AQA GCSE CHEMISTRY (4421)

CHEMISTRY



EXAM QUESTION PACK

UNIT C3 HIGHER TIER CHY3H PAPERS

STEMUP

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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 2012

Chemistry

CHY3H

Unit Chemistry C3

H

Written Paper

Thursday 24 May 2012 9.00 am to 9.45 am

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

You may use a calculator.

Time allowed
- 45 minutes

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 45.
- You are expected to use a calculator where appropriate.
- You are reminded of the need for good English and clear presentation in your answers.

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

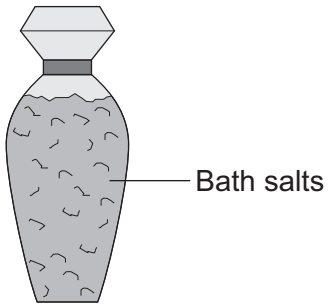
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Answer **all** questions in the spaces provided.

1 In some areas of the UK the water is hard.
Bath salts are added to bath water to soften the water.

1 (a) Bath salts contain sodium carbonate.



The equation shows one reaction in which sodium carbonate removes hardness from bath water.

$MgSO_4(aq)$	+	$Na_2CO_3(aq)$	→	$MgCO_3(s)$	+	$Na_2SO_4(aq)$
magnesium sulfate (dissolved in bath water)		sodium carbonate		magnesium carbonate		sodium sulfate

Use the equation and your knowledge of hard water to explain;

- why this bath water is hard

and

- how sodium carbonate removes hardness from bath water.

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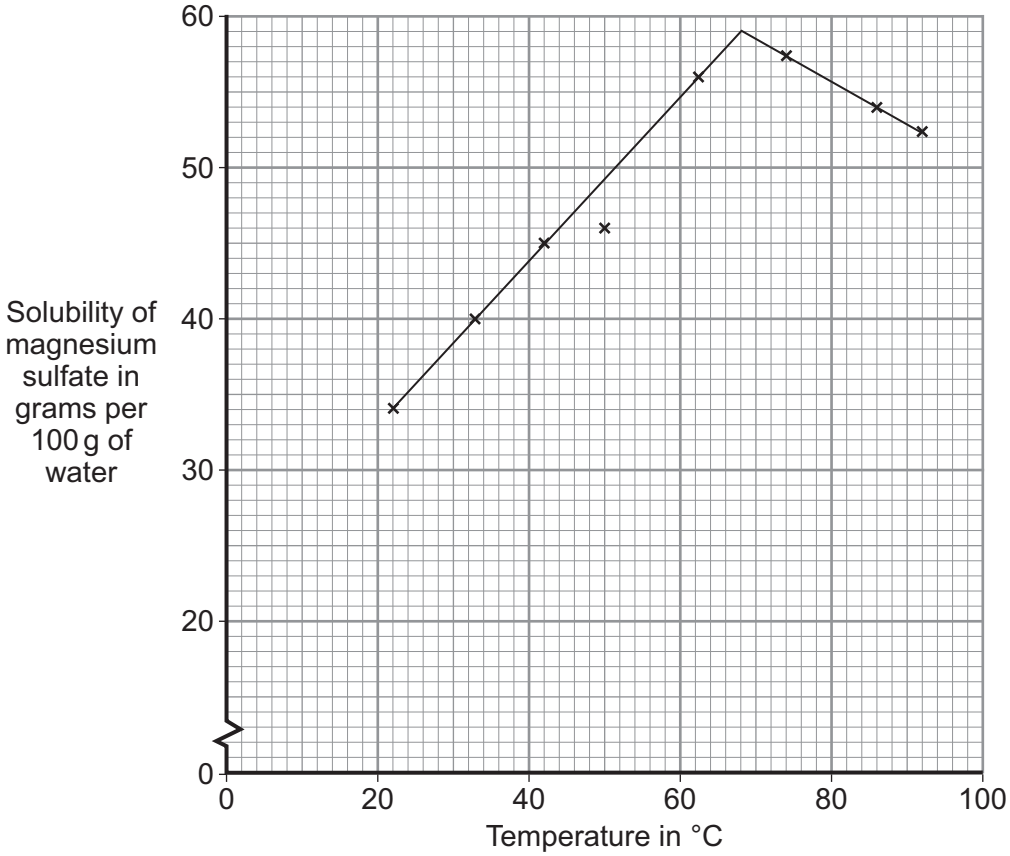
(3 marks)

1 (b) The bath water contains magnesium sulfate.

A student did experiments to find the maximum amount of magnesium sulfate that dissolves in water at different temperatures.

The student's results are shown on the graph.

Do not write outside the box



1 (b) (i) Why did the student **not** draw a line through the point at 50 °C?

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(1 mark)

1 (b) (ii) Suggest why the student did **not** do an experiment at 100 °C.

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(1 mark)

1 (b) (iii) At what temperature is the solubility of magnesium sulfate greatest?

Temperature = ... °C

(1 mark)

1 (b) (iv) Suggest why the student was surprised by the shape of the solubility graph line.

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(2 marks)

8

Turn over ▶

Do not write outside the box

2 John Newlands was a chemist who worked in a sugar factory.

In 1866 he designed a periodic table.
He arranged the elements in order of their relative atomic masses.

He found a repeating pattern for some of the elements.
Newlands wrote, 'the eighth element starting from a given one, is a kind of repetition of the first, like the eighth note in an octave of music'.

H	Li	G	Bo	C	N	O
F	Na	Mg	Al	Si	P	S
Cl	K	Ca	Cr	Ti	Mn	Fe
Co, Ni	Cu	Zn	Y	In	As	Se
Br	Rb	Sr	Ce, La	Zr	Di, Mo	Ro, Ru
Pd	Ag	Cd	U	Sn	Sb	Te
I	Cs	Ba, V	Ta	W	Nb	Au
Pt, Ir	Tl	Pb	Th	Hg	Bi	Os

Newlands' periodic table

2 (a) In Newlands' periodic table, the elements lithium, sodium and potassium are grouped together.

Give **two** properties of these elements which support the idea that they should be grouped together.

1 .....

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(2 marks)

Do not write outside the box

2 (b) Newlands' periodic table was not accepted by most chemists in 1866.

Suggest reasons why.
Use the information on page 4 to help you to answer this question.

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(3 marks)

2 (c) State **and** explain **one** way in which Mendeleev improved Newlands' periodic table.

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(2 marks)

7

Turn over for the next question

Do not write outside the box

3 Platinum and gold are transition elements.
They can both be used to make wedding rings.



3 (a) Platinum and gold are good materials for making wedding rings.

Use your knowledge of the properties of transition elements to suggest why.

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(2 marks)

3 (b) Explain, in terms of electronic structure, why transition elements have similar chemical properties.

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(2 marks)

4

Do not write outside the box

4 Vinegar can be added to food. Vinegar is an aqueous solution of ethanoic acid.



Ethanoic acid is a *weak* acid.

4 (a) Which ion is present in aqueous solutions of all acids?

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(1 mark)

4 (b) What is the difference between the pH of a *weak* acid compared to the pH of a strong acid of the same concentration?

Give a reason for your answer.

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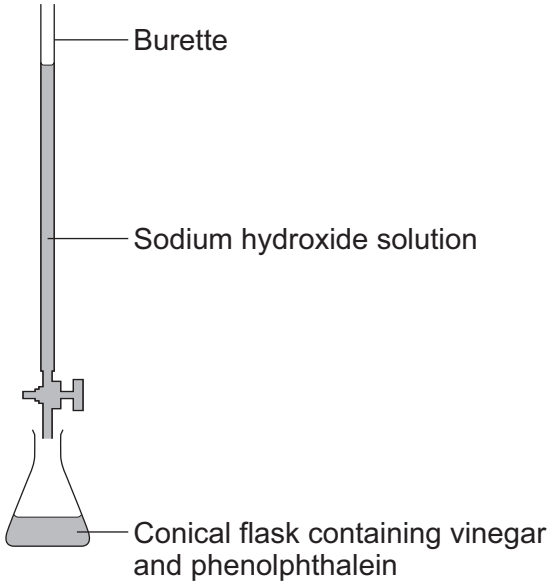
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(2 marks)

Question 4 continues on the next page

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4 (c) The diagram shows the apparatus used to find the concentration of ethanoic acid in vinegar.



4 (c) (i) Why should phenolphthalein indicator be used for this titration instead of methyl orange?

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(1 mark)

4 (c) (ii) 25.00 cm^3 of vinegar was neutralised by 30.50 cm^3 of a solution of sodium hydroxide with a concentration of 0.50 moles per cubic decimetre.

The equation for this reaction is:

$$CH_3COOH(aq) + NaOH(aq) \rightarrow CH_3COONa(aq) + H_2O(l)$$

Calculate the concentration of ethanoic acid in this vinegar.

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Concentration of ethanoic acid in this vinegar = ... moles per cubic decimetre

(2 marks)

Do not write outside the box

4 (d) The concentration of ethanoic acid in a different bottle of vinegar was 0.80 moles per cubic decimetre.

Calculate the mass in grams of ethanoic acid (CH_3COOH) in 250 cm^3 of this vinegar. The relative formula mass (M_r) of ethanoic acid = 60.

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Mass of ethanoic acid = ... g

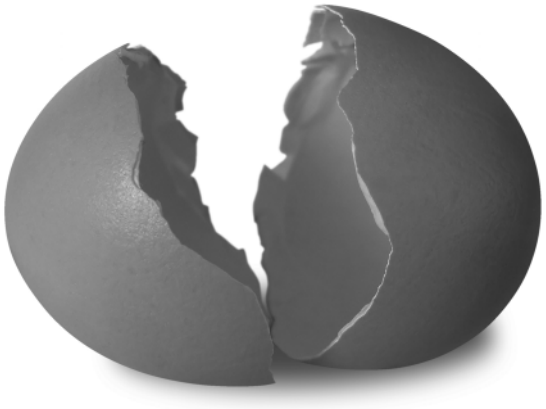
(2 marks)

8

Turn over for the next question

Do not write outside the box

5 A student investigated an egg shell.



5 (a) The student did some tests on the egg shell.

The student's results are shown in the table below.

Test		Observation
1	Dilute hydrochloric acid was added to the egg shell.	A gas was produced. The egg shell dissolved, forming a colourless solution.
2	A flame test was done on the colourless solution from test **1**.	The flame turned red.
3	Sodium hydroxide solution was added to the colourless solution from test **1**.	A white precipitate formed that did not dissolve in excess sodium hydroxide solution.
4	Silver nitrate solution was added to the colourless solution from test **1**.	A white precipitate formed.

5 (a) (i) The student concluded that the egg shell contains carbonate ions.

Describe how the student could identify the gas produced in test **1**.

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(2 marks)

Do not write outside the box

5 (a) (ii) The student concluded that the egg shell contains aluminium ions.

Is the student's conclusion correct? Use the student's results to justify your answer.

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(2 marks)

5 (a) (iii) The student concluded that the egg shell contains chloride ions.

Is the student's conclusion correct? Use the student's results to justify your answer.

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(2 marks)

5 (b) Some scientists wanted to investigate the amount of lead found in egg shells. They used a modern instrumental method which was *more sensitive* than older methods.

5 (b) (i) Name **one** modern instrumental method used to identify elements.

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(1 mark)

5 (b) (ii) What is the meaning of *more sensitive*?

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(1 mark)

8

Turn over for the next question

Do not write outside the box

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ANSWER IN THE SPACES PROVIDED

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6 The halogens are in Group 7 of the periodic table.

6 (a) Why, in terms of electrons, are the halogens in Group 7?

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(1 mark)

6 (b) Sea water contains bromide ions (Br^-).
The bromide ions can be changed to bromine by bubbling chlorine gas into sea water.
Chlorine is able to displace bromine from sea water because chlorine is more reactive than bromine.

$$2Br^-(aq) + Cl_2(g) \rightarrow Br_2(g) + 2Cl^-(aq)$$

Explain, in terms of electrons, why chlorine is more reactive than bromine.

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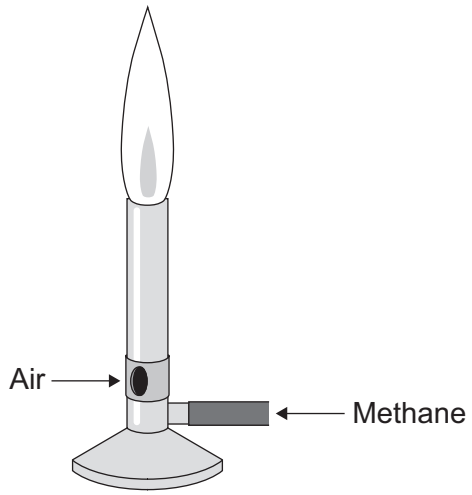
(3 marks)

4

Turn over for the next question

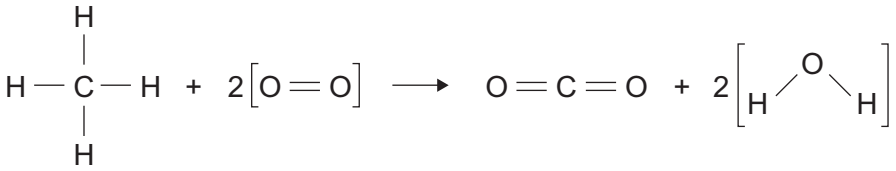
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7 A Bunsen burner releases heat energy by burning methane in air.



7 (a) Methane (CH_4) reacts with oxygen from the air to produce carbon dioxide and water.

7 (a) (i) Use the equation and the bond energies to calculate a value for the energy change in this reaction.



Bond	Bond energy in kJ per mole
C — H	414
O = O	498
C = O	803
O — H	464

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Do not write outside the box

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

7 (a) (ii) This reaction releases heat energy.

Explain why, in terms of bond energies.

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(2 marks)

7 (b) If the gas tap to the Bunsen burner is turned on, the methane does not start burning until it is lit with a match.

Why is heat from the match needed to start the methane burning?

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(1 mark)

6

END OF QUESTIONS

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Version: 10/08/2012

General Certificate of Secondary Education

Chemistry 4421

CHY3H Unit Chemistry 3

Mark Scheme

2012 examination – June series

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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 meeting attended by all examiners and is the scheme which was used by them in this examination. The standardisation meeting 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 the standardisation meeting each examiner analyses a number of students' scripts: alternative answers not already covered by the mark scheme are discussed at the meeting and legislated for. If, after this meeting, examiners encounter unusual answers which have not been discussed at the meeting 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 to download from the AQA Website: www.aqa.org.uk

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MARK SCHEME

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 lines 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.)

