[1 mark]

The modern periodic table places the elements in order of ..... .

2 (d) Lithium, sodium and potassium are all in Group 1 of the modern periodic table.

Explain why.

[2 marks]

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5

Turn over for the next question

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ANSWER IN THE SPACES PROVIDED

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3 This question is about the halogens (Group 7).

3 (a) How do the boiling points of the halogens change down the group from fluorine to iodine?

[1 mark]

.....

.....

3 (b) Sodium bromide is produced by reacting sodium with bromine.

Sodium bromide is an ionic compound.

3 (b) (i) Write down the symbols of the **two** ions in sodium bromide.

[1 mark]

.....

3 (b) (ii) Chlorine reacts with sodium bromide solution to produce bromine and one other product.

Complete the word equation for the reaction.

[1 mark]

chlorine + sodium bromide ⟶ bromine + ...

3 (b) (iii) Why does chlorine displace bromine from sodium bromide?

[1 mark]

.....

.....

3 (b) (iv) Use the Chemistry Data Sheet to help you to answer this question.

Suggest which halogen could react with sodium chloride solution to produce chlorine.

[1 mark]

.....

5

Turn over for the next question

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4 This question is about water.

4 (a) Rainwater is soft.

How is hard water produced from rainwater?

[2 marks]

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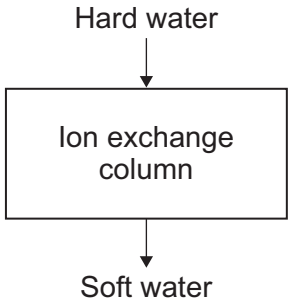
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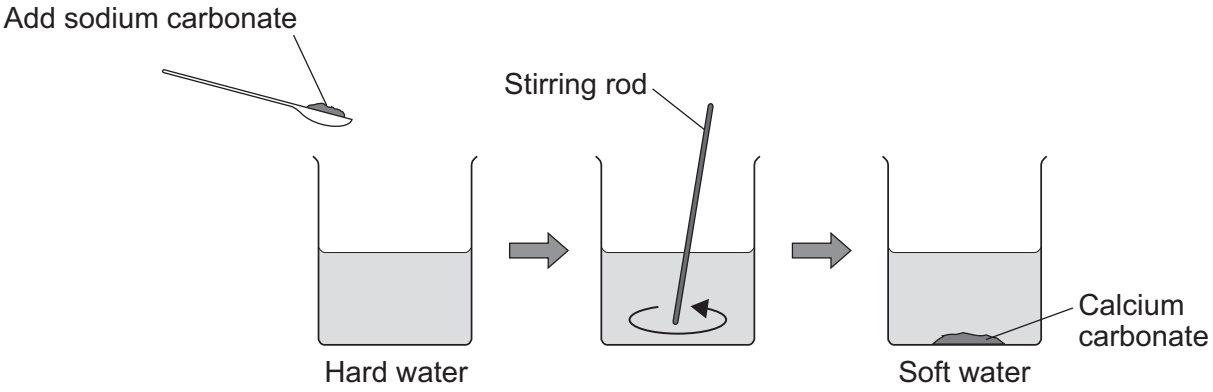
4 (b) **In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.**

Hard water can be softened by two different methods.

Method 1: Ion exchange



Method 2: Adding sodium carbonate (washing soda)



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Describe how each method softens water **and** compare the advantages of these two methods.

[6 marks]

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Extra space .....

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8

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5 This question is about organic compounds.

5 (a) Ethanol is an alcohol.
One use of ethanol is in alcoholic drinks.

Give **two** other uses of ethanol.

[2 marks]

.....

.....

5 (b) Which gas is produced when sodium reacts with ethanol?

[1 mark]

Tick (✓) **one** box.

Carbon dioxide ☐

Carbon monoxide ☐

Hydrogen ☐

Oxygen ☐

5 (c) Ethanoic acid (CH_3COOH) can be produced from ethanol (CH_3CH_2OH).

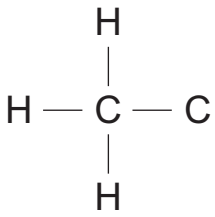
5 (c) (i) What type of reaction produces ethanoic acid from ethanol?

[1 mark]

.....

5 (c) (ii) Complete the displayed structure of ethanoic acid.

[1 mark]



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5 (c) (iii) Solutions of ethanoic acid and hydrochloric acid with the same concentration have different pH values.

Explain why the solution of ethanoic acid has a higher pH than the solution of hydrochloric acid.

[2 marks]

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5 (d) Ethanol and ethanoic acid react in the presence of a catalyst to form an ester.

5 (d) (i) Name the ester made from ethanol and ethanoic acid.

[1 mark]

.....

5 (d) (ii) What type of chemical is used as a catalyst in this reaction?

[1 mark]

.....

5 (d) (iii) Esters are used in perfumes because they smell pleasant and are volatile.

What does volatile mean?

[1 mark]

.....

10

Turn over for the next question

Do not write outside the box

6 This question is about reversible reactions and chemical equilibrium.

6 (a) Reversible reactions can reach equilibrium in a closed system.

6 (a) (i) What is meant by a closed system?

[1 mark]

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6 (a) (ii) Explain why, when a reversible reaction reaches equilibrium, the reaction appears to have stopped.

[2 marks]

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6 (b) In the Haber process, the reaction of nitrogen with hydrogen to produce ammonia is reversible.

$$N_2(g) + 3\,H_2(g) \rightleftharpoons 2\,NH_3(g)$$

6 (b) (i) Name a natural resource from which hydrogen is produced.

[1 mark]

.....

6 (b) (ii) The Haber process uses a catalyst to speed up the reaction.

Explain how a catalyst speeds up a reaction.

[2 marks]

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6 (b) (iii) What happens to the amount of ammonia produced at equilibrium if the pressure is increased?

Give a reason for your answer.

[2 marks]

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Question 6 continues on the next page

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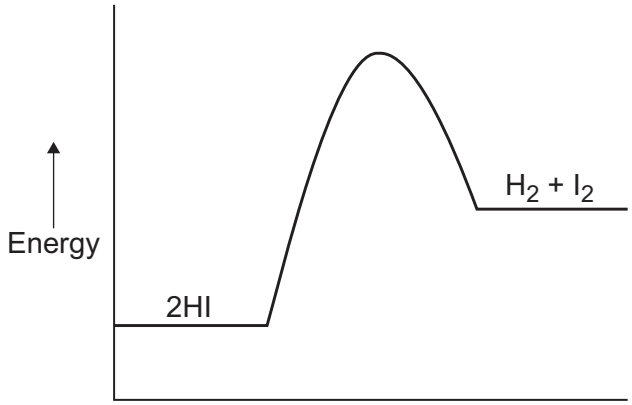
6 (c) The decomposition of hydrogen iodide into hydrogen and iodine is reversible.

$$2HI(g) \rightleftharpoons H_2(g) + I_2(g)$$

The forward reaction is endothermic.

The energy level diagram in **Figure 3** is for the forward reaction.

Figure 3



6 (c) (i) Draw an arrow to show the activation energy on the diagram in **Figure 3**.

[1 mark]

Do not write outside the box

6 (c) (ii) How does the diagram in **Figure 3** show that the reaction is endothermic?

[1 mark]

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6 (c) (iii) Suggest what effect, if any, increasing the temperature will have on the amount of hydrogen iodide at equilibrium.

Give a reason for your answer.

[2 marks]

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12

Turn over for the next question

Do not write outside the box

7 This question is about chemical analysis.

7 (a) A student has solutions of three compounds, **X**, **Y** and **Z**.

The student uses tests to identify the ions in the three compounds.

The student records the results of the tests in **Table 1**.

Table 1

	Test			
Compound	**Flame test**	**Add sodium hydroxide solution**	**Add hydrochloric acid and barium chloride solution**	**Add nitric acid and silver nitrate solution**
X	no colour	green precipitate	white precipitate	no reaction
Y	yellow flame	no reaction	no reaction	yellow precipitate
Z	no colour	brown precipitate	no reaction	cream precipitate

Identify the **two** ions present in each compound, **X**, **Y** and **Z**.

[3 marks]

X .....

Y .....

Z .....

7 (b) A chemist needs to find the concentration of a solution of barium hydroxide.
Barium hydroxide solution is an alkali.

The chemist could find the concentration of the barium hydroxide solution using two different methods.

Method 1

- An excess of sodium sulfate solution is added to 25 cm^3 of the barium hydroxide solution. A precipitate of barium sulfate is formed.
- The precipitate of barium sulfate is filtered, dried and weighed.
- The concentration of the barium hydroxide solution is calculated from the mass of barium sulfate produced.

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Method 2

- 25 cm^3 of the barium hydroxide solution is titrated with hydrochloric acid of known concentration.
- The concentration of the barium hydroxide solution is calculated from the result of the titration.

Compare the advantages and disadvantages of the two methods.

[5 marks]

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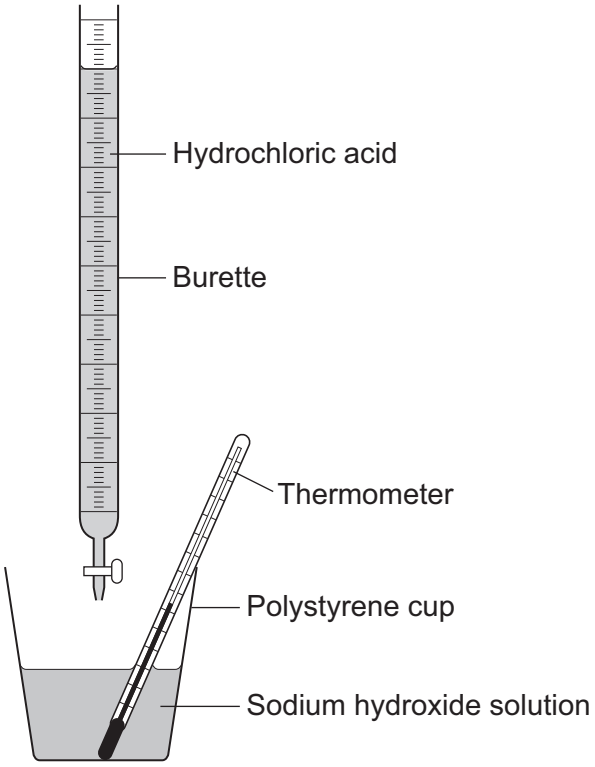
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8 A student investigates the energy released when hydrochloric acid completely neutralises sodium hydroxide solution.
The student uses the apparatus shown in **Figure 4**.

Figure 4



The student:

- measures 25 cm^3 sodium hydroxide solution into a polystyrene cup
- fills a burette with hydrochloric acid
- measures the temperature of the sodium hydroxide solution
- adds 5 cm^3 hydrochloric acid to the sodium hydroxide solution in the polystyrene cup
- stirs the mixture and measures the highest temperature of the mixture
- continues to add 5 cm^3 portions of hydrochloric acid, stirring and measuring the highest temperature of the mixture after each addition.