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.

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

Student	Response	Marks awarded
1	4,8	0
2	green, 5	0
3	red*, 5	1
4	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, as shown in the column 'answers', 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;

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.

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CHY3H

Question 1

question	answers	extra information	mark
1(a)		allow magnesium **or** calcium throughout	
	because the water contains magnesium ions **or** magnesium compounds / magnesium sulphate	allow because the water contains magnesium / Mg^{2+} / Mg / Mg^{+} / $MgSO_4$	1
		do not accept other ions	
	sodium carbonate / carbonate <u>ions</u> reacts with the magnesium <u>ions</u> / magnesium sulfate	allow sodium <u>ions</u> exchange / displace / magnesium <u>ions</u>	1
	to form solid / insoluble / precipitate of magnesium carbonate	allow solid contains magnesium (ions)	1
		ignore scale / scum	
1(b)(i)	any **one** from: • anomalous • does not fit the pattern / straight line	ignore error	1
1(b)(ii)	water boils (at 100 °C)	ignore evaporate	1
1(b)(iii)	68 (°C)		1
1(b)(iv)		'it' = solubility	
	solubility goes up then down (after 68 °C **or** ecf from 1(b)(iii))	allow solubility changes direction allow solubility goes down / decreases after 68°C (or ecf from 1(b)(iii))	1
	solubility usually increases as the temperature increases		1
Total			**8**

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CHY3H

Question 2

question	answers	extra information	mark
2(a)	any **two** from: • react with water **or** very reactive • (react with water) releasing gas / hydrogen / fizzing • (react with water) to form an alkaline / hydroxide solution • form ions with a 1+ charge	 allow lose one electron from the outer shell ignore other references to electronic structure ignore physical properties	2
2(b)	any **three** from: • some boxes contain two elements • groups / columns contain elements with different properties • Newlands not a well-known / respected scientist • new idea (not readily accepted by other scientists)	 allow specific examples: Co, Ni **or** Ce, La **or** Di, Mo **or** Ro, Ru **or** Ba, V **or** Pt, Ir allow groups / columns contain both metals and non-metals ignore examples ignore references to sugar factory allow musical scales thought to be silly by some scientists	3

Question 2 continues on the next page . . .

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CHY3H

Question 2 cont'd…

question	answers	extra information	mark
2(c)	one for improvement **and** one for explanation from: • left gaps (for undiscovered elements) (1) • so that elements were in their correct group (1) **or** • did not always follow order of relative atomic weights / masses (1) • so that elements were in their correct group (1)	 allow so the elements fitted the pattern of properties ignore references to atomic number / electronic structure allow so the elements fitted the pattern of properties	2
Total			**7**

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CHY3H

Question 3

question	answers	extra information	mark
3(a)	any **two** from: • do not react with water • do not react with air • malleable • high melting point	 allow unreactive **or** <u>stay</u> shiny **or** do not tarnish **or** do not corrode for either of first two points for **1** mark ignore rusts ignore durable ignore hard / strong ignore boiling point ignore other correct properties	2
3(b)	(transition elements have) same number / two electrons in outer shell / energy level / fourth shell any **one** from: • because lower energy level / inner shell being filled • because third energy level can hold up to eighteen electrons	ignore references to (metallic) structure / bonding	1 1
Total			**4**

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Question 4

question	answers	extra information	mark
4(a)	Hydrogen / H^+	ignore state symbols ignore proton / H	1
4(b)	pH of weak acid is higher than the pH of a strong acid	it = weak acid allow converse for strong acids allow correct numerical comparison	1
	any **one** from: • only partially dissociated (to form ions) • not as many hydrogen ions (in the solution)	allow converse for strong acids allow ionises less allow fewer H^+ released	1
4(c)(i)	(titration of) weak acid and strong base		1
4(c)(ii)	0.61	correct answer with or without working gains **2** marks if the answer is incorrect: moles of sodium hydroxide = (30.5 x 0.5)/1000 = 0.01525 moles **or** (0.5 x 30.5/25) gains **1** mark	2

Question 4 continues on the next page . . .

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Question 4 cont'd..

question	answers	extra information	mark
4(d)	12	correct answer with or without working gains **2** marks or even with incorrect working. if the answer is incorrect: 0.8 x 60 = 48g **or** evidence of dividing 48g (or ecf) by 4 **or** $\frac{0.8 \times 250}{1000} = \frac{0.8}{4} = 0.8 \times 0.25 = 0.2$ mol **or** evidence of multiplying 0.2mol (or ecf) by 60 would gain **1** mark	2
Total			**8**

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Question 5

question	answers	extra information	mark
5(a)(i)	(bubble gas produced through) limewater (limewater) goes cloudy / milky	incorrect tests = zero	1 1
5(a)(ii)	red flame indicates that calcium / lithium ions present **or** Ca/Mg also produce a (white) precipitate with NaOH the (white) precipitate formed in test 3 **or** by adding sodium hydroxide solution would dissolve (in excess) if aluminium ions were present	ignore yes or no allow aluminium has no flame colour	1 1
5(a)(iii)	because a white precipitate is formed in test 4 **or** by adding silver nitrate but chloride ions are in hydrochloric acid	ignore yes or no	1 1
5(b)(i)	mass spectrometry **or** atomic absorption spectroscopy	allow MS allow AAS spectrometry / spectroscopy alone is insufficient	1
5(b)(ii)	can detect a small(er) amount of the substance	allow can detect small(er) changes allow small(er) sample sizes ignore references to precision / accuracy	1
Total			**8**

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CHY3H

Question 6

question	answers	extra information	mark
6(a)	all have seven electrons in their outer shell / energy level		1
6(b)	chlorine atom is smaller than bromine atom **or** chlorine atom has fewer shells than bromine atom	must be comparative in all points or converse	1
	outer shell / energy level of chlorine has stronger (electrostatic) attraction to the nucleus than bromine **or** outer shell of chlorine is less shielded from the nucleus than bromine		1
	so chlorine more readily gains an extra electron		1
Total			**4**

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CHY3H

Question 7

question	answers	extra information	mark
7(a)(i)	(-)810	ignore sign correct answer gains **3** marks with or without working if the answer is incorrect look at the working up to a maximum of **two** • bonds broken = (4 x 414) + (2x498) = 2652 kJ • bonds formed = (2x803) + (4x464) = 3462 kJ • correct subtraction of their bonds formed from their bonds broken	3
7(a)(ii)	because energy needed to break the bonds is less than the energy released when bonds are formed		1 1
7(b)	to provide activation energy **or** to break bonds		1
Total			**6**

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Question	Mark
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General Certificate of Secondary Education
Higher Tier
January 2012

Chemistry

CHY3H

Unit Chemistry C3

H

Written Paper

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- the Data Sheet (enclosed).

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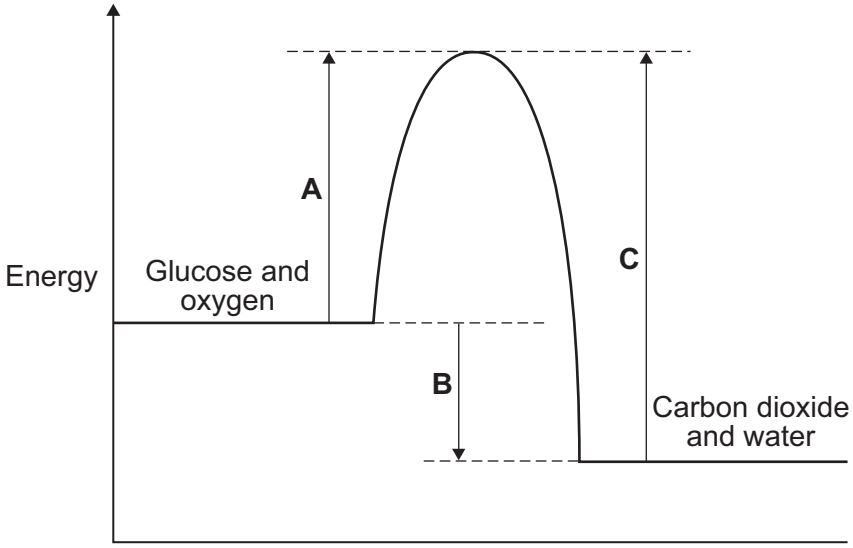
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1 Food provides chemicals and energy to keep your body working. In your body, energy is released by respiration when glucose, $C_6H_{12}O_6$, reacts with oxygen.

$$C_6H_{12}O_6 + 6\,O_2 \rightarrow 6\,CO_2 + 6\,H_2O$$

1 (a) The energy level diagram for the reaction of glucose with oxygen is shown.



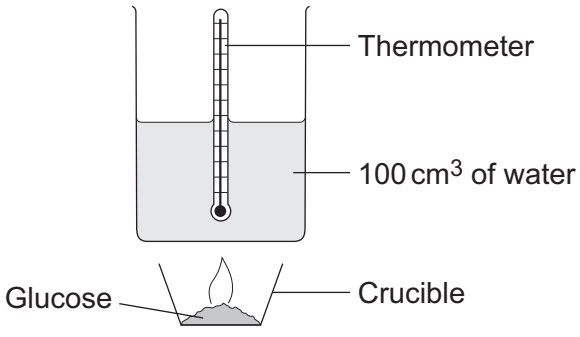
1 (a) (i) Which energy change, **A**, **B** or **C**, represents the activation energy? ☐

(1 mark)

1 (a) (ii) Which energy change, **A**, **B** or **C**, shows that the reaction is exothermic? ☐

(1 mark)

1 (b) A student did an investigation to find the amount of energy released when 1 g of glucose burns in air.



The student:

- recorded the room temperature
- placed 1 g of glucose into the crucible
- set up the equipment as shown in the diagram
- lit the glucose
- recorded the highest temperature of the water.

Do not write outside the box

1 (b) (i) One of the main errors in this experiment is energy loss to the surroundings.

Suggest **one** way that the equipment could be changed to reduce this energy loss.

.....

.....

(1 mark)

1 (b) (ii) The room temperature was 20 °C and the highest temperature recorded was 42 °C.
Use these temperature readings to calculate how much energy is released when 1 g of glucose burns.
The equation that you need to use is:

Energy released in joules = 100 × 4.2 × temperature change

Show clearly how you work out your answer.

.....

.....

.....

Burning 1 g of glucose releases ..... joules
(2 marks)

1 (b) (iii) The amount of energy released by 1 g of glucose should be 16 000 J.

Apart from energy loss to the surroundings, suggest **two** other reasons why the student's value was less than expected.

1 .....

.....

2 .....

.....
(2 marks)

1 (c) Suggest **one** reason why food labels provide information about the energy released by the food.

.....

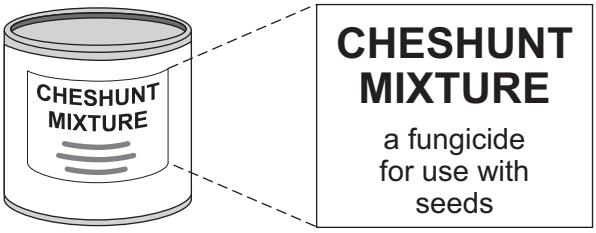
.....
(1 mark)

8

Turn over for the next question

Do not write outside the box

2 Cheshunt mixture is a powder containing copper sulfate, $CuSO_4$, and ammonium carbonate, $(NH_4)_2CO_3$



2 (a) A student tested the Cheshunt mixture.

2 (a) (i) Hydrochloric acid was added.
A gas was produced that turned limewater milky.

Complete the sentence.

The gas was ..... which shows

that ..... ions are in the mixture.

(2 marks)

2 (a) (ii) Sodium hydroxide solution was added.
A gas was produced that indicates that ammonium ions are in the mixture.

Complete the sentence.

The gas was ..... which turns

damp red ..... blue.

(2 marks)

2 (b) Cheshunt mixture is dissolved in water before it is used.
When the student dissolved the Cheshunt mixture in water it formed a blue solution.

2 (b) (i) Suggest how the student knew that copper ions are in this solution.

.....

.....

(1 mark)

2 (b) (ii) The student tested the Cheshunt solution and the result of the test indicated that sulfate ions are in the solution.

Complete the sentence.

The student added a solution of ..... in the presence of

dilute hydrochloric acid and a ..... precipitate was produced.

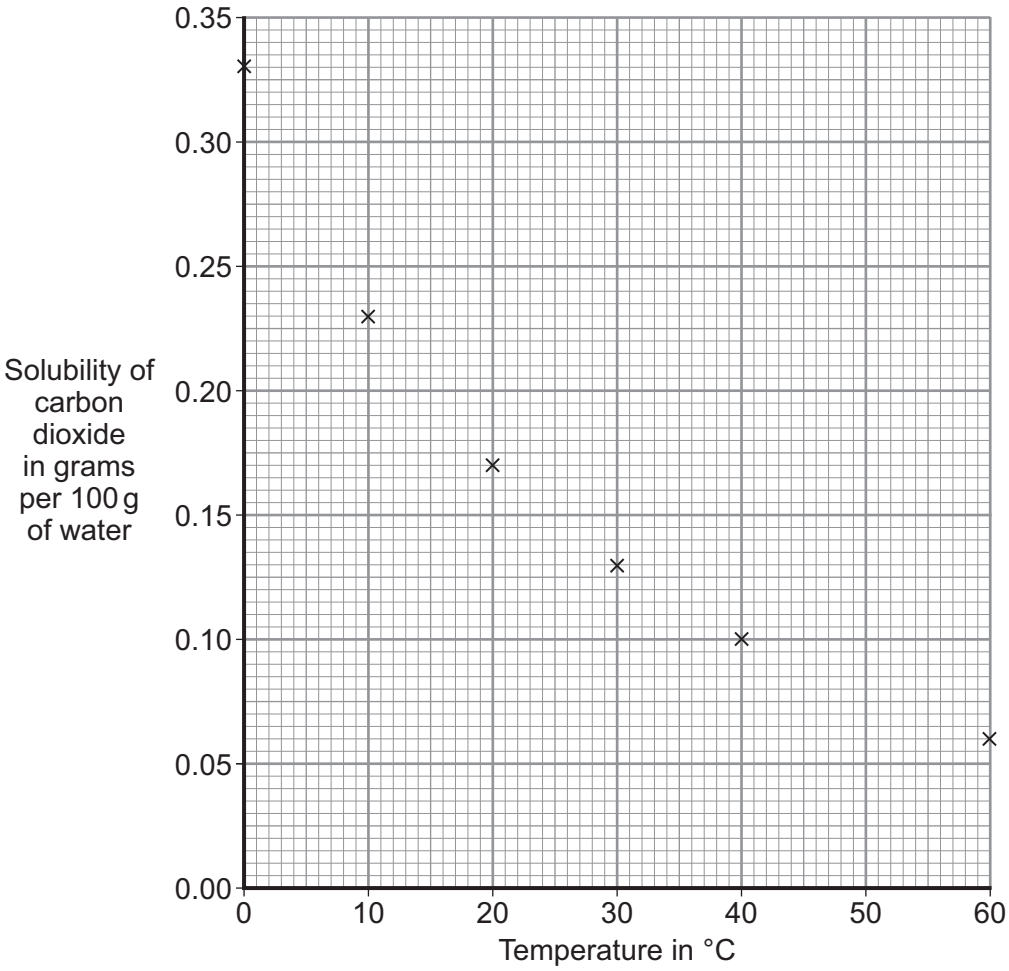
(2 marks)

7

Do not write outside the box

3 In some parts of the UK, the water is hard.

3 (a) As rain falls through the air, carbon dioxide dissolves in the water. The graph shows the solubility of carbon dioxide in water at different temperatures.