Question 8 continues on the next page

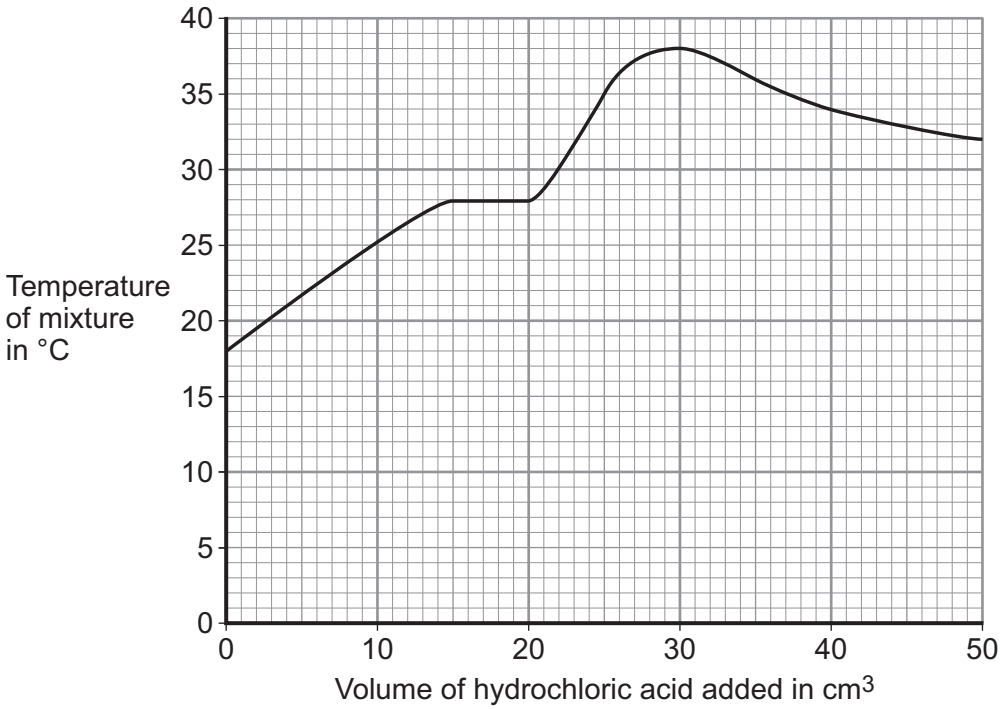
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8 (a) The student has plotted a graph of the results.

The graph line has been incorrectly drawn by including an anomalous result.

The graph is shown in **Figure 5**.

Figure 5



8 (a) (i) Suggest a cause for the anomalous result when 20 cm^3 of hydrochloric acid is added.

[1 mark]

.....

.....

8 (a) (ii) Suggest the true value of the temperature of the anomalous point.

[1 mark]

Temperature = ... °C

8 (a) (iii) What was the **total** volume of the mixture when the maximum temperature was reached?

[1 mark]

.....

Total volume of the mixture = ... cm^3

Do not write outside the box

8 (a) (iv) Calculate the overall temperature increase in this experiment.

[1 mark]

.....

Overall temperature increase = ... °C

8 (a) (v) Use your answers to **8(a)(iii)** and **8(a)(iv)** and the equation to calculate the energy released in the reaction. Give the unit.

[2 marks]

Assume the volume in cm^3 is equivalent to the mass of solution in grams.

Equation: $Q = mc\Delta T$

where:
Q = energy released
m = mass of solution (g)
c = 4.2 (J per g per °C)
ΔT = change in temperature (°C)

.....

.....

Energy released = ... Unit = ...

8 (b) The student did the experiment on page 19 again, starting with 50 cm^3 of sodium hydroxide solution instead of 25 cm^3.

Explain why this would make no difference to the overall temperature increase.

[2 marks]

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END OF QUESTIONS

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AQA

GCSE

Chemistry

CH3HP

Mark scheme

4402

June 2015

Version/Stage: 1.0 Final

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Mark schemes are prepared by the Lead Assessment Writer and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation events which all associates participate in and is the scheme which was used by them in this examination. The standardisation process ensures that the mark scheme covers the students' responses to questions and that every associate understands and applies it in the same correct way. As preparation for standardisation each associate analyses a number of students' scripts: alternative answers not already covered by the mark scheme are discussed and legislated for. If, after the standardisation process, associates encounter unusual answers which have not been raised they are required to refer these to the Lead Assessment Writer.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of students' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

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Information to Examiners

1. General

The mark scheme for each question shows:

- the marks available for each part of the question
- the total marks available for the question
- the typical answer or answers which are expected
- extra information to help the Examiner make his or her judgement and help to delineate what is acceptable or not worthy of credit or, in discursive answers, to give an overview of the area in which a mark or marks may be awarded
- the Assessment Objectives and specification content that each question is intended to cover.

The extra information is aligned to the appropriate answer in the left-hand part of the mark scheme and should only be applied to that item in the mark scheme.

At the beginning of a part of a question a reminder may be given, for example: where consequential marking needs to be considered in a calculation; or the answer may be on the diagram or at a different place on the script.

In general the right-hand side of the mark scheme is there to provide those extra details which confuse the main part of the mark scheme yet may be helpful in ensuring that marking is straightforward and consistent.

2. Emboldening and underlining

2.1 In a list of acceptable answers where more than one mark is available 'any **two** from' is used, with the number of marks emboldened. Each of the following bullet points is a potential mark.

2.2 A bold **and** is used to indicate that both parts of the answer are required to award the mark.

2.3 Alternative answers acceptable for a mark are indicated by the use of **or**. Different terms in the mark scheme are shown by a / ; eg allow smooth / free movement.

2.4 Any wording that is underlined is essential for the marking point to be awarded.

3. Marking points

3.1 Marking of lists

This applies to questions requiring a set number of responses, but for which students have provided extra responses. The general principle to be followed in such a situation is that 'right + wrong = wrong'.

Each error / contradiction negates each correct response. So, if the number of error / contradictions equals or exceeds the number of marks available for the question, no marks can be awarded.

However, responses considered to be neutral (indicated as * in example 1) are not penalised.

Example 1: What is the pH of an acidic solution? (1 mark)

Student	Response	Marks awarded
1	green, 5	0
2	red*, 5	1
3	red*, 8	0

Example 2: Name two planets in the solar system. (2 marks)

Student	Response	Marks awarded
1	Neptune, Mars, Moon	1
2	Neptune, Sun, Mars, Moon	0

3.2 Use of chemical symbols / formulae

If a student writes a chemical symbol / formula instead of a required chemical name, full credit can be given if the symbol / formula is correct and if, in the context of the question, such action is appropriate.

3.3 Marking procedure for calculations

Full marks can be given for a correct numerical answer, without any working shown.

However, if the answer is incorrect, mark(s) can be gained by correct substitution / working and this is shown in the 'extra information' column or by each stage of a longer calculation.

3.4 Interpretation of 'it'

Answers using the word 'it' should be given credit only if it is clear that the 'it' refers to the correct subject.

3.5 Errors carried forward

Any error in the answers to a structured question should be penalised once only.

Papers should be constructed in such a way that the number of times errors can be carried forward is kept to a minimum. Allowances for errors carried forward are most likely to be restricted to calculation questions and should be shown by the abbreviation e.c.f. in the marking scheme.

3.6 Phonetic spelling

The phonetic spelling of correct scientific terminology should be credited **unless** there is a possible confusion with another technical term.

3.7 Brackets

(…..) are used to indicate information which is not essential for the mark to be awarded but is included to help the examiner identify the sense of the answer required.

3.8 Ignore / Insufficient / Do <u>not</u> allow

Ignore or insufficient are used when the information given is irrelevant to the question or not enough to gain the marking point. Any further correct amplification could gain the marking point.

Do **not** allow means that this is a wrong answer which, even if the correct answer is given, will still mean that the mark is not awarded.

Quality of Written Communication and levels marking

In Question 4(b) students are required to produce extended written material in English, and will be assessed on the quality of their written communication as well as the standard of the scientific response.

Students will be required to:

- use good English
- organise information clearly
- use specialist vocabulary where appropriate.

The following general criteria should be used to assign marks to a level:

Level 1: basic

- Knowledge of basic information
- Simple understanding
- The answer is poorly organised, with almost no specialist terms and their use demonstrating a general lack of understanding of their meaning, little or no detail
- The spelling, punctuation and grammar are very weak.

Level 2: clear

- Knowledge of accurate information
- Clear understanding
- The answer has some structure and organisation, use of specialist terms has been attempted but not always accurately, some detail is given
- There is reasonable accuracy in spelling, punctuation and grammar, although there may still be some errors.

Level 3: detailed

- Knowledge of accurate information appropriately contextualised
- Detailed understanding, supported by relevant evidence and examples
- Answer is coherent and in an organised, logical sequence, containing a wide range of appropriate or relevant specialist terms used accurately.
- The answer shows almost faultless spelling, punctuation and grammar.

Question	Answers	Extra information	Mark	AO / Spec. Ref.
1(a)	Li **and** K	either order allow lithium **and** potassium	1	**AO1** 3.1.3.a
1(b)	Fe	allow iron	1	**AO1** 3.5.1.b
1(c)	N **and** As	either order allow nitrogen **and** arsenic	1	**AO2** 3.1.2.b
1(d)	Cu	allow copper	1	**AO1** 3.1.3.d
Total			**4**	

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Question	Answers	Extra information	Mark	AO / Spec. Ref.
2(a)	(iron) is a metal	accept transition element allow (iron) had different properties (to oxygen and sulfur) ignore electrons	1	**AO2** 3.1.1.a
2(b)	so that elements with similar properties could be placed together	allow to make the pattern fit ignore undiscovered elements	1	**AO1** 3.1.1.b
2(c)	atomic number(s)	allow proton number(s)	1	**AO1** 3.1.2.a
2(d)	all have one electron in the outer shell (highest energy level) (so they) have similar properties **or** react in the same way	allow same number of electrons in the outer shell (highest energy level) allow specific reactions e.g. with water	1 1	**AO1** 3.1.2.b
Total			**5**	

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Question	Answers	Extra information	Mark	AO / Spec. Ref.
3(a)	increase		1	**AO1** 3.1.3.f
3(b)(i)	Na^+ **and** Br^-	both required	1	**AO1** 3.1.3.a/e
3(b)(ii)	sodium chloride	allow NaCl do **not** allow sodium chlorine	1	**AO2** 3.1.3.g
3(b)(iii)	chlorine is more reactive than bromine	allow converse argument allow symbols Cl, Cl_2, Br and Br_2 allow chlorine / it is more reactive. do **not** allow chloride **or** bromide	1	**AO1** 3.1.3.g
3(b)(iv)	fluorine	allow F / F_2. do **not** allow fluoride.	1	**AO2** 3.1.3.g
Total			**5**	

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Question	Answers	Extra information	Mark	AO / Spec. Ref.
4(a)	(calcium or magnesium) ions causing water hardness are dissolved	ignore named anions	1	**AO1/ AO2** 3.2.1.b
	from rocks	allow limestone	1	

4(b) Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should also refer to the information on page 5, and apply a 'best-fit' approach to the marking.

AO1/ AO3 3.2.1.g 3.2.2.b

0 marks	Level 1 (1–2 marks)	Level 2 (3–4 marks)	Level 3 (5–6 marks)
No relevant content	There is a statement about one of the methods **or** one advantage of one of the methods	There is a description of one method of water softening **and** one advantage of a method is given	There is a description of both methods of water softening **and** a comparison of the two methods by giving an advantage of at least one of them

general:

- hard water contains calcium/magnesium (ions)
- softening water involves removal of calcium/magnesium (ions)

ion exchange:

- resin
- contains sodium/hydrogen ions
- which are exchanged with calcium/magnesium ions
- resin needs periodic replenishment with sodium ions/hydrogen ions or sodium chloride (disadvantage)
- increases sodium content of water (if sodium ions used) (disadvantage)
- easy/quick method to use (advantage)
- continuous process (advantage)

sodium carbonate:

- sodium carbonate is added to hard water
- calcium/magnesium ions precipitate out
- as calcium/magnesium carbonate
- batch process (disadvantage)
- leaves a residue of precipitated carbonate in the water (disadvantage)
- increases sodium content of water (disadvantage)
- easy method to use (advantage)
- relatively cheap (advantage)

Total			8

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Question	Answers	Extra information	Mark	AO / Spec. Ref.
5(a)	any **two** from: • fuel • solvent • antiseptic	 allow source of energy allow perfume / aftershave allow antibacterial	2	**AO1** 3.6.1.b
5(b)	Hydrogen		1	**AO1** 3.6.1.b
5(c)(i)	oxidation	do **not** allow redox	1	**AO1** 3.6.1.c
5(c)(ii)	correct structure		1	**AO1** 3.6.2.a
5(c)(iii)	 ethanoic acid is a weak / weaker acid because it does not completely ionise.	it = ethanoic acid allow because it does not completely dissociate allow it has a lower concentration of hydrogen ions allow converse for hydrochloric acid do **not** allow ionising	 1 1	**AO1/ AO2** 3.6.2.b
5(d)(i)	ethyl ethanoate		1	**AO1** 3.6.2.b
5(d)(ii)	acid	allow any strong acid allow correct formulae	1	**AO1** 3.6.2.b
5(d)(iii)	evaporates easily / quickly	allow low boiling point do **not** allow flammable	1	**AO1** 3.6.3.a
Total			**10**	

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Question	Answers	Extra information	Mark	AO / Spec. Ref.
6(a)(i)	nothing can enter **and** nothing can leave the reaction	allow sealed reaction vessel	1	**AO1** 3.5.1.c
6(a)(ii)	forward and backward reactions have same rate so there is no (overall) change in quantities of reactants and products	 allow concentrations of reactants and products	1 1	**AO1/ AO2** 3.5.1.c
6(b)(i)	natural gas	allow methane / CH_4 allow fossil fuels / hydrocarbons allow water	1	**AO1** 3.5.1.a
6(b)(ii)	provides an alternative reaction pathway which has a lower activation energy	 ignore references to collisions	1 1	**AO1** 3.3.1.h
6(b)(iii)	the amount (of ammonia) increases the equilibrium moves to the side (of the equation) with fewer (gaseous) molecules / moles	allow yield increases allow it favours the forward reaction	1 1	**AO1/ AO2** 3.5.1.d/g
6(c)(i)	vertical arrow from reactants to maximum		1	**AO2** 3.3.1.e
6(c)(ii)	(energy of) products higher than (energy of) reactants	allow converse	1	**AO2** 3.3.1.d
6(c)(iii)	amount of hydrogen iodide decreases equilibrium moves in the direction of the endothermic reaction	 allow it favours the forward reaction	1 1	**AO1/ AO2** 3.5.1.d/e
Total			**12**	

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Question	Answers	Extra information	Mark	AO / Spec. Ref.
7(a)	**X:** Fe^{2+} / iron(II), SO_4^{2-} / sulfate	allow iron(II) sulfate **or** $FeSO_4$	1	**AO1/ AO2** 3.4.1.a/c/e/f
	Y: Na^+ / sodium, I^- / iodide	allow sodium iodide **or** NaI	1	
	Z: Fe^{3+} **/** iron(III), Br^- / bromide	allow iron(III) bromide **or** $FeBr_3$	1	
		correct identification of any two ions = one mark correct identification of any four ions = two marks		
7(b)	any **five** from: method 1 • weighing is accurate • not all barium sulfate may be precipitated • precipitate may be lost • precipitate may not be dry • takes longer • requires energy method 2 • accurate • works for low concentrations	allow converse arguments allow not all the barium hydroxide has reacted allow reliable / precise	5	**AO3** 3.4.1.a/c/e/f
Total			**8**	

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Question	Answers	Extra information	Mark	AO / Spec. Ref.
8(a)(i)	any **one** from • incorrect measurement of temperature or volume • incorrect recording of temperature • failure to stir • heat loss	ignore faulty equipment	1	**AO3** 3.1.3.c
8(a)(ii)	32 - 33		1	**AO2** 3.1.3.c
8(a)(iii)	55		1	**AO2** 3.1.3.c
8(a)(iv)	20		1	**AO2** 3.1.3.c
8(a)(v)	4620 J / joules	allow 4.62 kJ for **2 marks** allow kJ if evidence of dividing by 1000 mark independently, but if a numerical answer has been divided by 1000 must be kJ. allow ecf from their answers to 8(a)(iii) and 8(a)(iv)	1 1	**AO2** 3.3.1.b/c
8(b)	twice as much energy released but twice as much water to heat	 allow more energy released but more water to heat for **2 marks** if no other mark awarded, allow twice the amount of hydrochloric acid used for **1 mark**	1 1	**AO3** 3.3.1.c
Total			**8**	

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Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										

For Examiner's Use	
Examiner's Initials	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
TOTAL	

General Certificate of Secondary Education
Higher Tier
June 2014

Chemistry
Unit Chemistry C3

CH3HP

H

Thursday 15 May 2014 9.00 am to 10.00 am

For this paper you must have:
- a ruler
- the Chemistry Data Sheet (enclosed).

You may use a calculator.

Time allowed
- 1 hour

A

Instructions
- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information
- The marks for questions are shown in brackets.
- The maximum mark for this paper is 60.
- You are expected to use a calculator where appropriate.
- You are reminded of the need for good English and clear presentation in your answers.
- Question 2(b)(ii) should be answered in continuous prose.
  In this question you will be marked on your ability to:
  – use good English
  – organise information clearly
  – use specialist vocabulary where appropriate.

Advice
- In all calculations, show clearly how you work out your answer.

Do not write outside the box

Answer **all** questions in the spaces provided.

1 Water in Britain is taken from reservoirs to use as drinking water.

Figure 1



1 (a) What are the **two** main steps used to treat water from reservoirs?

Give **one** reason for each step.

[4 marks]

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Do not write outside the box

1 (b) Some people use water filters to treat water before drinking it.

1 (b) (i) Water filters remove hardness from hard water.

What is in water filters that removes hardness from water?

[1 mark]

.....

.....

1 (b) (ii) Suggest why water filters used in the home contain particles of silver.

[1 mark]

.....

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1 (c) Pure water can be produced by distillation.

Why is distillation **not** usually an economic method of treating water for drinking?

[1 mark]

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1 (d) Drinking hard water has health benefits.

State **one** health benefit of drinking hard water.

[1 mark]

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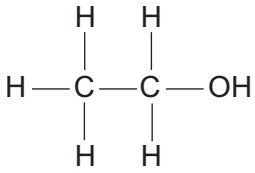
8

Turn over for the next question

Do not write outside the box

2 (a) The structure of an alcohol is shown in **Figure 2**.

Figure 2



2 (a) (i) Draw a circle around the functional group in the structure of the alcohol.

[1 mark]

2 (a) (ii) What is the chemical name of this alcohol?

[1 mark]

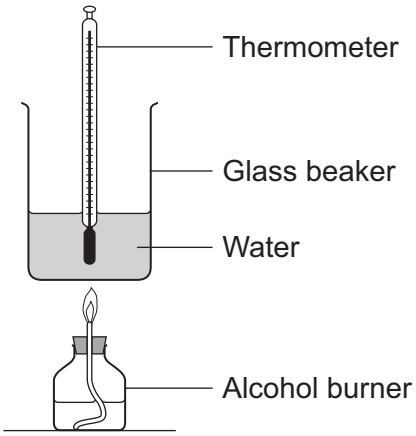
.....

2 (b) Alcohols are used as fuels.

A student plans an experiment to find the energy released per gram of alcohol burned.

The student uses the apparatus shown in **Figure 3**.

Figure 3



2 (b) (i) Suggest **two** ways that this apparatus could be improved to obtain accurate results.

[2 marks]

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Do not write outside the box

2 (b) (ii) In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.

Describe how the student should do this experiment.

You should include any measurements the student should make.

Do **not** describe any improvements to the apparatus.

Do **not** describe how to do any calculations.

[6 marks]

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Extra space .....

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10

Do not write outside the box

3 In 1869, Dmitri Mendeleev produced his periodic table of the elements.

Mendeleev placed the alkali metals in the same group.

3 (a) What evidence did Mendeleev use to decide that the alkali metals should be in the same group?

[1 mark]

.....

.....

3 (b) Describe how the elements in the modern periodic table are arranged:

3 (b) (i) in terms of protons

[1 mark]

.....

.....

3 (b) (ii) in terms of electrons.

[1 mark]

.....

.....

3 (c) State **two** properties of transition elements that make them more useful than alkali metals for making water pipes.

[2 marks]

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Do not write outside the box

3 (d) Describe and explain the trend in reactivity of the alkali metals (Group 1).

[4 marks]

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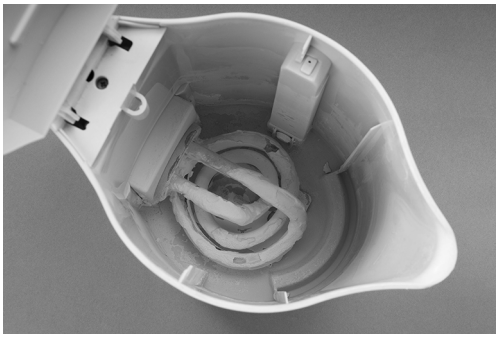
9

Turn over for the next question

Do not write outside the box

4 Hard water causes scale in kettles, as shown in **Figure 4**.

Figure 4



4 (a) Acids are used to remove scale.

4 (a) (i) Give the name of a carbonate in scale.

[1 mark]

.....

4 (a) (ii) When acids react with scale a gas is produced.

What is the name of the gas?

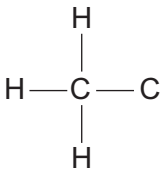
[1 mark]

.....

4 (b) Ethanoic acid is used to remove scale.

Complete the displayed structure of ethanoic acid (CH_3COOH).