3 (a) (i) Complete the graph by drawing a smooth curve through the points.

(1 mark)

3 (a) (ii) Use the graph to find the mass of carbon dioxide that dissolves in water at 50 °C.

Mass = ... g

(1 mark)

3 (a) (iii) Calculate the mass of carbon dioxide that bubbles out of 100 g of water when the temperature rises from 20 °C to 60 °C.

.....

.....

Mass = ... g

(2 marks)

Question 3 continues on the next page

Turn over ▶

Do not write outside the box

3 (b) Hard water contains dissolved calcium compounds.
Carbon dioxide dissolved in water reacts with calcium carbonate in limestone.
The product is calcium hydrogencarbonate which dissolves in water.

$$CaCO_3(s) + H_2O(l) + CO_2(g) \rightleftharpoons Ca(HCO_3)_2(aq)$$

When this hard water is heated, an insoluble scale is produced.
Use the chemical equation to explain how this happens.

.....

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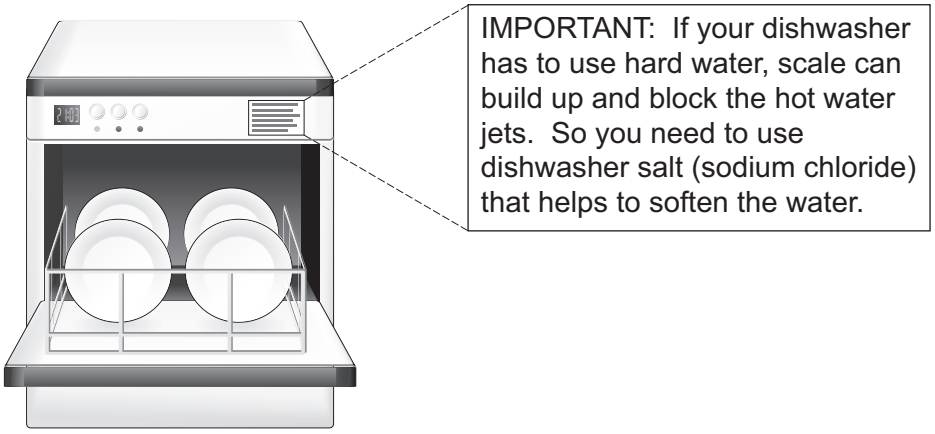
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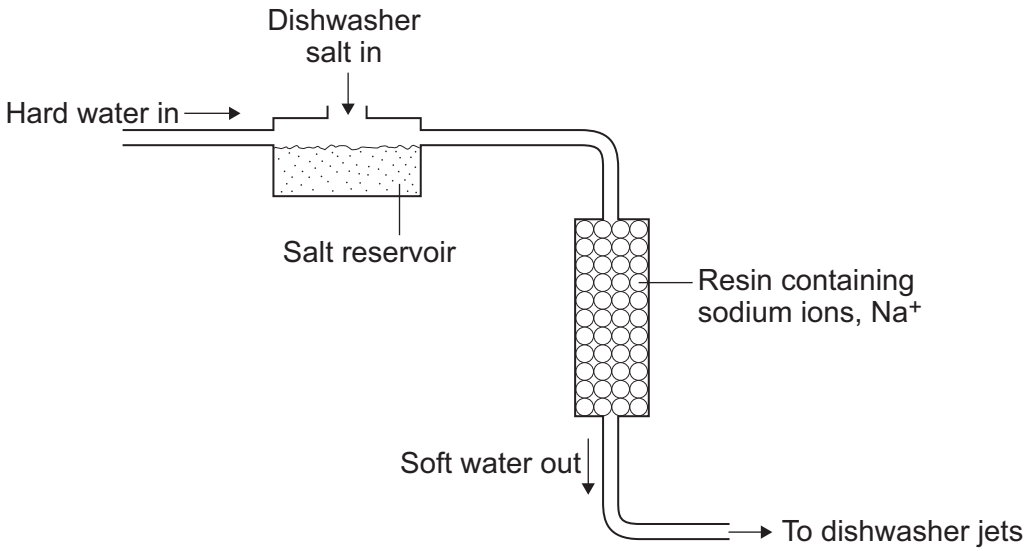
(2 marks)

3 (c) This label was on a dishwasher.



Do not write outside the box

This dishwasher has a built-in water softener.



Use the information and your knowledge and understanding to explain how sodium chloride helps to soften the water in this dishwasher.

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(4 marks)

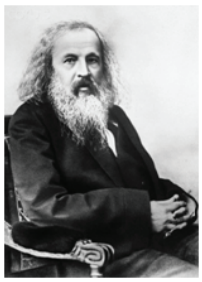
10

Turn over for the next question

Do not write outside the box

4 By 1869, about 60 elements had been discovered.
Mendeleev arranged these elements in a table, in order of their atomic weight.
He also put elements with similar chemical properties in the same columns.

Mendeleev and part of his table are shown below.



	Group							
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Period 1	H							
Period 2	Li	Be	B	C	N	O	F	
Period 3	Na	Mg	Al	Si	P	S	Cl	
Period 4	K Cu	Ca Zn	– –	Ti –	V As	Cr Se	Mn Br	Fe Co Ni

4 (a) (i) Name **one** element in Group 1 of Mendeleev's table that is not in Group 1 of the periodic table on the Data Sheet.
Give a reason why this element should not be in Group 1.

Name of element .....

Reason .....

.....

(2 marks)

4 (a) (ii) Which group of the periodic table on the Data Sheet is missing from Mendeleev's table?

.....

(1 mark)

4 (b) The gaps (–) in Mendeleev's table were for elements that had not been discovered.

4 (b) (i) Compare Mendeleev's table with the periodic table on the Data Sheet.

Name **one** of the elements in Period 4 that had not been discovered by 1869.

.....

(1 mark)

Do not write outside the box

4 (b) (ii) Mendeleev was able to make predictions about the undiscovered elements. This eventually led most scientists to accept his table.

Suggest what predictions Mendeleev was able to make about these undiscovered elements.

.....

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.....

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(2 marks)

4 (c) In terms of their electronic structure:

4 (c) (i) state why lithium and sodium are both in Group 1

.....

.....

.....

(1 mark)

4 (c) (ii) explain why sodium is more reactive than lithium.

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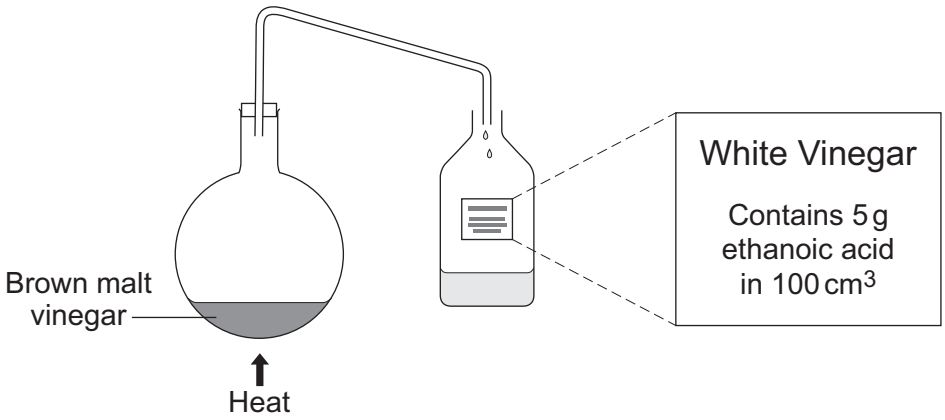
(3 marks)

10

Turn over for the next question

Do not write outside the box

5 White vinegar can be made by distillation of brown malt vinegar.



Ethanoic acid, CH_3COOH, is a *weak acid*.

$$CH_3COOH(aq) \rightleftharpoons CH_3COO^-(aq) + H^+(aq)$$

5 (a) Use the chemical equation to:

5 (a) (i) explain *weak* in terms of ionisation of ethanoic acid

.....

.....

(1 mark)

5 (a) (ii) explain why, according to Arrhenius, ethanoic acid is an *acid*.

.....

.....

(1 mark)

Do not write outside the box

5 (b) A student did a titration to find out if the white vinegar contains 5 g of ethanoic acid in 100 cm^3.
To do this, the student placed 25.0 cm^3 of white vinegar in a conical flask with 5 drops of phenolphthalein indicator.
The volume of sodium hydroxide solution needed to react completely with the ethanoic acid in the white vinegar was found by titration.

Describe how the student should do the titration.
Include the names of any equipment needed for the titration.

.....

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(4 marks)

Question 5 continues on the next page

Do not write outside the box

5 (c) The student repeated the titration three more times. The results are shown in the table.

Titration	**1**	**2**	**3**	**4**
Volume of sodium hydroxide in cm^3	23.5	20.1	19.9	20.0

The chemical equation for this reaction is:

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

5 (c) (i) Calculate the volume of sodium hydroxide solution that reacted completely with the ethanoic acid in 25.0 cm^3 of white vinegar.

.....

Volume = ... cm^3

(1 mark)

5 (c) (ii) Is the student able to conclude that the white vinegar contains 5 g of ethanoic acid in 100 cm^3?

Explain your answer.

Use the following to explain your answer:

- your answer to part (c)(i)
- the concentration of the sodium hydroxide solution is 1.0 moles per cubic decimetre
- one mole of ethanoic acid has a mass of 60 g.

.....

.....

.....

.....

.....

.....

.....

.....

(3 marks)

10

END OF QUESTIONS

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Version : 07/03/2012

General Certificate of Secondary Education

Chemistry 4421

CHY3H Unit Chemistry 3

Mark Scheme

2012 examination – January series

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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 meeting attended by all examiners and is the scheme which was used by them in this examination. The standardisation meeting 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 the standardisation meeting each examiner analyses a number of students' scripts: alternative answers not already covered by the mark scheme are discussed at the meeting and legislated for. If, after this meeting, examiners encounter unusual answers which have not been discussed at the meeting 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.

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MARK SCHEME

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 lines 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.)

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.

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

Student	Response	Marks awarded
1	4,8	0
2	green, 5	0
3	red*, 5	1
4	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, as shown in the column 'answers', 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;

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.

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CHY3H

Question 1

question	Answers	extra information	mark
1(a)(i)	A		1
1(a)(ii)	B		1
1(b)(i)	put a lid on (beaker) **or** insulate (top or sides of) beaker **or** use screens to prevent draughts	any addition to the equipment that would prevent energy loss allow bomb calorimeter do **not** allow polystyrene cup ignore 'move the crucible'	1
1(b)(ii)	(temperature change =) 22°C (100 x 4.2 x 22 =) 9240	correct answer is **2** marks with or without working allow ecf from their 22	1 1
1(b)(iii)	any **two** from: • a specified human/measurement error • water should be stirred • not all of the glucose burns • energy used to heat the beaker / container • recorded the room temperature (at the beginning)	 ignore 1g of glucose insufficient ignore 100cm^3 of water too much ignore calculation error ignore not repeated / anomalous results allow thermometer in fixed position allow glucose was impure ignore light energy / evaporation allow room temperature was higher/different to the temperature of the (cold) water allow did not measure the water temperature at the beginning	2

Question 1 continues on the next page . . .

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Question 1 continued

question	Answers	extra information	mark
1(c)	any **one** from: • for dietary information • different foods produce different amounts of energy • legal requirement	 allow consequences of diet allow for nutritional information allow eat healthily ignore balanced diet ignore to know how much energy is taken in	1
Total			**8**

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CHY3H

Question 2

question	Answers	extra information	mark
2(a)(i)	carbon dioxide / CO_2 carbonate / CO_3^{2-}	answers must be in the order shown marks are independent	1 1
2(a)(ii)	ammonia / NH_3 litmus	answers must be in the order shown marks are independent	1 1
2(b)(i)	solution is blue	accept blue precipitate only if sodium hydroxide added allow blue liquid allow copper sulfate / copper ions are blue	1
2(b)(ii)	barium chloride / $BaCl_2$ white	allow barium nitrate / barium ions / Ba^{2+} answers must be in the order shown marks are independent	1 1
Total			**7**

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CHY3H

Question 3

question	Answers	extra information	mark
3(a)(i)	smooth curve drawn through <u>all</u> points ± ½ small square	do **not** accept double lines **or** straight lines point to point	1
3(a)(ii)	a value in the range 0.07 – 0.08	or from their graph ± ½ small square	1
3(a)(iii)	0.11	correct answer with or without working gains **2** marks if answer is incorrect allow **1** mark for 0.17 **or** 0.06	2
3(b)	(calcium) carbonate / $CaCO_3$ is the scale	accept clear implication that (calcium) carbonate is scale	1
	because the reaction is reversible **or** because (calcium) hydrogencarbonate decomposes	allow description ignore equilibrium unless qualified accept equation written in reverse	1
3(c)	sodium chloride / dishwater salt contains <u>sodium</u> <u>ions</u>		1
	sodium ions / Na^+ <u>in the resin</u> are used	allow sodium ions <u>in the resin</u> need replacing	1
	to exchange / replace / displace	accept ion exchange	1
	for calcium / magnesium (ions from the hard water)	allow calcium / magnesium (ions) removed (from the hard water)	1
Total			**10**

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CHY3H

Question 4

question	Answers	extra information	mark
4(a)(i)		incorrect or no element = **0** marks	
	hydrogen	allow H / H_2	1
	all the other elements are metals **OR**	allow hydrogen is a not an (alkali / group 1) metal ignore hydrogen is a gas	1
	copper (1)	allow Cu	
	(copper) is not an alkali metal (1)	allow Cu is a transition element / metal allow any valid specific chemical property eg Cu does not react with water ignore references to electronic structure ignore physical properties	
4(a)(ii)	Group 0 / noble gases	ignore Group 8	1
4(b)(i)	scandium / gallium / germanium	accept Sc / Ga / Ge allow Krypton / Kr	1
4(b)(ii)	predicted they were metals	allow atomic mass / weight ignore atomic structure	1
	predicted their (chemical/physical) properties / reactivity	accept any chemical / physical property allow similar properties if mentioned in context of a group	1
4(c)(i)	(both) have <u>one</u> / <u>an</u> electron in the outer energy level / shell	ignore form single plus ions	1

Question 4 continues on the next page . . .