[1 mark]



Do not write outside the box

4 (c) A student compared the rates at which ethanoic acid and hydrochloric acid react with scale.

Both acids had the same concentration.

4 (c) (i) The student found that hydrochloric acid reacts faster than ethanoic acid with scale.

Explain why hydrochloric acid reacts faster than ethanoic acid.

[2 marks]

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4 (c) (ii) Hydrochloric acid should **not** be used to dissolve scale in kettles.

Suggest why.

[1 mark]

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4 (d) A student does a titration to find the concentration of a solution of hydrochloric acid.

The student titrates 25.00 cm^3 of hydrochloric acid with sodium hydroxide solution of concentration 0.200 moles per dm^3. The equation for the reaction is:

$$HCl + NaOH \longrightarrow NaCl + H_2O$$

The student added 28.60 cm^3 of sodium hydroxide solution to neutralise the hydrochloric acid.

Calculate the concentration of the hydrochloric acid.

[3 marks]

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Concentration = ... moles per dm^3

9

Turn over ▶

Do not write outside the box

5 In 1909 Fritz Haber invented a process to produce ammonia from nitrogen and hydrogen.

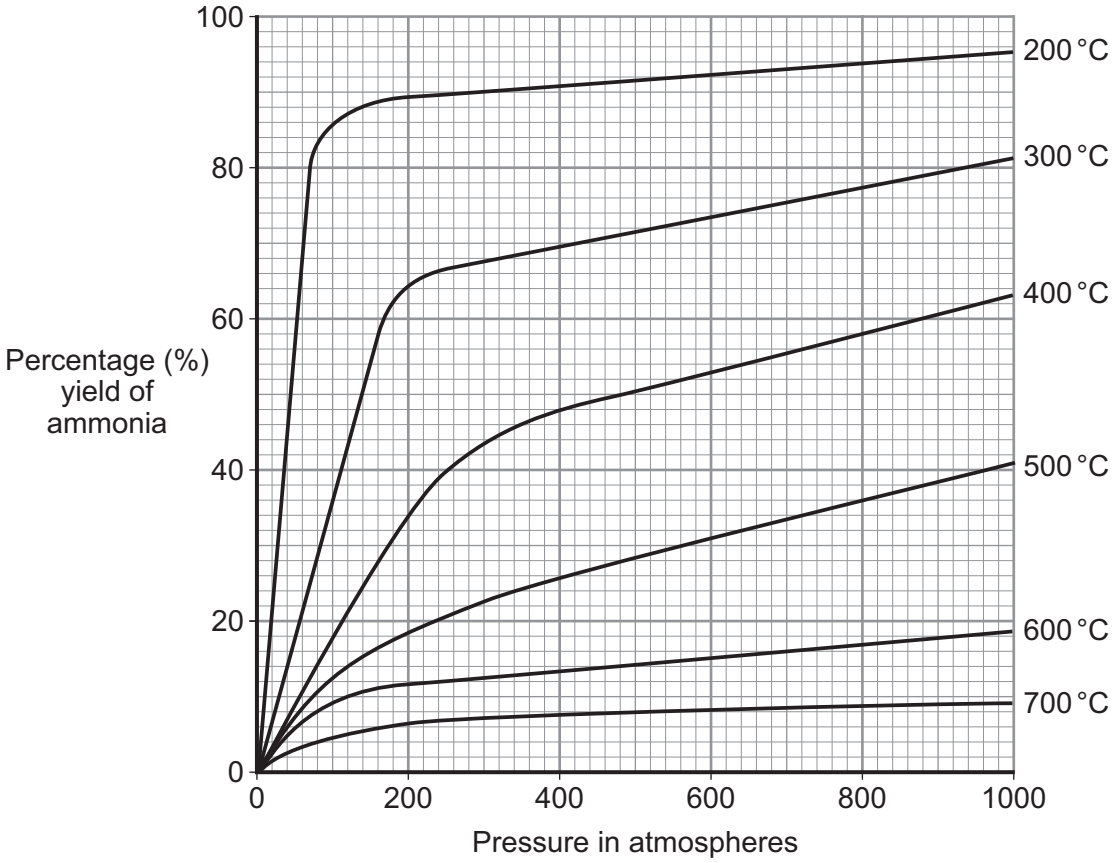
5 (a) Complete and balance the chemical equation for the production of ammonia from nitrogen and hydrogen.

[2 marks]

$$N_2 + 3H_2 \rightleftharpoons \text{.....}$$

5 (b) **Figure 5** shows how the equilibrium yield of ammonia changes with pressure at different temperatures.

Figure 5



5 (b) (i) Use the information in **Figure 5** to complete the sentence.

[1 mark]

The temperature on the graph that gives the highest yield of ammonia is ..... °C.

5 (b) (ii) The temperature used in the Haber process for the production of ammonia is 450 °C.

Why is a temperature much lower than 450 °C **not** used for the Haber process?

[1 mark]

.....

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Do not write outside the box

5 (b) (iii) Use the information in **Figure 5** to answer this question.

Draw a ring around the pressure that gives the highest yield of ammonia.

[1 mark]

100 **200** **300** **400**

5 (b) (iv) The pressure used in the Haber process for the production of ammonia is 200 atmospheres.

Why is a pressure lower than 200 atmospheres **not** used for the Haber process?

[1 mark]

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5 (c) Explain how ammonia is separated from unreacted nitrogen and hydrogen in the Haber process.

[2 marks]

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Turn over for the next question

Do not write outside the box

6 Some cars are powered by hydrogen fuel cells.

Figure 6



6 (a) What type of energy is released by hydrogen fuel cells?

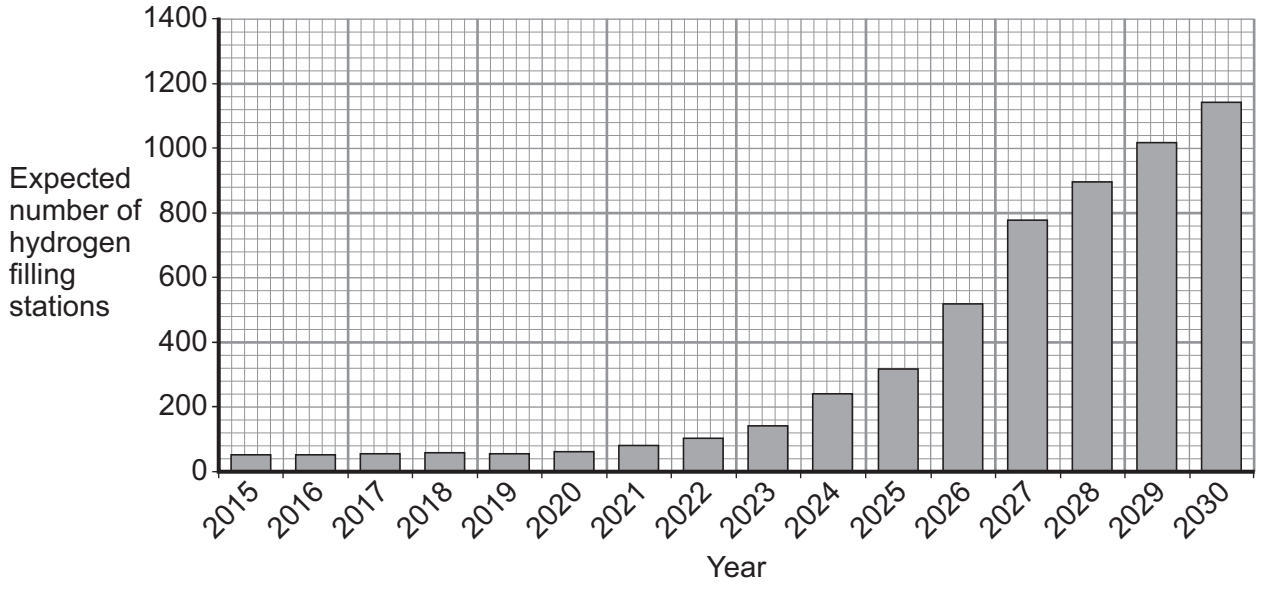
[1 mark]

.....

6 (b) Owners of cars powered by fuel cells buy hydrogen from hydrogen filling stations.

Figure 7 shows how the number of hydrogen filling stations in the UK is expected to increase up to the year 2030.

Figure 7



Do not write outside the box

Use the information in **Figure 7** and your own knowledge to answer this question.

Suggest **two** reasons why the UK government might encourage the building of more hydrogen filling stations.

[2 marks]

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Question 6 continues on the next page

Do not write outside the box

6 (c) The equation for the reaction of hydrogen with oxygen is:

$$2H_2 + O_2 \longrightarrow 2H_2O$$

During the reaction, energy is used to break the bonds of the reactants.

Energy is released when new bonds are made to form the product.

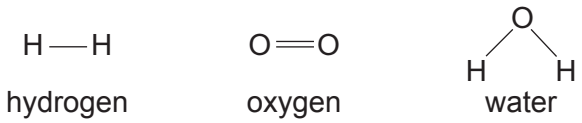
Bond energies for the reaction are given in **Table 1**.

Table 1

Bond	Bond energy in kJ
H—H	436
O=O	498
O—H	464

The structures of the reactants and product are shown in **Figure 8**.

Figure 8



6 (c) (i) Calculate the energy change for the reaction:

$$2H_2 + O_2 \longrightarrow 2H_2O$$

[3 marks]

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Energy change = ... kJ

Do not write outside the box

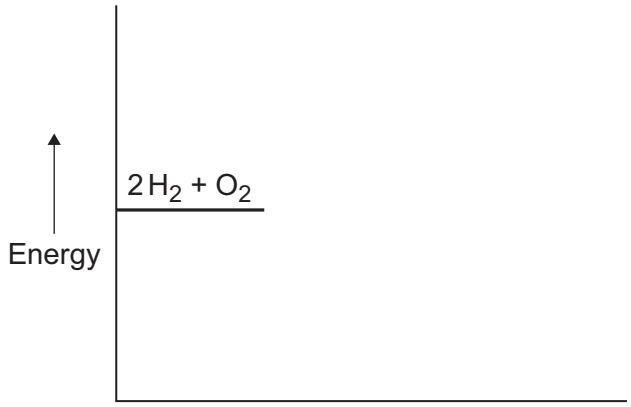
6 (c) (ii) The reaction of hydrogen with oxygen is exothermic.

Complete the energy level diagram for this reaction on **Figure 9**.

Clearly label the activation energy.

[3 marks]

Figure 9



9

Turn over for the next question

Do not write outside the box

7 The colours of fireworks are produced by chemicals.

Figure 10



7 (a) Information about four chemicals is given in **Table 2**.

Complete **Table 2**.

[2 marks]

Table 2

Chemical	Colour produced in firework
barium chloride	green
..... carbonate	crimson
sodium nitrate	.....
calcium sulfate	red

Do not write outside the box

7 (b) Describe a test to show that barium chloride solution contains chloride ions.

Give the result of the test.

[2 marks]

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7 (c) A student did two tests on a solution of compound **X**.