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CHY3H

Question 4 continued

question	Answers	extra information	mark
4(c)(ii)		accept shell for energy level accept converse explanation for lithium if 'outer' not mentioned, max 2 marks ignore sodium reacts more easily	
	sodium loses one outer electron more easily (than lithium)		1
	because outer electrons/energy level further from the nucleus in sodium **or** because sodium has more shells (than lithium)	do **not** accept 'more outer shells' allow sodium (atom) is larger	1
	because forces/attraction to hold outer electron are weaker in sodium (than lithium)	accept more shielding in sodium (than lithium)	1
Total			**10**

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Question 5

question	Answers	extra information	mark
5(a)(i)	because (ethanoic acid) is not fully ionised / dissociated	accept (ethanoic acid) is partially ionised ignore weakly ionised ignore reversible reaction / equilibrium do **not** accept (weakly) ionising	1
5(a)(ii)	because (ethanoic acid) forms H^+ / hydrogen ions (in water)	do **not** accept 'it is a proton donor' allow contains hydrogen ions / H^+	1
5(b)		if acid to acid titration described, first two marking points **not** available if a titration not described, **0** marks	
	sodium hydroxide solution in burette		1
	add sodium hydroxide solution until (indicator) changes colour / (from colourless) to pink	do **not** accept incorrect indicator **or** incorrect colour change ignore clear allow red	1
	note (burette) volume used or final reading	allow calculate the volume needed	1
	any **one** from: • repeat • white background • add dropwise or slowly • swirl/mix • read meniscus at eye level • wash/rinse equipment		1
5(c)(i)	20.0		1

Question 5 continues on the next page . . .

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CHY3H

Question 5 continued

question	answers	extra information	mark
5(c)(ii)	(no)	ecf from 5(c)(i)	
	evidence of concentration of ethanoic acid (20/25 x 1.0) is 0.8 moles per cubic decimetre	allow any clear alternative method that leads to the correct answer	1
	evidence of concentration of ethanoic acid (0.8 x 60) is 48g per cubic decimetre		1
	evidence of conversion of 48g per cubic decimetre to 4.8g per $100cm^3$		1
Total			**10**

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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	
TOTAL	

General Certificate of Secondary Education
Higher Tier
June 2011

Chemistry

CHY3H

Unit Chemistry C3

H

Written Paper

Wednesday 25 May 2011 9.00 am to 9.45 am

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

You may use a calculator.

Time allowed
- 45 minutes

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 45.
- You are expected to use a calculator where appropriate.
- You are reminded of the need for good English and clear presentation in your answers.

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

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Do not write outside the box

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

1 These labels have been taken from two bottles of spring water.

Mountain View

Natural Spring Water

Contains essential minerals for good health

Analysis

Ions present	mg/dm^3
Calcium	65
Magnesium	35
Potassium	5
Sodium	12
Chloride	9
Hydrogencarbonate	269
Sulfate	21

Also tested by the independent Food Standards Agency and approved safe.

Valley Croft

Pure Spring Water

With healthy minerals as Nature intended

Analysis

Ions present	mg/dm^3
Calcium	16
Magnesium	14
Potassium	5
Sodium	34
Chloride	13
Hydrogencarbonate	62
Sulfate	7

Pure and natural – contains no chemicals.

Tested in our own laboratories by our own scientists to keep you safe.

1 (a) Mountain View and Valley Croft spring waters are hard because they contain calcium and magnesium ions.

1 (a) (i) Mountain View spring water is about **three** times as hard as Valley Croft spring water.

Use the information on the labels to explain why.

.....

.....

.....

.....

(2 marks)

Do not write outside the box

1 (a) (ii) Describe how a student could use soap solution to show that Mountain View spring water is about **three** times as hard as Valley Croft spring water.

You should state how the experiment is made fair and give the expected result.

.....

.....

.....

.....

.....

.....

(3 marks)

1 (b) Why is hard water good for health?

.....

.....

(1 mark)

1 (c) Give **one** disadvantage of hard water.

.....

(1 mark)

1 (d) (i) Suggest why people should be concerned about the claim that Valley Croft spring water "contains no chemicals''.

.....

.....

.....

(1 mark)

1 (d) (ii) Suggest why people should be concerned that Valley Croft spring water has only been tested by their own scientists.

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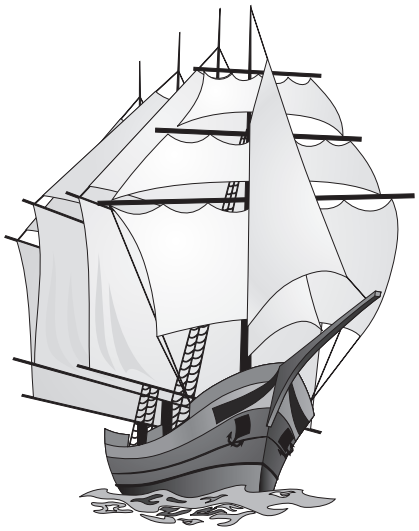
(1 mark)

9

Do not write outside the box

2 Read the information about protecting the bottoms of ships.

A Copper-bottomed Investment



From the 16th to the 19th century, the bottoms of many wooden ships were protected from marine organisms by being covered with sheets of metal.

At first lead was used on the bottoms of ships, then copper was used until 1832 when Muntz Metal replaced it. Muntz Metal is an alloy of two transition metals, copper and zinc.

Table of data

	Lead	**Copper**	**Muntz Metal**
Cost (£/kg)	£1.20	£3.20	£2.30
Melting point (°C)	327	1083	904
Stops sea worms attacking wood	Yes	Yes	Yes
Stops barnacles and seaweed sticking to the bottom of the ship	No	Yes	Yes

Do not write outside the box

2 (a) Use the information to answer the following questions.

2 (a) (i) Suggest why copper replaced lead.

.....

.....

(1 mark)

2 (a) (ii) Suggest why Muntz Metal replaced copper.

.....

.....

(1 mark)

2 (b) A sample of Muntz Metal contains a very small amount of iron as an impurity.

2 (b) (i) Name an instrumental method of analysis that could be used to detect iron.

.....

(1 mark)

2 (b) (ii) Suggest why an instrumental method would detect the iron in this sample of Muntz Metal but a chemical method is **not** likely to be successful.

.....

.....

(1 mark)

2 (c) Today, ships are made from steel. Steels are alloys of iron, a transition metal.

Give **two** properties of transition metals that make them suitable for making ships.

Property 1 .....

.....

Property 2 .....

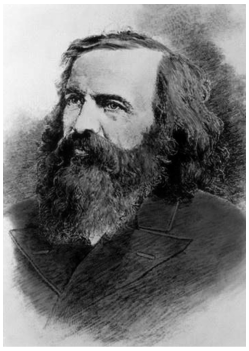
.....

(2 marks)

6

Do not write outside the box

3 Use the periodic table on the Data Sheet and the information below to help you answer these questions.



Mendeleev was one of the first chemists who classified elements in a systematic way based on atomic weight. He suggested his version of the periodic table in 1869.

He put the elements in order of their atomic weights but reversed the order for some pairs of elements. Then he arranged them in a table so that chemically similar elements were in columns known as Groups. He also left gaps and made predictions.

Part of Mendeleev's table is shown below.

Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7
H						
Li	Be	B	C	N	O	F
Na	Mg	Al	Si	P	S	Cl
K Cu	Ca Zn	# #	Ti #	V As	Cr Se	Mn Br
Rb Ag	Sr Cd	Y In	Zr Sn	Nb Sb	Mo Te	# I

The gaps Mendeleev left are shown by #.

3 (a) Which group of elements in the modern periodic table is missing from Mendeleev's table?

.....

(1 mark)

Do not write outside the box

3 (b) Mendeleev reversed the order for some pairs of elements. For example, he put tellurium (Te, atomic weight 128) before iodine (I, atomic weight 127), as shown in his table.

Why did he do this?

.....

.....

(1 mark)

3 (c) In 1869 many chemists did **not** agree with Mendeleev's periodic table.

Suggest **three** reasons why.

.....

.....

.....

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.....

(3 marks)

3 (d) In the 20th century, the arrangement of elements in the periodic table was explained in terms of atomic structure.

Describe the links between atomic structure and the periodic table.

.....

.....

.....

.....

.....

.....

(2 marks)

7

Do not write outside the box

4 Hydrogen peroxide decomposes to give water and oxygen.

$$2H_2O_2 \rightarrow 2H_2O + O_2$$

The reaction is *exothermic.*

4 (a) Explain, in terms of bond breaking and bond making, why the decomposition of hydrogen peroxide is *exothermic*.

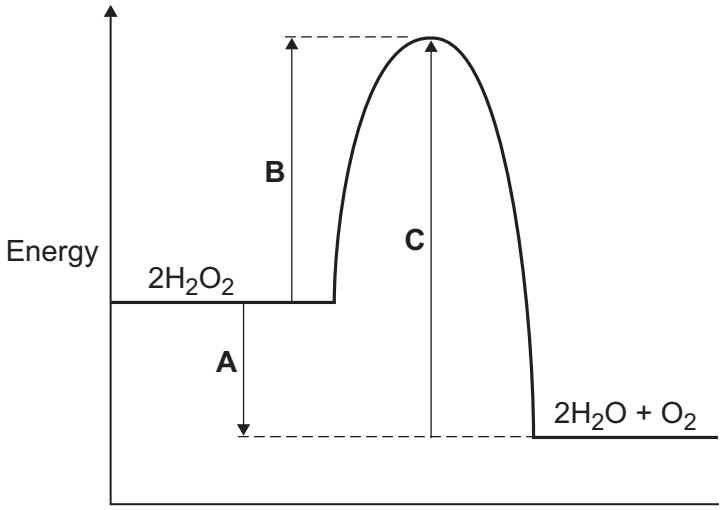
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(1 mark)

4 (b) The energy level diagram for this reaction is shown below.



The energy changes, **A**, **B** and **C**, are shown on the diagram.

Use the diagram to help you answer these questions.

4 (b) (i) How do you know that this reaction is *exothermic*?

.....

.....

.....

(1 mark)

4 (b) (ii) The decomposition of hydrogen peroxide is slow.
What does this suggest about energy change **B**?

.....

.....

.....

(1 mark)

Do not write outside the box

4 (b) (iii) Hydrogen peroxide decomposes quickly when a small amount of manganese(IV) oxide is added.

Explain why.

.....

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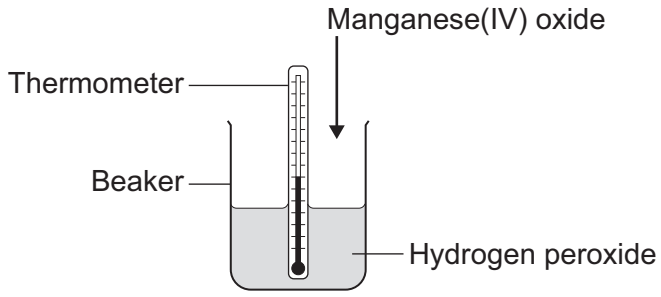
.....

.....

(2 marks)

4 (c) A student did an experiment to find the amount of energy produced when hydrogen peroxide solution is decomposed using manganese(IV) oxide.

The apparatus the student used is shown in the diagram.



The student first measured the temperature of the hydrogen peroxide. Then the student added the manganese(IV) oxide and recorded the highest temperature.

The temperature rise was smaller than expected.

Suggest why.

.....

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.....

.....

.....

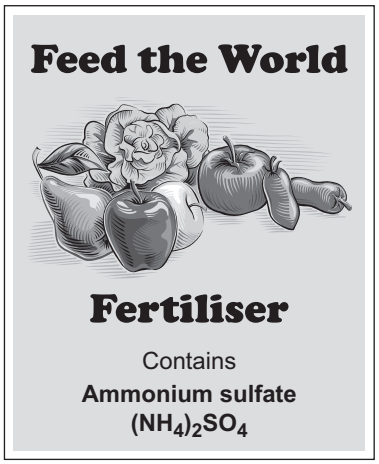
(2 marks)

7

Turn over ▶

Do not write outside the box

5 Ammonium sulfate is an artificial fertiliser.



5 (a) (i) When this fertiliser is warmed with sodium hydroxide solution, ammonia gas is given off. Describe and give the result of a test for ammonia gas.

Test .....

.....

Result .....

.....

(2 marks)

5 (a) (ii) Describe and give the result of a chemical test to show that this fertiliser contains sulfate ions (SO_4^{2-}).

Test .....

.....

Result .....

.....

(2 marks)

5 (b) Ammonium sulfate is made by reacting sulfuric acid (a *strong* acid) with ammonia solution (a *weak* alkali).

5 (b) (i) Explain the meaning of *strong* in terms of ionisation.

.....

(1 mark)

Do not write outside the box

5 (b) (ii) A student made some ammonium sulfate in a school laboratory.

The student carried out a titration, using a suitable indicator, to find the volumes of sulfuric acid and ammonia solution that should be reacted together.

Name a suitable indicator for strong acid-weak alkali titrations.

.....

(1 mark)

5 (b) (iii) The student found that 25.0 cm^3 of ammonia solution reacted completely with 32.0 cm^3 of sulfuric acid of concentration 0.050 moles per cubic decimetre.