Test 1
Sodium hydroxide solution was added.
A blue precipitate was formed.

Test 2
Dilute hydrochloric acid was added.
Barium chloride solution was then added.
A white precipitate was formed.

The student concluded that compound **X** is iron(II) sulfate.

Is the student's conclusion correct?

Explain your answer.

[3 marks]

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7

END OF QUESTIONS

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ANSWER IN THE SPACES PROVIDED

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GCSE
CHEMISTRY

CH3HP
Mark scheme

4402
June 2014

Version: 1.0 Final

STEMUP.CO.UK

Mark schemes are prepared by the Lead Assessment Writer and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation events which all associates participate in and is the scheme which was used by them in this examination. The standardisation process ensures that the mark scheme covers the students' responses to questions and that every associate understands and applies it in the same correct way. As preparation for standardisation each associate analyses a number of students' scripts: alternative answers not already covered by the mark scheme are discussed and legislated for. If, after the standardisation process, associates encounter unusual answers which have not been raised they are required to refer these to the Lead Assessment Writer.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of students' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

Further copies of this Mark Scheme are available from aqa.org.uk

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Information to Examiners

1. General

The mark scheme for each question shows:

- the marks available for each part of the question
- the total marks available for the question
- the typical answer or answers which are expected
- extra information to help the Examiner make his or her judgement and help to delineate what is acceptable or not worthy of credit or, in discursive answers, to give an overview of the area in which a mark or marks may be awarded
- the Assessment Objectives and specification content that each question is intended to cover.

The extra information is aligned to the appropriate answer in the left-hand part of the mark scheme and should only be applied to that item in the mark scheme.

At the beginning of a part of a question a reminder may be given, for example: where consequential marking needs to be considered in a calculation; or the answer may be on the diagram or at a different place on the script.

In general the right-hand side of the mark scheme is there to provide those extra details which confuse the main part of the mark scheme yet may be helpful in ensuring that marking is straightforward and consistent.

2. Emboldening and underlining

2.1 In a list of acceptable answers where more than one mark is available 'any **two** from' is used, with the number of marks emboldened. Each of the following bullet points is a potential mark.

2.2 A bold **and** is used to indicate that both parts of the answer are required to award the mark.

2.3 Alternative answers acceptable for a mark are indicated by the use of **or**. Different terms in the mark scheme are shown by a / ; eg allow smooth / free movement.

2.4 Any wording that is underlined is essential for the marking point to be awarded.

3. Marking points

3.1 Marking of lists

This applies to questions requiring a set number of responses, but for which students have provided extra responses. The general principle to be followed in such a situation is that 'right + wrong = wrong'.

Each error / contradiction negates each correct response. So, if the number of error / contradictions equals or exceeds the number of marks available for the question, no marks can be awarded.

However, responses considered to be neutral (indicated as * in example 1) are not penalised.

Example 1: What is the pH of an acidic solution? (1 mark)

Student	Response	Marks awarded
1	green, 5	0
2	red*, 5	1
3	red*, 8	0

Example 2: Name two planets in the solar system. (2 marks)

Student	Response	Marks awarded
1	Neptune, Mars, Moon	1
2	Neptune, Sun, Mars, Moon	0

3.2 Use of chemical symbols / formulae

If a student writes a chemical symbol / formula instead of a required chemical name, full credit can be given if the symbol / formula is correct and if, in the context of the question, such action is appropriate.

3.3 Marking procedure for calculations

Full marks can be given for a correct numerical answer, without any working shown.

However, if the answer is incorrect, mark(s) can be gained by correct substitution / working and this is shown in the 'extra information' column or by each stage of a longer calculation.

3.4 Interpretation of 'it'

Answers using the word 'it' should be given credit only if it is clear that the 'it' refers to the correct subject.

3.5 Errors carried forward

Any error in the answers to a structured question should be penalised once only.

Papers should be constructed in such a way that the number of times errors can be carried forward are kept to a minimum. Allowances for errors carried forward are most likely to be restricted to calculation questions and should be shown by the abbreviation e.c.f. in the marking scheme.

3.6 Phonetic spelling

The phonetic spelling of correct scientific terminology should be credited **unless** there is a possible confusion with another technical term.

3.7 Brackets

(…..) are used to indicate information which is not essential for the mark to be awarded but is included to help the examiner identify the sense of the answer required.

3.8 Ignore / Insufficient / Do <u>not</u> allow

Ignore or insufficient is used when the information given is irrelevant to the question or not enough to gain the marking point. Any further correct amplification could gain the marking point.

Do **not** allow means that this is a wrong answer which, even if the correct answer is given, will still mean that the mark is not awarded.

Quality of Written Communication and levels marking

In Question 2(b)(ii) students are required to produce extended written material in English, and will be assessed on the quality of their written communication as well as the standard of the scientific response.

Students will be required to:

- use good English
- organise information clearly
- use specialist vocabulary where appropriate.

The following general criteria should be used to assign marks to a level:

Level 1: Basic

- Knowledge of basic information
- Simple understanding
- The answer is poorly organised, with almost no specialist terms and their use demonstrating a general lack of understanding of their meaning, little or no detail
- The spelling, punctuation and grammar are very weak.

Level 2: Clear

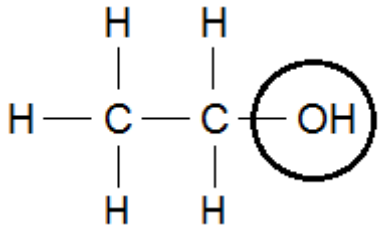
- Knowledge of accurate information
- Clear understanding
- The answer has some structure and organisation, use of specialist terms has been attempted but not always accurately, some detail is given
- There is reasonable accuracy in spelling, punctuation and grammar, although there may still be some errors.

Level 3: Detailed

- Knowledge of accurate information appropriately contextualised
- Detailed understanding, supported by relevant evidence and examples
- Answer is coherent and in an organised, logical sequence, containing a wide range of appropriate or relevant specialist terms used accurately.
- The answer shows almost faultless spelling, punctuation and grammar.

Question	Answers	Extra information	Mark	AO / Spec. Ref.	ID
1(a)	filter to remove *solids* ***or*** *insoluble particles* ***OR*** *add coagulant (1)* flocculation / settling / remove *solids* (1) (add) chlorine to reduce the number of microbes	 *accept ozone / UV* accept to kill microbes / bacteria / germs accept sterilise *allow disinfect* *ignore remove microbes*	1 1 1 1	1 / 3.2.2a/c	E
1(b)(i)	ion exchange resin	allow ion exchange column *allow sodium ions / Na^+* *allow hydrogen ions / H^+*	1	1 / 3.2.2b	E
1(b)(ii)	prevent growth of microbes	*accept sterilise* *accept to kill microbes / bacteria / germs* *accept to reduce the number of microbes* *ignore remove microbes*	1	1 / 3.2.2b	E
1(c)	high cost of energy / *heating*	*allow uses a lot of energy*	1	2 / 3.2.2d	E
1(d)	any **one** from: • helps to develop / maintain bones • helps to develop / maintain teeth • reduces heart disease	 allow any suitable positive effect on bones allow any suitable positive effect on teeth	1	1 / 3.2.1f	E
Total			**8**		

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Question	Answers	Extra information	Mark	AO / Spec. Ref.	ID
2(a)(i)			1	1 / 3.6	G
2(a)(ii)	ethanol	*allow ethyl alcohol* *do **not** accept ethanal* *ignore all formulae*	1	1 / 3.3.1a	G
2(b)(i)	any **two** from: • lid • *metal* calorimeter • insulation (around sides of beaker) • excluding draughts • stirrer	 allow *metal* beaker do **not** allow flammable insulation / beaker *allow stirring*	2	3 / 3.3.1a	E

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<table>
<tr><th>Question</th><th>Answers</th><th>Extra information</th><th>Mark</th><th>AO / Spec. Ref.</th><th>ID</th></tr>
<tr><td colspan="4">2(b)(ii) Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should also refer to the information on page 5, and apply a ‘best-fit’ approach to the marking.
<table>
<tr><th>0 marks</th><th>Level 1 (1–2 marks)</th><th>Level 2 (3–4 marks)</th><th>Level 3 (5–6 marks)</th></tr>
<tr><td>No relevant content</td><td>There is a description of part of an experimental method or a measurement which should be taken.</td><td>There is a description of some parts of an experimental method and a measurement which should be taken.</td><td>There is a description of an experimental method and measurements which should be taken.</td></tr>
<tr><td colspan="4">Examples of the points that may be made in the response</td></tr>
<tr><td colspan="4">• light ethanol and heat water
• extinguish ethanol
• after suitable temperature rise or after a suitable time
• stir water
• measure mass / volume of water
• measure initial temperature of water
• measure final temperature of water
• measure temperature rise
• measure initial mass of ethanol (and burner)
• measure final mass of ethanol (and burner)
• measure change in mass of ethanol</td></tr>
</table></td><td></td><td>1 + 3 / 3.3.1a</td><td>E</td></tr>
<tr><td>Total</td><td></td><td></td><td>9</td><td></td><td></td></tr>
</table>

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Question	Answers	Extra information	Mark	AO / Spec. Ref.	ID
3(a)	similar properties	*allow same properties* allow correct example of property ignore answers in terms of atomic structure	1	1 / 3.1.1a	E
3(b)(i)	in order of atomic / *proton* number	*allow increasing number (of protons)*	1	1 / 3.1.2a	E
3(b)(ii)	elements in same group have same number *(of electrons)* in outer shell **or** *highest energy level*	*allow number (of electrons) increases across a period*	1	1 / 3.1.2b	E
3(c)	any **two** from: • stronger / harder • less reactive • higher melting points	*statements must be comparative* *ignore higher densities* *ignore boiling point*	2	2 / 3.1.3c	E
3(d)	*reactivity increases down group* *outer electron is further from nucleus* *less attraction between outer electron and nucleus* *therefore outer electron lost more easily*	*allow converse throughout* *for next three marks, outer electron needs to be mentioned once otherwise max = **2*** *allow more energy levels / shells* *allow larger atoms* *allow more shielding*	1 1 1 1	1 / 3.1.3b/h	E
Total			**9**		

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Question	Answers	Extra information	Mark	AO / Spec. Ref.	ID
4(a)(i)	calcium (carbonate) **or** magnesium (carbonate)	allow $CaCO_3$ allow $MgCO_3$	1	1 / 3.2.1b	E
4(a)(ii)	carbon dioxide	allow CO_2	1	1 / 3.4.1d	G
4(b)	– COOH group <u>correctly displayed</u>		1	1 / 3.6	E
4(c)(i)	 because hydrochloric acid is a strong(er) acid which ionises more	allow converse *throughout* 'it' refers to hydrochloric acid *allow because hydrochloric acid has lower pH* accept produces / has more hydrogen ions / H^+ ions	 1 1	1 + 3 / 3.6.2b	E
4(c)(ii)	corrosive	allow reacts with *heating* element / kettle *ignore dissolves*	1	3 / 3.6.2b	E
4(d)	0.2288	correct answer gains **3** marks with or without working accept 0.229 ***or*** *0.23* if answer is incorrect 28.6 x 0.2 ÷ 1000 (=0.00572) gains **1** mark 0.00572 x 1000 ÷ 25 or ecf gains **1** mark ***or*** 28.6 x 0.2 ÷ 25 gains **2** marks	3	2 / 3.4.1h	E
Total			**9**		

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Question	Answers	Extra information	Mark	AO / Spec. Ref.	ID
5(a)	$2NH_3$	allow NH_3 with incorrect or missing balancing for **1** mark *allow multiples*	2	2 / 3.5.1b	E
5(b)(i)	200		1	3 / 3.5	G
5(b)(ii)	rate of reaction (too) slow	*allow converse* ignore references to yield / *cost*	1	2 / 3.5.1f/h	E
5(b)(iii)	400		1	2 / 3.5	A
5(b)(iv)	lower yield	*allow converse* accept shifts equilibrium to left allow favours the backward reaction allow favours side with *more* (gaseous) molecules allow lower rate	1	2 / 3.5.1g/h	E
5(c)	(gases) cooled *ammonia* liquefied	*it = ammonia* accept *ammonia* condensed accept ammonia cooled below boiling point for **2** marks	 1 1	1 / 3.5.1b	E
Total			**8**		

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Question	Answers	Extra information	Mark	AO / Spec. Ref.	ID
6(a)	electrical		1	1 / 3.3.1i	G
6(b)	using hydrogen saves petrol / diesel / *crude oil* *using hydrogen (in fuel cells) does not cause pollution*	allow crude oil is non-renewable *ignore hydrogen is renewable* accept no carbon dioxide produced *allow less carbon dioxide produced* *allow hydrogen produces only water*	1 1	3 / 3.3.1i	E
6(c)(i)	(–)486	correct answer with or without working gains **3** marks if answer is incorrect: (2 x 436) + 498 **or** 1370 gains **1** mark 4 x 464 **or** 1856 gains **1** mark *correct subtraction of ecf* gains **1** mark	3	2 / 3.3.1f	E
6(c)(ii)	products lower than reactants *reaction curve correctly drawn* activation energy labelled		1 1 1	1 + 2 / 3.3.1d	E
Total			**9**		

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Question	Answers	Extra information	Mark	AO / Spec. Ref.	ID
7(a)	lithium yellow	*allow Li^+ / Li* *allow orange*	1 1	2 / 3.4.1a	E
7(b)	silver nitrate (solution) white precipitate	incorrect test = **0** marks ignore (nitric) acid do **not** allow other *named* acids	1 1	1 / 3.4.1e	E
7(c)	blue precipitate (with sodium hydroxide) indicates copper ions and white precipitate (with barium chloride) indicates sulfate ions but iron(II) ions produce a green precipitate (with sodium hydroxide)	*allow Cu^{2+}* *allow SO_4^{2-}* *accept compound X is copper sulfate/$CuSO_4$ for **1** mark*	1 1 1	3 / 3.4.1c/f	E
Total			**7**		

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Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										

For Examiner's Use	
Examiner's Initials	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
TOTAL	

General Certificate of Secondary Education
Higher Tier
June 2013

Chemistry

CH3HP

Unit Chemistry C3

H

Written Paper

Monday 20 May 2013 1.30 pm to 2.30 pm

For this paper you must have:
- a ruler
- the Chemistry Data Sheet (enclosed).

You may use a calculator.

Time allowed
- 1 hour

Instructions
- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information
- The marks for questions are shown in brackets.
- The maximum mark for this paper is 60.
- You are expected to use a calculator where appropriate.
- You are reminded of the need for good English and clear presentation in your answers.
- Question 3 should be answered in continuous prose.
  In this question you will be marked on your ability to:
  – use good English
  – organise information clearly
  – use specialist vocabulary where appropriate.

Advice
- In all calculations, show clearly how you work out your answer.

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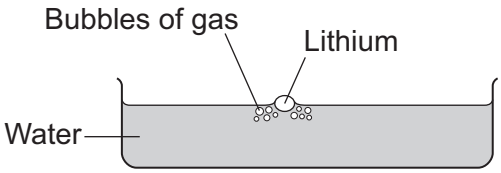
DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED

Do not write outside the box

Answer **all** questions in the spaces provided.

1 Lithium is in Group 1 of the periodic table.

Lithium reacts with water to produce a gas and an alkaline solution.



1 (a) (i) Name the gas produced.

.....

(1 mark)

1 (a) (ii) Which ion causes the solution to be alkaline?

.....

(1 mark)

1 (b) Potassium is also in Group 1 of the periodic table.
Potassium reacts with water in a similar way to lithium.

Write down **two** differences you would see between the reactions of potassium and lithium with water.

1 .....

.....

2 .....

.....

(2 marks)

4

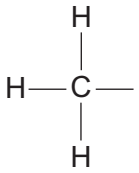
Turn over for the next question

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2 This question is about organic compounds.

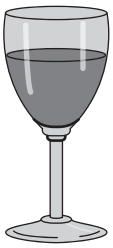
2 (a) Wine contains ethanol (CH_3CH_2OH).

2 (a) (i) Complete the displayed structure of ethanol.



(1 mark)

2 (a) (ii) Wine left in a glass for several days turns sour.
The sour taste is caused by ethanoic acid.



Complete the sentences.

The ethanoic acid is produced from a reaction between ethanol

and ..... .

This type of reaction is ..... .

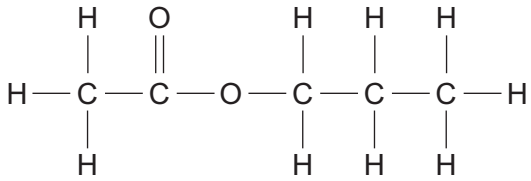
(2 marks)

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2 (b) Propyl ethanoate, a fragrance, can be produced by reacting ethanoic acid with an alcohol.

Propyl ethanoate is a member of a series of organic compounds. The members of the series all have the same functional group.

The displayed structure of propyl ethanoate is:



2 (b) (i) Draw a ring around the functional group for this series on the displayed structure of propyl ethanoate.

(1 mark)

2 (b) (ii) Name the series of organic compounds with this functional group.

.....

(1 mark)

2 (b) (iii) The alcohol used to make propyl ethanoate has the formula $CH_3CH_2CH_2OH$

Name this alcohol.

.....

(1 mark)

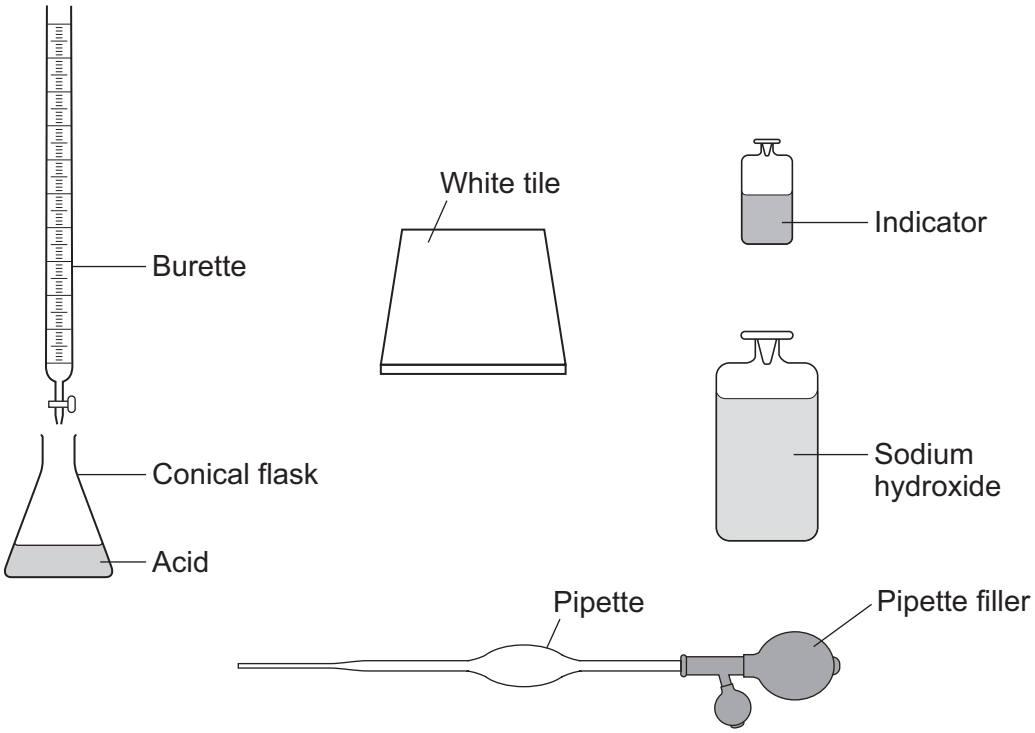
6

Turn over for the next question

Do not write outside the box

3 *In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.*

A student used the equipment shown to do a titration.



Describe how a student should use this equipment to find the volume of sodium hydroxide solution that reacts with a known volume of acid.
Include any measurements the student should make.

Do **not** describe how to do any calculations.

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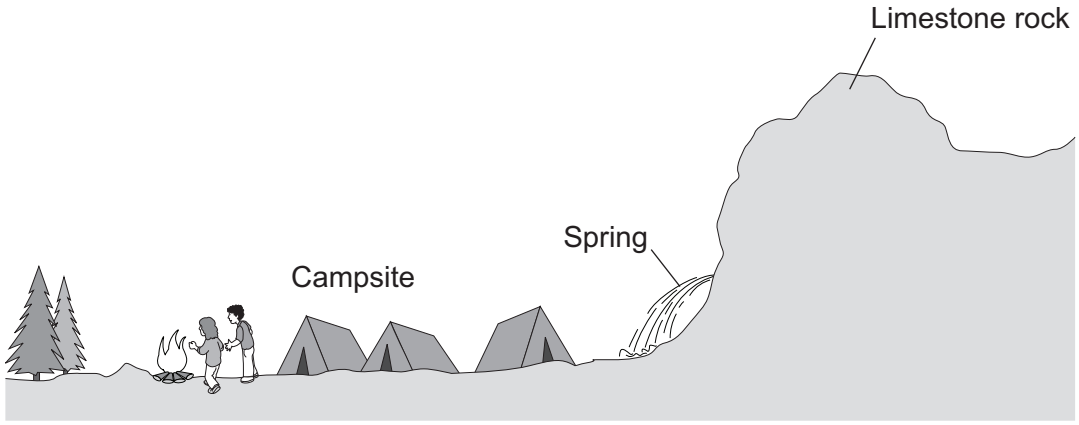
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(6 marks)

6

Do not write outside the box

4 (a) A campsite has a spring, where hard water flows out of limestone rock.



A student compared the hardness of the spring water with two other samples of water.

The student measured 20 cm^3 of water into a boiling tube.