The equation that represents this reaction is:

$$H_2SO_4\,(aq) + 2NH_3\,(aq) \rightarrow (NH_4)_2SO_4\,(aq)$$

Calculate the concentration of this ammonia solution in moles per cubic decimetre.

.....

.....

.....

.....

.....

Concentration = ... moles per cubic decimetre

(3 marks)

5 (b) (iv) Use your answer to (b)(iii) to calculate the concentration of ammonia in grams per cubic decimetre.

(If you did not answer part (b)(iii), assume that the concentration of the ammonia solution is 0.15 moles per cubic decimetre. This is **not** the correct answer to part (b)(iii).)

Relative formula mass of ammonia (NH_3) = 17.

.....

.....

.....

Concentration = ... grams per cubic decimetre

(2 marks)

11

Turn over for the next question

Do not write outside the box

6 *Unsaturated* organic compounds are used to make polymers.

6 (a) (i) Describe what you would **see** when bromine water reacts with an *unsaturated* organic compound.

.....

.....

(1 mark)

6 (a) (ii) In terms of structure, what makes an organic compound *unsaturated*?

.....

.....

(1 mark)

6 (b) When 2.1 g of an unsaturated hydrocarbon were completely burned in oxygen, 6.6 g of carbon dioxide and 2.7 g of water were the only products.

Relative formula masses: CO_2 = 44; H_2O = 18.

Use this information to calculate the number of moles of carbon dioxide and of water produced in this reaction. Use your answer to calculate the empirical formula of the hydrocarbon.

You must show your working to gain full marks.

.....

.....

.....

.....

.....

.....

.....

Empirical formula = ...

(3 marks)

5

END OF QUESTIONS

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Version: 04/08/2011



General Certificate of Secondary Education

Chemistry 4421

CHY3H Unit Chemistry 3

Mark Scheme

2011 examination – June series

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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 meeting attended by all examiners and is the scheme which was used by them in this examination. The standardisation meeting ensures that the mark scheme covers the candidates' responses to questions and that every examiner understands and applies it in the same correct way. As preparation for the standardisation meeting each examiner analyses a number of candidates' scripts: alternative answers not already covered by the mark scheme are discussed at the meeting and legislated for. If, after this meeting, examiners encounter unusual answers which have not been discussed at the meeting 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 candidates' 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 to download from the AQA Website: www.aqa.org.uk

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MARK SCHEME

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 lines 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.)

3. Marking points

3.1 Marking of lists

This applies to questions requiring a set number of responses, but for which candidates 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.

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

Candidate	Response	Marks awarded
1	4,8	0
2	green, 5	0
3	red*, 5	1
4	red*, 8	0

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

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

3.2 Use of chemical symbols / formulae

If a candidate 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, as shown in the column 'answers', 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;

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.

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CHY3H

Question 1

question	answers	extra information	mark
1(a)(i)	Mountain View: (65+35 =)100		1
	Valley Croft: (16+14 =) 30 **OR** Mountain View Ca (65) is about 4 times Valley Croft (Ca 16) (1) Mountain View Mg (35) is about twice Valley Croft (Mg 14) (1)		1
		ignore other ions unless used in another calculation or calculations. In this case the list principle applies if no other mark awarded either: Ca 65 compared with Ca 16 **and** Mg 35 compared with Mg 14 gains **1** mark **or** difference in Ca (65 – 16) = 49 **and** Mg (35 – 14) = 21 gains **1** mark	
1(a)(ii)	shake / stir / swirl (water with soap)	allow mix ignore add / use soap / titrate	1
	(about) 3 × the scum / precipitate / solid (compared with Valley Croft)	accept (about) 3 × volume / drops / amount / quantity of soap solution for (permanent) lather (compared with Valley Croft) ignore scale / time	1
	fair test: eg same volume / amount of water **or** shake for same amount of time **or** use same type / concentration of soap	allow same temperature do **not** accept same volume of soap ignore repeat the experiment	1

Question 1 continues on the next page

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Question 1 continued

question	answers	extra information	mark
1(b)	strong(er) teeth / bones **or** good for heart	allow contains calcium (ions / compounds) ignore magnesium **or** charge on the calcium ion do **not** accept any other ions	1
1(c)	any **one** from: • produces scale / limescale / calcium carbonate / magnesium carbonate • produces scum • more soap needed • costs more to soften water • (scale) lowers efficiency of appliances	ignore health effects allow fur for scale allow doesn't lather easily ignore detergent allow costs if qualified ignore just damage to pipes	1
1(d)(i)	water / everything is made of / contains chemicals **or** water contains named ion from the label	accept company (probably) means water contains no added substances ignore water has not been treated	1
1(d)(ii)	Valley Croft scientists may be biased / vested interest	accept Food Standards Agency / independent scientists (more likely to be) unbiased allow Valley Croft scientists may falsify results ignore accuracy / reliability / fairness / validity	1
Total			**9**

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CHY3H

Question 2

question	answers	extra information	mark
2(a)(i)	(copper) stops barnacles / seaweed (sticking)	it = copper accept lead doesn't stop barnacles / seaweed (sticking) ignore all other properties	1
2(a)(ii)	(Muntz Metal) is less expensive / cheaper / cheapest	it = Muntz Metal must be a comparison accept copper is more expensive ignore other properties	1
2(b)(i)	atomic absorption spec(troscopy) / spectrometry **or** mass spec(trometry) / spectroscopy	accept spectroscopy / spectrometry alone allow AAS / MS do **not** allow NMR spectroscopy **or** IR spectrometry **or** chromatography	1
2(b)(ii)	sensitive **or** detect (very) small amounts **or** only small sample needed	it = instrumental method allow (more) precise ignore accurate allow converse for chemical method ignore metal contains small amount / low concentration of iron	1
2(c)	any **two** from: • unreactive / not very reactive • strong / hard • malleable / easy to shape	transition elements (= they) allow does not corrode ignore reference to rust ignore tough / durable / hard wearing ignore ductile / density / melting point	2
Total			**6**

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CHY3H

Question 3

question	answers	extra information	mark
3(a)	Group O / 8 **or** noble / rare / inert gases	accept transition elements / metals apply list principle	1
3(b)	(chemically) similar elements (now) in the same group / column	accept iodine has properties of Group 7 / halogens **or** iodine does not have group 6 properties **or** converse for tellurium ignore 'it fits the pattern' or any reference to proton / atomic numbers / atomic structure	1
3(c)	any **three** from: • (some) boxes had <u>two</u> elements • Group 1: copper / silver unreactive (not like the others) • there are non-metals and metals in the same group / box • Mendeleev left spaces / gaps • Medeleev reversed the order (for some elements)	ignore not enough evidence / proof **or** Mendeleev not respected allow <u>two</u> correctly identified elements together (in the same box) allow copper / silver not alkali metals / Group 1 accept named examples accept (some chemists thought) there were no more elements to discover	3

Question 3 continues on the next page

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Question 3 continued

question	answers	extra information	mark
3(d)	any **two** from: • elements arranged in proton / atomic number order • group: elements in same group / column have same number of outer electrons • elements in same period / row have same number of (electron) shells / energy levels	ignore mass number / atomic weight / neutrons throughout allow number of protons / electrons increases across period allow number of (electron) shells / energy level increase down group allow electron rings allow orbits	2
Total			**7**

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CHY3H

Question 4

question	answers	extra information	mark
4(a)	energy released from making (new) bonds is greater than the energy needed to break (existing) bonds	accept the energy needed to break (existing) bonds is less than the energy released in making (new) bonds do **not** accept energy needed to make bonds	1
4(b)(i)	energy / heat of products less than energy of reactants	accept products are lower than reactants **or** reactants higher than products accept more energy / heat given out than taken in **or** less energy / heat taken in than given out accept energy / heat is given out / lost (to the surroundings) allow produce heat ignore produce energy accept △H is negative **or** energy change / **A** is negative **or B** is less than **C**	1
4(b)(ii)	**B** is (very) high / large	it = **B** ignore energy change **C** is high	1
4(b)(iii)	(MnO_2) catalyst (is added) **or** reaction catalysed (by MnO_2) which lowers activation energy **or** which lowers (energy change) **B**	it = MnO_2 accept it is a catalyst do **not** accept MgO / magnesium oxide accept provides alternative / lower energy pathway if hydrogen peroxide is given as a catalyst instead of MnO_2 penalise once only in question	1 1

Question 4 continues on the next page

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Question4 continued

question	answers	extra information	mark
4(c)	any **two** from: • (chemicals) not mixed / stirred • heat / energy lost (from apparatus) • (apparatus) not insulated **or** no lid • low amount / mass / not enough MnO_2 **or** low concentration H_2O_2 • thermometer read incorrectly	 ignore other experimental error	2
Total			**7**

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CHY3H
Question 5

question	answers	extra information	mark
5(a)(i)		incorrect test or no test = **0** mark testing the solution **or** using blue litmus = **0** mark	
	(test ammonia / gas with red) litmus	accept any acid-base indicator with correct result	1
	(goes) blue		1
	OR		
	(conc.) HCl (1)		
	white fumes / smoke / solid (1)	allow white gas / vapour	
	OR		
	(test ammonia / gas with) Universal Indicator (1)		
	blue / purple (1)		
5(a)(ii)		incorrect test or no test = **0** marks	
	add barium chloride / $BaCl_2$ (solution) **or** add barium nitrate / $Ba(NO_3)_2$ (solution)	do **not** accept H_2SO_4 added allow Ba^{2+} solution / aqueous added	1
	white precipitate / solid (formed)	allow white barium sulfate / $BaSO_4$ ignore barium sulfate / $BaSO_4$ alone	1
5(b)(i)	fully / completely ionised / dissociated **or** hydrogen ions fully dissociated	accept has more ions than weaker acid / alkali of same concentration ignore strongly ionised do **not** accept ions are fully ionised ignore concentrated **or** reference to concentrations of ions	1

Question 5 continues on the next page

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Question 5 continued

question	answers	extra information	mark
5(b)(ii)	methyl orange	accept correct spelling only accept any strong acid-weak base indicator do **not** allow phenolphthalein / litmus / universal indicator	1
5(b)(iii)	32 × 0.05/1000 **or** 0.0016 (mole H_2SO_4) (reacts with) 2 × 0.0016 **or** 0.0032 (mole NH_3 in $25cm^3$) (0.0032 × 1000/25 =) 0.128	accept (0.05 x 32) = (V x 25) **or** 0.05 x 32 / 25 accept dividing rhs by 2 **or** multiplying lhs by 2 allow ecf from previous stage correct answer 0.128 **or** 0.13 with or without working gains all **3** marks	1 1 1
5(b)(iv)	2.176 **or** 2.18 **or** ecf from candidate's answer to (b)(iii) **or** 2.55 if 0.15 moles used	correct answer with or without working if answer incorrect or no answer 0.128 × 17 **or** 0.13 x 17 **or** their (b)(iii) × 17 **or** 0.15 × 17 gains **1** mark	2
Total			**11**

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CHY3H

Question 6

question	answers	extra information	mark
6(a)(i)	(brown / red / orange / yellow) goes colourless / decolourised	ignore discoloured / goes clear do **not** accept incorrect initial colour	1
6(a)(ii)	(carbon carbon) double bond	accept triple / multiple bonds do **not** allow incorrect double bond	1
6(b)	CO_2: 6.6/44 **or** 0.15(mole) H_2O: 2.7/18 **or** 0.15(mole) CH_2	 ignore multiples	1 1 1
Total			**5**

The AQA UMS Conversion Calculator is available on the Results statistics page of the AQA Website

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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
January 2011

Chemistry

CHY3H

Unit Chemistry C3

H

Written Paper

Monday 17 January 2011 9.00 am to 9.45 am

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

You may use a calculator.

Time allowed
- 45 minutes

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 45.
- You are expected to use a calculator where appropriate.
- You are reminded of the need for good English and clear presentation in your answers.

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

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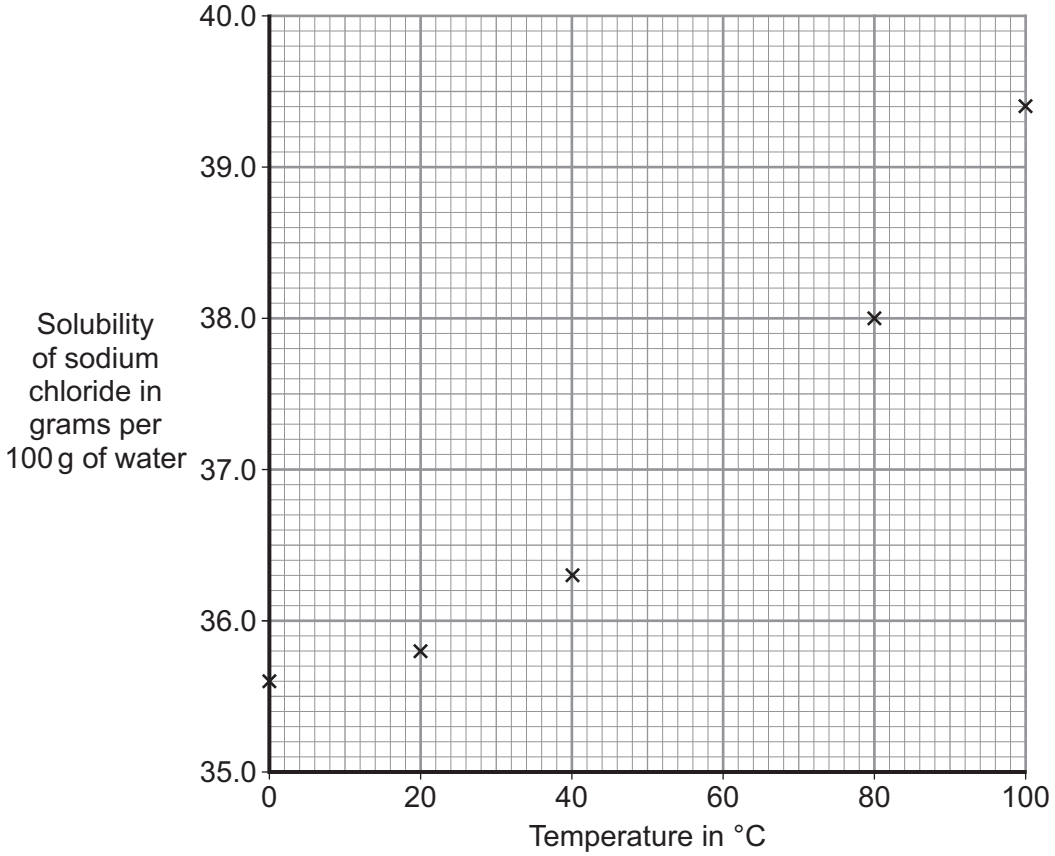
Do not write outside the box

1 The table gives the solubility of sodium chloride in water at different temperatures.

Temperature in °C	**0**	**20**	**40**	**80**	**100**
Solubility in g per 100 g of water	35.6	35.8	36.3	38.0	39.4

1 (a) A student plotted Graph **A** using the data in the table.