The student then:

- added a drop of soap solution
- shook the boiling tube for 10 seconds
- looked to see if a permanent lather had formed.

The student repeated the procedure until a permanent lather formed.

The results are shown in the table.

Water sample	**Number of drops of soap solution needed to form a permanent lather**			
	Test 1	**Test 2**	**Test 3**	**Mean**
Spring water (from the campsite)	13	11	6	
Tap water	7	5	6	6
Distilled water	1	1	1	1

Do not write outside the box

4 (a) (i) Calculate the correct mean for spring water.

.....

.....

Mean = ... drops

(2 marks)

4 (a) (ii) What conclusion could the student make from her results?

Use the results in the table to give a reason for your answer.

.....

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.....

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.....

(2 marks)

4 (a) (iii) Another student at the campsite boils some of the hard spring water in a pan. The inside of the pan becomes coated with a white solid.

Explain how the white solid is produced.

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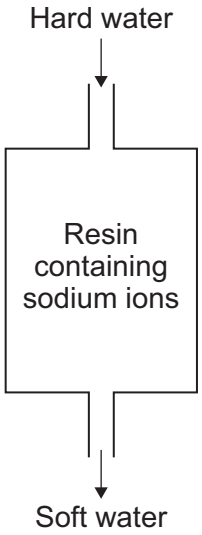
.....

(3 marks)

Question 4 continues on the next page

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4 (b) Ion exchange columns can be used to soften hard water.



4 (b) (i) Describe how an ion exchange column softens water.

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(3 marks)

Do not write outside the box

4 (b) (ii) An ion exchange column is used for a few weeks.

Sodium chloride solution now needs to be passed through the ion exchange column.

Suggest why.

.....

.....

(1 mark)

4 (c) Tap water in the UK is safe to drink because water companies add chlorine to sterilise the water.

Suggest **one** argument for and **one** argument against water companies adding chlorine to sterilise water.

.....

.....

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.....

(2 marks)

13

Turn over for the next question

Do not write outside the box

5 Low sodium salt is used on food. This label is from a packet of low sodium salt.

Low Sodium Salt

Ingredients:

Sodium chloride
Potassium chloride
Drying agent: magnesium carbonate

A student tests the low sodium salt for the substances on the label.

5 (a) (i) The same test can be used to identify sodium ions and potassium ions.

Describe the test.

Give the result of the test for sodium ions and for potassium ions.

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(3 marks)

5 (a) (ii) It is difficult to identify potassium ions when sodium ions are present.

Suggest why.

.....

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(1 mark)

Do not write outside the box

5 (b) Describe how the student would test a solution of the low sodium salt for chloride ions.

Give the result of the test.

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(3 marks)

5 (c) To test for magnesium ions, the student adds a few drops of sodium hydroxide solution to a solution of the low sodium salt.

A white precipitate is produced.

This test also gives a white precipitate with aluminium ions and calcium ions.

5 (c) (i) Describe how the student could confirm that the low sodium salt contains magnesium ions and **not** aluminium ions.

.....

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(2 marks)

5 (c) (ii) Describe a test the student could do to confirm that the low sodium salt does **not** contain calcium ions.

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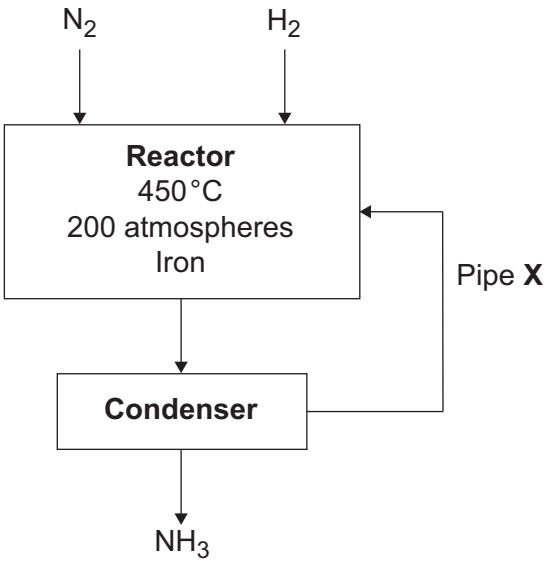
(2 marks)

11

Turn over ▶

Do not write outside the box

6 The flow diagram shows the Haber process. In the Haber process, ammonia (NH_3) is produced from nitrogen (N_2) and hydrogen (H_2).



6 (a) Which raw material is nitrogen obtained from?

.....

(1 mark)

6 (b) What is the purpose of Pipe **X**?

.....

.....

.....

.....

(2 marks)

6 (c) Balance the chemical equation below for the production of ammonia.

N_2 + ...H_2 $\rightleftharpoons$ .....NH_3

(1 mark)

Do not write outside the box

6 (d) A temperature of 450 °C is used in the reactor.
The reaction of nitrogen with hydrogen is reversible.
The forward reaction is exothermic.

Explain why a temperature of 450 °C is the optimum temperature for the Haber process.

.....

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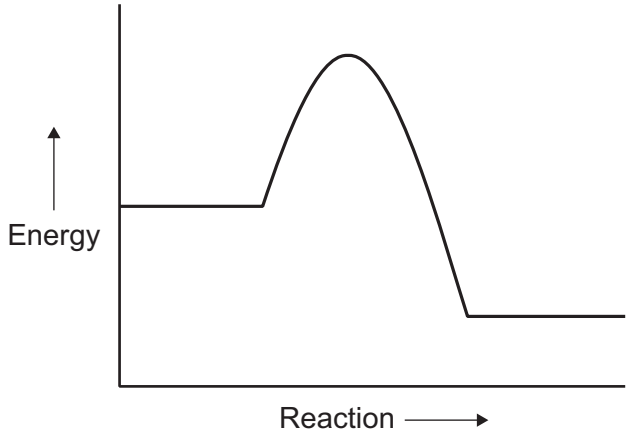
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(2 marks)

6 (e) An energy level diagram for the reaction between nitrogen and hydrogen is shown below.



6 (e) (i) How does the energy level diagram show this reaction is exothermic?

.....

.....

(1 mark)

6 (e) (ii) In the Haber process iron is used as a catalyst.

Draw a line on the energy level diagram to show the effect of adding a catalyst.

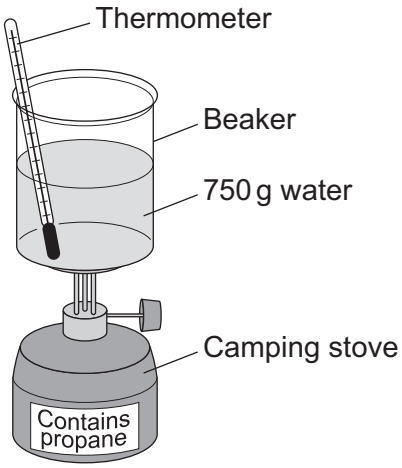
(1 mark)

8

Turn over ▶

Do not write outside the box

7 A camping stove uses propane gas.



7 (a) A student did an experiment to find the energy released when propane is burned.

The student:

- put 750 g water into a beaker
- measured the temperature of the water, which was 17 °C
- heated the water by burning propane
- measured the temperature of the water again, which was then 64 °C.

The student calculated the energy released using the equation

$$Q = m \times 4.2 \times \Delta T$$

Where:
Q = energy released (J)
m = mass of water (g)
ΔT = temperature change (°C)

7 (a) (i) Use the student's results to calculate the energy released in joules (J).

.....

.....

.....

.....

.....

Energy released = ... J

(3 marks)

Do not write outside the box

7 (a) (ii) To find how much propane had been used the student weighed the camping stove before and after the experiment. The mass of the camping stove decreased by 6.0 g.

Using this information and your answer to part **7(a)(i)**, calculate the energy in kJ released when 1 mole of propane burns.

(If you have no answer for part **7(a)(i)**, assume the energy released during the experiment is 144 000 J. This is **not** the answer to part **7(a)(i)**.)

Relative formula mass (M_r) of propane = 44.

.....

.....

.....

.....

Energy released = ... kJ

(2 marks)

7 (a) (iii) Suggest **two** things the student could do to make his results more accurate.

.....

.....

.....

.....

(2 marks)

7 (a) (iv) The student's method does **not** give accurate results.

However, this method is suitable for comparing the energy released by different fuels.

Suggest why.

.....

.....

(1 mark)

Question 7 continues on the next page

Do not write outside the box

7 (b) The student used bond energies to calculate the energy released when propane is burned.

The equation for the combustion of propane is:

$$C_3H_8 + 5O_2 \longrightarrow 3CO_2 + 4H_2O$$

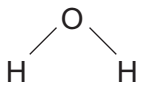
Some bond energies are given in the table.

Bond	Bond Energy in kJ per mole
C ═ O	803
O — H	464

The displayed structures of the products are:

carbon dioxide O ═ C ═ O

water



Do not write outside the box

7 (b) (i) Calculate the energy released by bond making when the products are formed.

.....

.....

.....

.....

.....

Energy released = ... kJ per mole
(3 marks)

7 (b) (ii) The energy used for bond breaking of the reactants in the equation is 6481 kJ per mole.

Calculate the overall energy change of this reaction.

.....

.....

Overall energy change = ... kJ per mole
(1 mark)

12

END OF QUESTIONS

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Version 1.0



General Certificate of Secondary Education
June 2013

Chemistry CH3HP

(Specification 4402)

Unit 3: Chemistry 3

Final

Mark Scheme

Mark schemes are prepared by the Principal Examiner and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation events which all examiners participate in and is the scheme which was used by them in this examination. The standardisation process ensures that the mark scheme covers the students' responses to questions and that every examiner understands and applies it in the same correct way. As preparation for standardisation each examiner analyses a number of students' scripts: alternative answers not already covered by the mark scheme are discussed and legislated for. If, after the standardisation process, examiners encounter unusual answers which have not been raised they are required to refer these to the Principal Examiner.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of students' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

Further copies of this Mark Scheme are available from: aqa.org.uk

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Information to Examiners

1. General

The mark scheme for each question shows:

- the marks available for each part of the question
- the total marks available for the question
- the typical answer or answers which are expected
- extra information to help the Examiner make his or her judgement and help to delineate what is acceptable or not worthy of credit or, in discursive answers, to give an overview of the area in which a mark or marks may be awarded.

The extra information is aligned to the appropriate answer in the left-hand part of the mark scheme and should only be applied to that item in the mark scheme.

At the beginning of a part of a question a reminder may be given, for example: where consequential marking needs to be considered in a calculation; or the answer may be on the diagram or at a different place on the script.

In general the right-hand side of the mark scheme is there to provide those extra details which confuse the main part of the mark scheme yet may be helpful in ensuring that marking is straightforward and consistent.

2. Emboldening

2.1 In a list of acceptable answers where more than one mark is available 'any **two** from' is used, with the number of marks emboldened. Each of the following bullet points is a potential mark.

2.2 A bold **and** is used to indicate that both parts of the answer are required to award the mark.

2.3 Alternative answers acceptable for a mark are indicated by the use of **or**. Different terms in the mark scheme are shown by a / ; e.g. allow smooth / free movement.