Graph A



1 (a) (i) Draw a smooth curve through all the points on Graph **A**. *(1 mark)*

1 (a) (ii) Use this graph to find the mass of sodium chloride that dissolves in 100 g of water at 60 °C.

Mass = ... g
(1 mark)

1 (a) (iii) A saturated solution of sodium chloride in 100 g of water is made at 60 °C. It is then cooled to 20 °C.

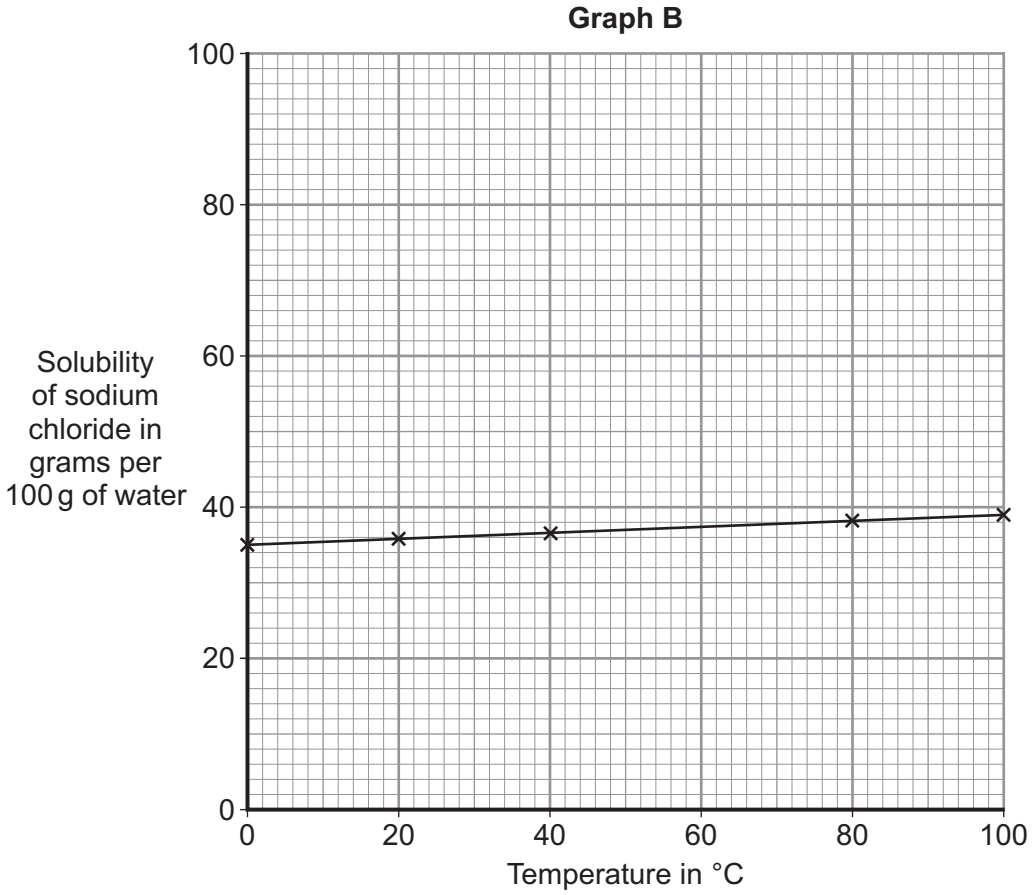
What mass of sodium chloride crystallises from the solution?

.....

.....
(2 marks)

Do not write outside the box

1 (b) Another student plotted Graph **B** using the same data.



The table shows the conclusion that each student made.

	How solubility changes as temperature increases
1st student (Graph A)	Very large increase
2nd student (Graph B)	Very small increase

Suggest why the students came to such different conclusions even though they had used the same data to plot their graphs.

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.....

.....

(1 mark)

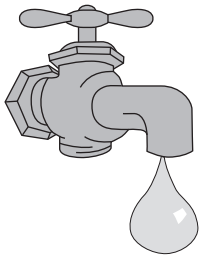
5

Turn over ▶

Do not write outside the box

2 Good quality water is essential for life.

2 (a) In the United Kingdom, water is filtered **and** treated with chlorine to make it safe to drink.



Explain why the water is:

filtered .....

.....

treated with chlorine. .....

.....

(2 marks)

2 (b) Millions of people in Bangladesh drink water from wells that contain high levels of arsenic. Arsenic is poisonous.

The World Health Organisation recommends that there should be no more than 0.01 mg of arsenic per litre in drinking water.

The table gives some information about two instrumental methods of testing for arsenic.

Factor to consider	**Laboratory Instrumental Method**	**Portable Instrumental Method**
Cost of equipment	£10 000	£50
Skill level of technician	Highly skilled	Little training needed
Where test is done	Laboratory only	Anywhere
Time to prepare the instrument for the test	5 minutes	10 seconds
Sensitivity of the instrument	0.000001 mg of arsenic per litre of water	0.1 mg of arsenic per litre of water

Do not write outside the box

2 (b) (i) Use the information in the table to give **two** advantages and **one** disadvantage of using the Portable Instrumental Method compared with the Laboratory Instrumental Method.

.....

.....

.....

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.....

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.....

.....

(3 marks)

2 (b) (ii) The information about these two instrumental methods was provided by the Professional Institute of Water Engineers (PIWE). The Institute has no connection with the companies that make these instruments.

Suggest why many people would accept the views of PIWE rather than the views of the companies that make the instruments.

.....

.....

(1 mark)

6

Turn over for the next question

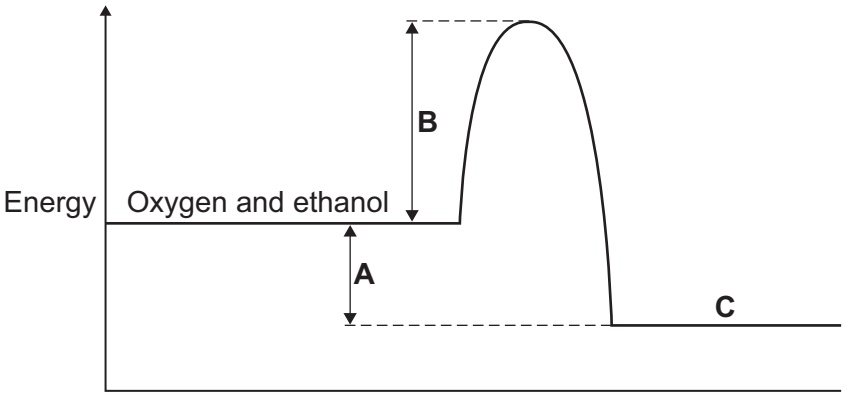
Do not write outside the box

3 V2 rockets were used during the Second World War.



V2 rockets were powered by liquid oxygen and ethanol. Oxygen and ethanol react to produce carbon dioxide and water.

The energy level diagram represents the energy changes during this reaction.



3 (a) On the energy level diagram what is represented by the letter:

A .....

B .....

C .....

(3 marks)

3 (b) What type of reaction is represented by this energy level diagram?

.....

.....

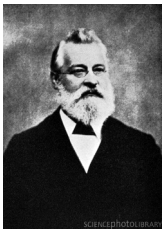
(1 mark)

4

Do not write outside the box

4 The periodic table on the Data Sheet may help you answer these questions.

4 (a) Many chemists have contributed to the development of the periodic table.



John Newlands was one of the first chemists who attempted to classify elements in a systematic way based on atomic weight. In 1866 he suggested that there was a repeating pattern of elements with similar properties every eighth element.
Part of Newlands' periodic table is shown below.

H	Li	Be	B	C	N	O
F	Na	Mg	Al	Si	P	S
Cl	K	Ca	Cr	Ti	Mn	Fe
Co, Ni	Cu	Zn	Y	In	As	Se
Br	Rb	Sr	Ce, La	Zr	Di, Mo	Ro, Ru

Many chemists in 1866 did not accept Newlands' periodic table.

4 (a) (i) Give **one** piece of evidence which supports Newlands' ideas.

.....

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(1 mark)

4 (a) (ii) Suggest **two** reasons why many chemists in 1866 did not accept Newlands' ideas.

1 .....

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2 .....

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(2 marks)

Turn over ▶

Do not write outside the box

4 (b) Chlorine, bromine and iodine are Group 7 elements.

A student investigated the reactivity of these elements.
The student added:

- aqueous chlorine to potassium bromide and potassium iodide solutions
- aqueous bromine to potassium chloride and potassium iodide solutions
- aqueous iodine to potassium chloride and potassium bromide solutions.

The student's results are shown below.

Solution	Potassium chloride	Potassium bromide	Potassium iodide
Chlorine		Solution turned orange-brown	Solution turned brown
Bromine	No reaction		Solution turned brown
Iodine	No reaction	No reaction	

4 (b) (i) Use these results to state **and** explain the trend in reactivity of these Group 7 elements.

.....

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(2 marks)

4 (b) (ii) Complete the equation below, which represents the reaction between chlorine and potassium bromide.

$$Cl_2 \quad + \quad 2KBr \quad \longrightarrow \quad \ldots\ldots \quad + \quad 2KCl$$

(1 mark)

4 (b) (iii) In terms of electronic structure, state why chlorine, bromine and iodine are in Group 7.

.....

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(1 mark)

Do not write outside the box

4 (c) Lithium, sodium and potassium are Group 1 elements.

Group 1 elements become **more** reactive down the group.

Explain why in terms of electronic structure.

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(3 marks)

10

Turn over for the next question

Do not write outside the box

5 Read the information in the box and then answer the questions.

Seidlitz Powder is the name of a medicine.

Seidlitz Powder comes as two powders. One powder is wrapped in white paper and contains tartaric acid ($C_4H_6O_6$). The other powder is wrapped in blue paper and contains potassium sodium tartrate ($KNaC_4H_4O_6$) and sodium hydrogencarbonate ($NaHCO_3$).

The contents of the blue paper are completely dissolved in water and then the contents of the white paper are added.

The equation which represents this reaction is:

$$C_4H_6O_6\,(aq) + 2NaHCO_3\,(aq) \longrightarrow Na_2C_4H_4O_6\,(aq) + 2H_2O\,(l) + 2CO_2\,(g)$$

5 (a) Describe and give the result of a test to identify the gas produced in this reaction.

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(2 marks)

5 (b) One of the chemicals in Seidlitz Powder is potassium sodium tartrate ($KNaC_4H_4O_6$).

Suggest why it would be difficult to identify **both** potassium ions and sodium ions in potassium sodium tartrate using a flame test.

.....

.....

(1 mark)

Do not write outside the box

5 (c) Some Seidlitz Powder was bought on the Internet. However, when tested, it was found to be only magnesium sulfate.

5 (c) (i) Describe and give the result of a chemical test to show that magnesium sulfate contains sulfate ions.

Test .....

.....

Result .....

.....

(2 marks)

5 (c) (ii) Magnesium sulfate contains magnesium ions.

Describe what you **see** when sodium hydroxide solution is added to a solution of magnesium sulfate.

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.....

(1 mark)

6

Turn over for the next question

Do not write outside the box

6 This label was on a bottle of vinegar.



Vinegar contains ethanoic acid, which is a *weak* acid.

6 (a) (i) According to Arrhenius, acids are chemicals that produce hydrogen ions (H^+) in aqueous solution.

Complete the following equation to show why ethanoic acid (CH_3COOH) is an acid in aqueous solution.

$$CH_3COOH\ (l) \xrightleftharpoons{\text{water}} \text{..... (aq)} + \text{..... (aq)}$$

(1 mark)

6 (a) (ii) Explain the meaning of *weak* in terms of ionisation.

.....

.....

(1 mark)

6 (a) (iii) What is the Brønsted and Lowry definition of acids?

.....

(1 mark)

6 (b) 25.0 cm^3 of diluted vinegar were placed in a conical flask using a pipette.

The volume of sodium hydroxide solution needed to react completely with the ethanoic acid in 25.0 cm^3 of diluted vinegar can be found by titration using phenolphthalein indicator.

6 (b) (i) Why is phenolphthalein used instead of methyl orange for this titration?

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(1 mark)

Do not write outside the box

6 (b) (ii) Describe how you would do the titration.

You should include the names of any apparatus you would use.

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(4 marks)

6 (c) The ethanoic acid in 25.0 cm^3 of diluted vinegar reacted completely with 15.0 cm^3 of sodium hydroxide solution of concentration 0.10 moles per cubic decimetre.

The equation which represents this reaction is:

$$CH_3COOH + NaOH \longrightarrow CH_3COONa + H_2O$$

Calculate the concentration of ethanoic acid in moles per cubic decimetre.

.....

.....

.....

Concentration = ... moles per cubic decimetre

(2 marks)

10

Turn over for the next question

Do not write outside the box

7 Hydrogen peroxide is often used to bleach or lighten hair.

Hydrogen peroxide slowly decomposes to produce water and oxygen.

7 (a) The equation for the reaction can be represented using structural formulae.

$$2\ H-O-O-H \longrightarrow 2\ H-O-H + O=O$$

Use the bond energies in the table to help you to calculate the energy change for this reaction.

Bond	Bond energy in kJ per mole
H – O	464
O – O	146
O = O	498

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Energy change = ... kJ

(3 marks)

7 (b) Explain, in terms of bond making and bond breaking, why the reaction is exothermic.

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(1 mark)

4

END OF QUESTIONS

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Version : 08/03/2011



General Certificate of Secondary Education

Chemistry 4421

CHY3H Unit Chemistry 3

Mark Scheme

2011 examination – January series

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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 meeting attended by all examiners and is the scheme which was used by them in this examination. The standardisation meeting ensures that the mark scheme covers the candidates' responses to questions and that every examiner understands and applies it in the same correct way. As preparation for the standardisation meeting each examiner analyses a number of candidates' scripts: alternative answers not already covered by the mark scheme are discussed at the meeting and legislated for. If, after this meeting, examiners encounter unusual answers which have not been discussed at the meeting 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 candidates' 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 to download from the AQA Website: www.aqa.org.uk

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MARK SCHEME

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 lines 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.)

3. Marking points

3.1 Marking of lists

This applies to questions requiring a set number of responses, but for which candidates 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.

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

Candidate	Response	Marks awarded
1	4,8	0
2	green, 5	0
3	red*, 5	1
4	red*, 8	0

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

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

3.2 Use of chemical symbols / formulae

If a candidate 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, as shown in the column 'answers', 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;

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.

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Question 1

question	answers	extra information	mark
1(a)(i)	smooth curve through all points	do **not** accept multiple lines	1
1(a)(ii)	36.9 to 37.2	if outside range accept correct reading from candidate's own curve +/- half small square	1
1(a)(iii)	35.8 (at 20°C) correctly calculated answer to their (a)(ii) – 35.8	 ignore units ecf from incorrect reading of 35.8 or incorrect transfer of (a)(ii) correct answer from (a)(ii) without working = **2** marks	1 1
1(b)	some recognition that the (y-axis) scales are different **or** some indication of the effect this has eg in **B**: values compressed / not fine enough **or** scale in **B** less precise / larger range	do **not** accept x-axis scale is different accept converse for **A** ignore precise graph	1
Total			**5**

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CHY3H

Question 2

question	answers	extra information	mark
2(a)	filtered: removes insoluble / solid	Ignore named substances / minerals do **not** accept ions	1
	chlorine: kills microorganisms / microbes / bacteria / disinfects (water)	allow kills germs / pathogens **or** sterilises allow chlorine is a disinfectant ignore cleans water or removes impurities / bacteria	1
2(b)(i)	<u>advantages of portable</u>: any **two** from : • costs less • little training needed • water can be tested within 10 seconds / immediately / quicker • can be used anywhere <u>disadvantage of portable</u>	accept converse throughout	 2
	less precise / sensitive	allow only detect down to 0.1 mg ignore less accurate	1
2(b)(ii)	(PIWE) is unbiased **or**	it / they = PIWE allow honest / trusted / respected / reliable ignore professional / scientific / skilled	1
	company may be biased	allow company trying to sell products	
Total			**6**

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CHY3H

Question 3

question	answers	extra information	mark
3(a)	A = energy / enthalpy change / difference	allow heat change **or** ΔH allow energy released	1
	B = activation energy / EA	allow definition of activation energy	1
	C = carbon dioxide and water	accept products	1
3(b)	exothermic	allow combustion / redox / oxidation ignore reduction / burning	1
Total			**4**

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Question 4

question	answers	extra information	mark
4(a)(i)	a correct link between any two named elements eg same group / column same properties / number of outer electrons	allow some link between any two elements in the same group (in both Newlands' and **or** the modern periodic table)	1
4(a)(ii)	any **two** from: • elements still being discovered **or** no gaps for undiscovered elements • some boxes have 2 elements in them • metals and non-metals in same column / mixed up • pattern for first 16 or so elements only	ignore statements about lack of evidence / proof accept some elements in same column have different properties. allow any sensible suggestion about misplaced elements eg copper in group 1 elements allow did not work for all elements	2
4(b)(i)	Cl > Br > I **or** I < Br < Cl Cl has 2 reactions, Br has 1 reaction, I doesn't react	accept reactivity / it decreases down the group owtte allow Cl has most / more reactions and I has least / less reactions (must be clear about where Br fits in)	1 1

Question 4 continues on the next page

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Question 4 contd

question	answers	extra information	mark
4(b)(ii)	Br_2	allow multiples / fractions if correctly completed and balanced	1
4(b)(iii)	(they) have 7 outer electrons	allow (they) have 7 electrons in highest occupied (energy) level / shells / rings	1
4(c)		outer / last / final must be mentioned once in correct context, otherwise max **2** marks comparative required on all three points accept converse ie less reactive up group	
	down group (atom / elements) bigger **or** outer electrons (level / shell / ring) further from nucleus / centre **or** more shells / level / rings	ignore more electrons do **not** accept more outer shells for this mark	1
	force(s) / attraction(s) are weaker **or** more shielding **or** attracts less	allow electron(s) attracted less easily allow electron(s) less under influence (of nucleus) do **not** accept magnetic / gravitational / intermolecular forces	1
	electron(s) lost more easily	allow electron(s) more likely to be lost allow easier to give away	1
Total			**10**

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Question 5

question	answers	extra information	mark
5(a)	limewater / calcium hydroxide (limewater) goes milky / cloudy **or** gives white precipitate / solid	 do **not** allow this mark if lime water added to solution or powder	1 1
5(b)	eg flame colour of (Na) and flame colour of (K) interfere / mask / mix with each other	accept difficult to determine the colour **or** hard to distinguish accept some indication that two distinct colours are not seen	1
5(c)(i)	barium chloride (solution) / $BaCl_2$ white precipitate / white solid	ignore mention of acidification but do **not** allow sulfuric acid. wrong reagent = no mark allow white barium sulfate **or** barium sulfate precipitate	1 1
5(c)(ii)	white precipitate / white solid	ignore goes milky do **not** accept any mention of precipitate dissolving	1
Total			**6**

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Question 6

question	answers	extra information	mark
6(a)(i)	H^+ and CH_3COO^-	allow H_3O^+ for H^+ allow $CH_3CO_2^-$ for CH_3COO^-	1
6(a)(ii)	not fully ionised / dissociated	accept partially / slightly ionised / dissociated accept does not ionise well ignore (does not produce many ions) do **not** accept ions ionise	1
6(a)(iii)	proton donor(s)	do **not** accept H^+ ions	1
6(b)(i)	colour change in right (pH) range **or** this is a weak acid and strong alkali titration	it = phenolphthalein accept methyl orange does not change colour **or** methyl orange changes in the wrong (pH) range accept methyl orange is for strong acid and weak alkali titration.	1

Question 6 continues on the next page

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Question 6 contd

question	answers	extra information	mark
6(b)(ii)		must be description of an acid / alkali titration ie quantitative measures of volume no titration = **0** marks vinegar = ethanoic acid = acid	
	NaOH / alkali in burette	accept phonetic spelling do **not** accept biuret	1
	add NaOH until (indicator) changes from colourless to pink **or** until (indicator) changes colour	do **not** accept incorrect indicator **or** incorrect colour change allow unit indicator changes	1
	note (burette) volume used **or** final volume	allow work out the volume **or** see how much is used	1
	any **one** other point from • repeat • white tile / background • add dropwise / slowly • swirling / mix • read meniscus at eye level • some indication that some apparatus has been washed	ignore stir (with rod)	1

Question 6 continues on the next page

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Question 6 contd

question	answers	extra information	mark
6(c)	0.06	correct answer with or without working = **2** marks if answer is incorrect (0.1 x 15)/25 **or** 0.0015 x 40 gains **1** mark	2
Total			**10**

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Question 7

question	answers	extra information	mark
7(a)		correct answer with or without working = **3** marks	
	M1: (bonds broken) = 2148 (kJ)		1
	M2: (bonds made) = 2354 (kJ)		1
	M3: change in energy = (–) 206 (kJ)	ecf ignore sign	1
7(b)	energy released from forming new bonds is greater than energy needed to break existing bonds	allow the energy needed to break bonds is less than the energy released in forming bonds do **not** accept energy needed to form bonds	1
Total			**4**

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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 2010

Chemistry

CHY3H

Unit Chemistry C3

H

Wednesday 26 May 2010 9.00 am to 9.45 am

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

You may use a calculator.

Time allowed
- 45 minutes

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 45.
- You are expected to use a calculator where appropriate.
- You are reminded of the need for good English and clear presentation in your answers.

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

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Do not write outside the box

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

1 The table gives some information about the composition of three samples of water from wells in the Canary Islands, Crete and Cyprus.

	Mineral content of water in mg per litre		
Ions	**Canary Islands**	**Crete**	**Cyprus**
Calcium, Ca^{2+}	28	82	18
Magnesium, Mg^{2+}	14	41	13
Sodium, Na^{+}	53	7	22
Chloride, Cl^{-}	7	143	39
Hydrogencarbonate, HCO_3^{-}	281	5	93
Sulfate, SO_4^{2-}	2	14	16

1 (a) Describe and explain how ions get into these samples of water.

.....

.....

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(2 marks)

1 (b) The sample of water from Crete is harder than the other two.

Use the information in the table to explain why.

.....

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(1 mark)

Do not write outside the box

1 (c) People who use hard water can expect higher costs than people who use soft water.

Explain why.

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(2 marks)

1 (d) Hard water can be made soft by removing the ions that cause hardness.

State **one** way these ions can be removed.

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(1 mark)

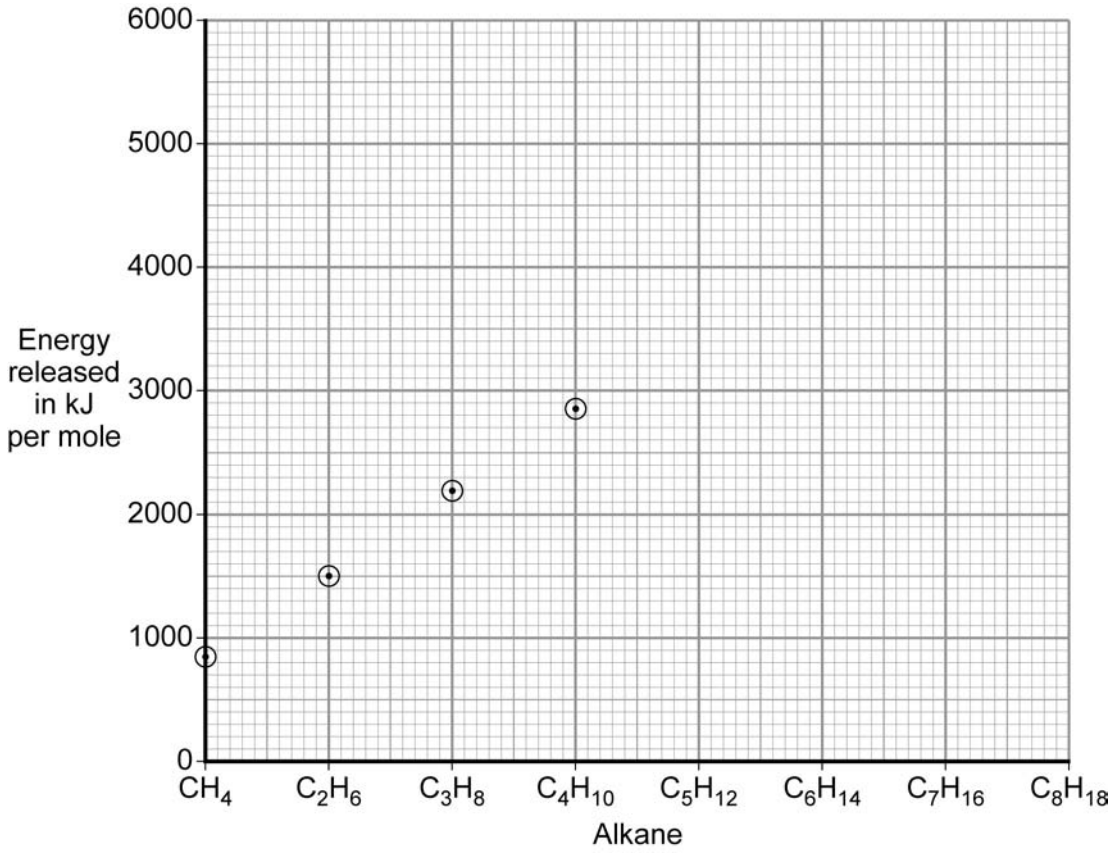
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Turn over for the next question

Do not write outside the box

2 (a) Alkanes are important hydrocarbon fuels. They have the general formula C_nH_{2n+2}

The points on the graph show the amount of energy released when 1 mole of methane (CH_4), ethane (C_2H_6), propane (C_3H_8) and butane (C_4H_{10}) are burned separately.



2 (a) (i) Draw a line through the points and extend your line to the right-hand edge of the graph.
(1 mark)

2 (a) (ii) Use the graph to estimate the amount of energy released when 1 mole of octane (C_8H_{18}) is burned.

Energy released = ... kJ
(1 mark)

Do not write outside the box

2 (a) (iii) Suggest why we can make a good estimate for the energy released by 1 mole of pentane (C_5H_{12}).

.....

.....

(1 mark)

2 (a) (iv) A student noticed that octane (C_8H_{18}) has twice as many carbon atoms as butane (C_4H_{10}), and made the following prediction:

"When burned, 1 mole of octane releases twice as much energy as 1 mole of butane."

Use the graph to decide if the student's prediction is correct. You **must** show your working to gain credit.

.....

.....

.....

.....

(2 marks)

Question 2 continues on the next page

Do not write outside the box

2 (b) Some information about four fuels is given in the table.

Fuel	Type	Heat released in kJ per g	Combustion products			Type of flame
			CO_2	SO_2	H_2O	
Bio-ethanol	Renewable	29	✓		✓	Not smoky
Coal	Non-renewable	31	✓	✓	✓	Smoky
Hydrogen	Renewable	142			✓	Not smoky
Natural gas	Non-renewable	56	✓		✓	Not smoky

From this information a student made two conclusions.

For each conclusion, state if it is correct **and** explain your answer.

2 (b) (i) "Renewable fuels release more heat per gram than non-renewable fuels."

.....

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(2 marks)

2 (b) (ii) "Non-renewable fuels are better for the environment than renewable fuels."

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(2 marks)

9

Do not write outside the box

Turn over for the next question

DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED

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3 (a) Sodium is a Group 1 element.

3 (a) (i) A small piece of sodium is added to some water containing Universal Indicator solution.

Describe what you would **see** happening.

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(3 marks)

3 (a) (ii) Complete **and** balance the equation for the reaction of sodium with water.

.....Na + ...H_2O → ..... + H_2

(2 marks)

3 (b) Francium is the most reactive element in Group 1.

Explain why in terms of electronic structure.

.....

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(3 marks)

Do not write outside the box

3 (c) The transition elements have different properties from the elements in Group 1.

Give **two** of these different properties of transition elements.

1 .....

.....

2 .....

.....

(2 marks)

10

Turn over for the next question

Do not write outside the box

4 Chemical tests can be used to detect and identify elements and compounds.

Two jars of chemicals from 1870 are shown.