3. Marking points

3.1 Marking of lists

This applies to questions requiring a set number of responses, but for which students have provided extra responses. The general principle to be followed in such a situation is that 'right + wrong = wrong'.

Each error / contradiction negates each correct response. So, if the number of error / contradictions equals or exceeds the number of marks available for the question, no marks can be awarded.

However, responses considered to be neutral (indicated as * in example 1) are not penalised.

Example 1: What is the pH of an acidic solution? (1 mark)

Student	Response	Marks awarded
1	green, 5	0
2	red*, 5	1
3	red*, 8	0

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Example 2: Name two planets in the solar system. (2 marks)

Student	Response	Marks awarded
1	Neptune, Mars, Moon	1
2	Neptune, Sun, Mars, Moon	0

3.2 Use of chemical symbols / formulae

If a student writes a chemical symbol / formula instead of a required chemical name, full credit can be given if the symbol / formula is correct and if, in the context of the question, such action is appropriate.

3.3 Marking procedure for calculations

Full marks can be given for a correct numerical answer, without any working shown.

However, if the answer is incorrect, mark(s) can be gained by correct substitution / working and this is shown in the 'extra information' column or by each stage of a longer calculation.

3.4 Interpretation of 'it'

Answers using the word 'it' should be given credit only if it is clear that the 'it' refers to the correct subject.

3.5 Errors carried forward

Any error in the answers to a structured question should be penalised once only.

Papers should be constructed in such a way that the number of times errors can be carried forward are kept to a minimum. Allowances for errors carried forward are most likely to be restricted to calculation questions and should be shown by the abbreviation e.c.f. in the marking scheme.

3.6 Phonetic spelling

The phonetic spelling of correct scientific terminology should be credited **unless** there is a possible confusion with another technical term.

3.7 Brackets

(…..) are used to indicate information which is not essential for the mark to be awarded but is included to help the examiner identify the sense of the answer required.

3.8 Ignore / Insufficient / Do <u>not</u> allow

Ignore or insufficient is used when the information given is irrelevant to the question or not enough to gain the marking point. Any further correct amplification could gain the marking point.

Do **not** allow means that this is a wrong answer which, even if the correct answer is given, will still mean that the mark is not awarded.

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Quality of Written Communication and levels marking

In Question 3 candidates are required to produce extended written material in English, and will be assessed on the quality of their written communication as well as the standard of the scientific response.

Candidates will be required to:

- use good English
- organise information clearly
- use specialist vocabulary where appropriate.

The following general criteria should be used to assign marks to a level:

Level 1: basic

- Knowledge of basic information
- Simple understanding
- The answer is poorly organised, with almost no specialist terms and their use demonstrating a general lack of understanding of their meaning, little or no detail
- The spelling, punctuation and grammar are very weak.

Level 2: clear

- Knowledge of accurate information
- Clear understanding
- The answer has some structure and organisation, use of specialist terms has been attempted but not always accurately, some detail is given
- There is reasonable accuracy in spelling, punctuation and grammar, although there may still be some errors.

Level 3: detailed

- Knowledge of accurate information appropriately contextualised
- Detailed understanding, supported by relevant evidence and examples
- Answer is coherent and in an organised, logical sequence, containing a wide range of appropriate or relevant specialist terms used accurately.
- The answer shows almost faultless spelling, punctuation and grammar.

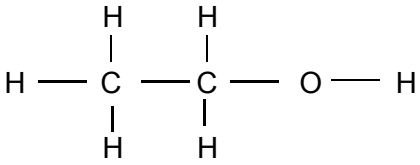
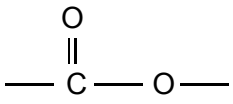
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Question 1

question	Answers	extra information	Mark
1(a)(i)	hydrogen	accept H_2 allow H	1
1(a)(ii)	hydroxide	accept OH^- allow OH do **not** accept lithium hydroxide	1
1(b)	any **two** from: potassium: • reacts / dissolves faster • bubbles / fizzes faster • moves faster (on the surface) • melts • produces (lilac / purple) flame	'it' = potassium accept converse for lithium allow reacts more vigorously / quickly / violently / explodes ignore reacts more allow fizzes more allow more gas allow moves more allow forms a sphere allow catches fire / ignites do **not** accept other colours	2
Total			**4**

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Question 2

question	Answers	extra information	Mark
2(a)(i)		allow other arrangements provided connectivity is correct allow —OH	1
2(a)(ii)	oxygen oxidation	accept O_2 allow O allow oxidisation / oxidising / oxidised allow redox	1 1
2(b)(i)	ring around 		1
2(b)(ii)	ester(s)	do **not** allow ether(s)	1
2(b)(iii)	propanol	accept propan-1-ol allow propyl alcohol	1
Total			**6**

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Question 3

question	answers	extra information	Mark
3	Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should also refer to the information on page 5.		6

0 marks	**Level 1 (1-2 marks)**	**Level 2 (3-4 marks)**	**Level 3 (5-6 marks)**
No relevant content.	There is a simple description of using some of the equipment.	There is a description of an experimental method involving a measurement, **or** including addition of alkali to acid (or vice versa).	There is a description of a titration that would allow a successful result to be obtained.

examples of chemistry points made in the response could include:

- acid in (conical) flask
- volume of acid measured using pipette
- indicator in (conical) flask
- sodium hydroxide in burette
- white tile under flask
- slow addition
- swirling
- colour change
- volume of sodium hydroxide added

Extra information

- allow acid in the burette to be added to sodium hydroxide in the (conical) flask
- allow any specified indicator

colour change need not be specified

Total			**6**

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Question 4

question	Answers	extra information	Mark
4(a)(i) **E**	12	correct answer with or without working gains **2 marks** if answer incorrect allow (13+11)/2 for **1 mark** allow 10 for **1 mark**	2
4(a)(ii) **E**	spring water is hardest because it takes the most drops (of soap solution) **or** distilled water is softest (1) because it takes the fewest drops (of soap solution) (1)	**must** be comparative for each marking point 2nd mark must refer to amount of soap added accept correct comparison of tap water with either spring or distilled water	1 1
4(a)(iii) **E**	water contains (calcium) hydrogencarbonate which decomposes (on heating) to (calcium) carbonate	allow magnesium instead of calcium accept HCO_3^- allow breaks down accept CO_3^{2-} allow (lime)scale do **not** accept scum correct complete equation = 2 marks	1 1 1
4(b)(i) **E**	calcium ions (in water) replaced by / exchanged for sodium ions (in resin)	accept Ca^{2+} allow magnesium ions / Mg^{2+} ignore Ca^+ / Mg^+ any reference to reaction or reactivity series negates this mark accept Na^+ allow hydrogen ions / H^+	1 1 1

Question 4 continues on the next page

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Question 4 continues

question	Answers	extra information	Mark
4(b)(ii)	to replenish sodium ions (in resin)	accept Na^+ allow 'to top up the sodium ions' allow 'so sodium ions do not run out' allow 'to remove calcium / magnesium ions'	1
4(c)	Argument for : any **one** from: • prevents disease • kills microbes / microorganisms / bacteria / pathogens • only small amounts needed Argument against : any **one** from: • toxic / poisonous • no consumer choice	 ignore sterilise / disinfect allow prevents illness ignore removes ignore cost / taste / corrosive ignore harmful **or** causes health problems **or** specific illnesses / diseases allow unethical	 1 1
Total			**13**

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Question 5

question	Answers	extra information	Mark
5(a)(i)	place sample in flame	accept flame test accept any workable method allow burn ignore heat	1
	sodium: yellow (flame)	allow orange	1
	potassium: lilac (flame)	allow purple	1
5(a)(ii)	(lilac) colour (of potassium) obscured by (yellow) colour of sodium	allow difficult to see two colours allow sodium colour is brighter allow colours mix	1
5(b)	acidify (with nitric acid)	do **not** accept if acidified with anything other than nitric acid	1
	add silver nitrate (solution)		1
	white precipitate	depends on second marking point allow white solid ignore silver chloride ignore solution goes cloudy / milky	1
5(c)(i)	add excess (sodium hydroxide)	allow add sodium hydroxide	1
	<u>aluminium</u> (ions / hydroxide) (re)dissolve	depends on first marking point allow if aluminium, (white) precipitate / solid dissolves allow magnesium (ions / hydroxide) do not (re)dissolve	1
5(c)(ii)	place sample in flame	accept flame test accept any workable method allow burn ignore heat	1
	flame does not go red	accept calcium (ions / hydroxide would produce) red flame allow magnesium (ions / hydroxide) (produce) no flame colour	1
Total			**11**

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Question 6

question	Answers	extra information	Mark
6(a)	air		1
6(b)	recycle (unreacted) nitrogen and hydrogen	allow re-use allow N_2 and H_2	1 1
6(c)	N_2 + **3**H_2 → **2**NH_3	allow correct multiples	1
6(d)	because a higher temperature would reduce (equilibrium) yield because a lower temperature would reduce rate	allow converse arguments ignore references to compromise allow higher temperature favours backward reaction	1 1
6(e)(i)	(energy of) reactants greater than (energy of) products	allow converse allow (overall) energy decreases allow energy required to break bonds is less than the energy released making bonds	1
6(e)(ii)	line starting and finishing at same levels but with lower peak		1
Total			**8**

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Question 7

question	Answers	extra information	Mark
7(a)(i)	ΔT = (64 – 17) = 47 °C		1
	750 x 4.2 x 47	allow ecf using their ΔT	1
	148 050	correct answer gains **3 marks** with **or** without working ignore sign allow 148.05kJ allow 148kJ	1
7(a)(ii)	1085.7	correct answer gains **2** marks with or without working. allow answer in range 1080 – 1089 for **2 marks** allow answer in range 1080000 – 1089000 for **1 mark** if answer is incorrect allow 6/44 = 0.136 mol for **1 mark** allow (44 x their 7(a)(i))/(6 x 1000) correctly calculated for **2 marks** allow (44 x their 7(a)(i))/6 correctly calculated for **1 mark** If they have used the given value of 144 000: Allow any answer in range 1051 - 1059 for **2 marks** with or without working. allow any answer in range 1051000 – 1059000 for **1 mark**	2

Question 7 continues on the next page

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Question 7 continued

question	Answers	extra information	Mark
7(a)(iii)	repeat the experiment and then calculate the mean any **one** from: • use a lid • insulate the beaker • stir • prevent draughts	 do **not** allow flammable insulation	1 1
7(a)(iv)	inaccuracies likely to have similar effects	allow systematic errors	1
7(b)(i)	8530	correct answer gains 3 marks with or without working. If answer is incorrect; (6 x 803) = 4818 gains 1 mark (8 x 464) = 3712 gains 1 mark correct addition of their calculated values gains 1 mark (ecf)	3
7(b)(ii)	(6481 – 8530) = (-)2049	ignore sign allow ecf from 7(b)(i)	1
Total			**12**

UMS Conversion Calculator: www.aqa.org.uk/umsconversion

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