4 (a) One jar contains copperas. Copperas was a name used for iron(II) sulfate, $FeSO_4$
It does not contain any copper!

Describe and give the result of a chemical test to show that a solution of copperas contains:

4 (a) (i) iron(II) ions, Fe^{2+}

Test .....

.....

Result .....

.....

(2 marks)

4 (a) (ii) sulfate ions, SO_4^{2-}

Test .....

.....

Result .....

.....

(2 marks)

Do not write outside the box

4 (b) The other jar contained a mixture of common salt (sodium chloride, NaCl) and washing soda (sodium carbonate, Na_2CO_3).

To show that the mixture contains chloride ions, silver nitrate solution ($AgNO_3$) and nitric acid (HNO_3) are added. A white precipitate is produced.

$$AgNO_3(aq) + NaCl(aq) \rightarrow AgCl(s) + NaNO_3(aq)$$

4 (b) (i) The carbonate ions in the mixture will affect the test for chloride ions.

Use the equations to explain why carbonate ions affect the test for chloride ions **and** how nitric acid overcomes this problem.

$$AgCl\ (s) + HNO_3\ (aq) \rightarrow \text{no reaction}$$

$$2AgNO_3\ (aq) + Na_2CO_3\ (aq) \rightarrow Ag_2CO_3\ (s) + 2NaNO_3\ (aq)$$
white

$$Ag_2CO_3\ (s) + 2HNO_3\ (aq) \rightarrow 2AgNO_3\ (aq) + H_2O\ (l) + CO_2\ (g)$$

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(2 marks)

4 (b) (ii) Hydrochloric acid (HCl) should **not** be used instead of nitric acid when testing for chloride ions with silver nitrate solution.

Suggest why.

.....

.....

(1 mark)

7

Turn over ▶

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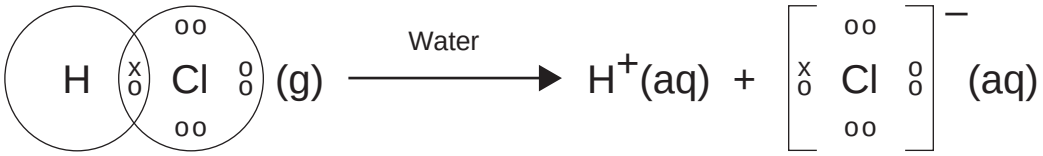
5 In 1884 Svante Arrhenius put forward ideas to explain acid-base behaviour. It was many years before his ideas were accepted. In 1903 he was awarded the Nobel Prize for Chemistry.



Use the ideas of Arrhenius to answer parts (a) and (b).

5 (a) Hydrogen chloride solution is called hydrochloric acid. It is made by dissolving hydrogen chloride gas in water.

An equation which represents this reaction is:



hydrogen chloride

hydrochloric acid

Explain why

- a solution of hydrogen chloride in water is acidic
- dry hydrogen chloride gas is **not** acidic.

.....

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.....

(2 marks)

Do not write outside the box

5 (b) The equation below represents the reaction between potassium hydroxide solution and dilute hydrochloric acid:

$$KOH(aq) + HCl(aq) \rightarrow KCl(aq) + H_2O(l)$$

5 (b) (i) Explain why potassium hydroxide solution, KOH(aq), is a strong alkali.

.....

.....

.....

.....

(2 marks)

5 (b) (ii) Explain why potassium chloride solution, KCl(aq), is neutral.

.....

.....

(1 mark)

5 (c) In 1923, Johannes Brønsted and Thomas Lowry extended Arrhenius' ideas on acids and bases. Their ideas were quickly accepted.

5 (c) (i) What is Brønsted and Lowry's definition of a base?

.....

.....

.....

(1 mark)

5 (c) (ii) Suggest why the ideas of Brønsted and Lowry were accepted more quickly than those of Arrhenius.

.....

.....

.....

(1 mark)

7

Do not write outside the box

6 Sodium chloride (common salt) can be made from chlorine.

When a student read that chlorine gas is poisonous, the student concluded that sodium chloride must also be poisonous.

6 (a) Use your knowledge of chlorine and sodium chloride to explain why this conclusion is **not** correct.

.....

.....

.....

.....

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.....

(2 marks)

6 (b) Suggest under what circumstances sodium chloride (common salt) could be harmful.

.....

.....

.....

(1 mark)

3

Do not write outside the box

7 When a known mass of a hydrocarbon was completely burned in oxygen, 17.6 g of carbon dioxide and 7.2 g of water were the only products.

Relative formula masses (M_r): $CO_2 = 44$; $H_2O = 18$.

Use this information to calculate the number of moles of carbon dioxide and of water produced in this reaction. Use your answers to calculate the empirical formula of this hydrocarbon.

You must show your working to gain full marks.

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The empirical formula of this hydrocarbon is .....

(3 marks)

3

END OF QUESTIONS

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Version: 17/08/2010

General Certificate of Secondary Education

Chemistry 4421

CHY3H Unit Chemistry 3

Mark Scheme

2010 Examination – June Series

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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 meeting attended by all examiners and is the scheme which was used by them in this examination. The standardisation meeting ensures that the mark scheme covers the candidates' responses to questions and that every examiner understands and applies it in the same correct way. As preparation for the standardisation meeting each examiner analyses a number of candidates' scripts: alternative answers not already covered by the mark scheme are discussed at the meeting and legislated for. If, after this meeting, examiners encounter unusual answers which have not been discussed at the meeting they are required to refer these to the Principal Examiner.

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Marking Guidance for Examiners

GCSE Science Papers

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 lines 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.)

3. Marking points

3.1 Marking of lists

This applies to questions requiring a set number of responses, but for which candidates 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.

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

Candidate	Response	Marks awarded
1	4,8	0
2	green, 5	0
3	red*, 5	1
4	red*, 8	0

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

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

3.2 Use of chemical symbols / formulae

If a candidate 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, as shown in the column 'answers', 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;

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.

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CHY3H

Question 1

question	answers	extra information	mark
1(a)	contact with rocks (ions) dissolve / soluble / react	 allow water is a solvent ignore 'picks up' / 'gets into' / absorbed	1 1
1(b)	more calcium / Ca^{2+} and / or magnesium / Mg^{2+} (ions in Crete water)	accept 'a lot' of calcium / magnesium allow incorrectly charged Ca and Mg ions accept correct comparison using numbers from the table do **not** accept mention of other ions	1
1(c)	**two** from: • scum / calcium stearate / magnesium stearate • (scum) more soap used • scale / limescale / calcium carbonate / magnesium carbonate • (scale) less efficient heating systems / kettles / appliances • use of a water softener eg sodium carbonate / ion-exchange	if an effect and clarification are given, the clarification must be correct to gain both marks accept does not lather (easily) ignore costs more unqualified ignore fur ignore costs more unqualified ignore blocks pipes unqualified accept salt in dishwashers	2

Question 1 continues on the next page

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CHY3H

Question 1 continued

question	answers	extra information	mark
1(d)	any **one** from: • sodium carbonate / washing soda • ion-exchange • distillation	ignore filter / filtration allow soap accept de-ionised ignore boiling / heating / evaporation	1
Total			**6**

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CHY3H

Question 2

question	answers	extra information	mark
2(a)(i)	straight line through the 'points' and extended to C_8H_{18}	do **not** accept multiple lines	1
2(a)(ii)	5500	range 5400 *to* 5600 accept ecf from their graph	1
2(a)(iii)	it is a straight line graph	allow directly proportional accept constant difference between (energy) values accept C_5H_{12} close to values on the graph **or** C_5H_{12} comes in middle of the graph ignore 'fits the pattern' unqualified ignore 'line of best fit' ignore 'positive correlation'	1
2(a)(iv)	expected ranges for working are: (5400 to 5600) – (2800 to 2900) = (2500 to 2800) **or** their value from (a)(ii) – a value from 2800 to 2900 **or** (5400 to 5600) / their (a)(ii) divided by 2 **or** a value from 2800 to 2900 × 2 no / not quite / almost / yes	accept correct numerical answer as evidence of working this mark is only awarded on evidence from their correct working	1 1

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2(b)(i)	Incorrect / no **or** partially correct bio-ethanol produces least energy **or** bio-ethanol produces 29 kJ	ignore references to hydrogen mark independently	1 1
2(b)(ii)	any **two** from: • hydrogen produces only H_2O • coal produces SO_2 • coal produces smoke • both renewable and non-renewable fuels produce CO_2 • (both) the non-renewable fuels produce CO_2 • (both) renewable fuels produce no smoke • (both) renewable fuels produce no SO_2	ignore incorrect / correct accept hydrogen does not produce harmful gases / CO_2 / SO_2 allow coal causes acid rain / respiratory problems allow coal causes global dimming accept bio-ethanol and natural gas / coal produce CO_2 / global warming accept coal and natural gas produce CO_2 / global warming accept hydrogen and bio-ethanol do not produce smoke / global dimming accept hydrogen and bio-ethanol do not produce SO_2 / acid rain	2
Total			**9**

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CHY3H

Question 3

question	answers	extra information	mark
3(a)(i)	UI / solution turns blue / purple	allow violet / lilac	1
	any **two** from:		2
	• floats		
	• melts / forms a sphere		
	• moves	note: moves on surface = **2** marks (points 1 and 3)	
	• effervescence / fizz / bubbles / gas	ignore the name of the gas	
	• (yellow) flame	ignore sparks / ignites / burns	
	• reduces in size	allow dissolves	
		ignore 'reacts violently' unqualified	
		ignore reference to exothermic / heat evolved	
3(a)(ii)	**2**Na + **2**H_2O → **2NaOH** + H_2	correct equation = **2** marks allow correct multiples / fractions	2
		if this equation is unbalanced, allow **1** mark for NaOH	

Question 3 continues on the next page

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CHY3H

Question 3 continued

question	answers	extra information	mark
3(b)	biggest atom **or** (outer) shell / energy level / electron furthest from nucleus **or** most (number of) shells	it = francium <u>outer</u> electron / shell / energy level must be mentioned once for all **3** marks	1
	least attraction (to nucleus) **or** most shielding	allow the attraction is <u>very</u> weak do **not** allow less magnetic / gravitational attraction	1
	(outer) electron more easily lost / taken	ignore francium reacts more easily / vigorously	1
3(c)	any **two** from: transition elements: • high melting point **or** high boiling point • high density • strong / hard • not very reactive • catalysts • ions have different charges • coloured compounds	ignore other properties / specific reactions they / it = transition elements allow if state group 1 elements • low melting point **or** low boiling point • low density • weak / soft • reactive • not catalysts • +1 ions • white compounds	2
Total			**10**

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CHY3H

Question 4

question	answers	extra information	mark
4(a)(i)	sodium hydroxide / NaOH (solution)	accept potassium hydroxide / KOH accept ammonia (solution) / $NH_3(aq)$ / NH_4OH do **not** accept limewater / calcium hydroxide incorrect reagent **or** no reagent = **0** marks	1
	(pale) <u>green</u> <u>precipitate</u> / <u>solid</u>	allow iron(II) hydroxide / $Fe(OH)_2$ (formed) allow OH^- / hydroxide solution gives a green precipitate for **1** mark	1
4(a)(ii)	(acidified) barium chloride / $BaCl_2$ **or** barium nitrate / $Ba(NO_3)_2$	do **not** accept sulphuric acid incorrect reagent **or** no reagent = **0** marks	1
	<u>white</u> <u>precipitate</u> / <u>solid</u>	allow barium sulfate / $BaSO_4$ (formed) allow a solution of barium ions / Ba^{2+} gives a white precipitate for **1** mark	1
4(b)(i)	carbonate (ions) give (white) ppt (with silver nitrate)	credit can not be obtained for incorrect reactions owtte	1
	(nitric) acid reacts with / removes / displaces carbonate (ions)	owtte	1

Question 4 continues on the next page

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CHY3H

Question 4 continued

question	answers	extra information	mark
4(b)(ii)	hydrochloric acid is a chloride / contains chloride (ions) / Cl^-	accept hydrochloric acid reacts with silver nitrate do **not** accept chlorine	1
Total			**7**

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CHY3H

Question 5

question	answers	extra information	mark
5(a)	in water: hydrogen ions / H^+ present when dry: HCl gas is covalent / molecular	 accept hydrogen still bonded to chloride / chlorine **or** HCl is not ionic	1 1
5(b)(i)	(KOH) has hydroxide ions / OH^- fully ionised / dissociated	 allow ions fully dissociate do **not** accept highly ionising ignore reference to concentration / pH	1 1
5(b)(ii)	equal concentrations / numbers / amounts of H^+ and OH^- ions **or** KCl: doesn't have any excess H^+ or OH^- ions	accept the acid / base has been neutralised **or** the reaction is a neutralisation accept H^+ react with / cancel out OH^- (to form water)	1
5(c)(i)	(base) is a <u>proton acceptor</u>	do **not** accept 'accepts hydrogen ions / H^+' ignore reference to OH^- ions	1
5(c)(ii)	B&L: building on established ideas **or** were reputable scientists owtte	Arrhenius was 'the first' / a student **or** his views not accepted by established scientific community owtte ignore references to technology / equipment	1
Total			**7**

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CHY3H

Question 6

question	answers	extra information	mark
6(a)	**either** chlorine is an element and sodium chloride is a compound the properties of elements are not transferred to their compounds **or** chlorine is Cl_2 / has molecules / covalent (1) sodium chloride is Na^+Cl^- / has ions / ionic (1)	 owtte	 1 1
6(b)	too much / large amounts / (very) high concentrations consumed	allow reference to risk of heart disease / high blood pressure	1
Total			**3**

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CHY3H

Question 7

question	answers	extra information	mark
7	$\frac{17.6}{44}$ (moles) **or** 0.4 (moles) CO_2		1
	$\frac{7.2}{18}$ (moles) **or** 0.4 (moles) H_2O		1
	empirical formula = CH_2	allow 1C:2H **or** correct simplest ratio related to elements **or** ecf from previous stage allow this mark for correct formula alone	1
Total			**3**

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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	
8	
TOTAL	

General Certificate of Secondary Education
Higher Tier
January 2010

Chemistry

CHY3H

Unit Chemistry C3

H

Written Paper

Monday 18 January 2010 9.00 am to 9.45 am

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

You may use a calculator.

Time allowed
- 45 minutes

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. Answers written in margins or on blank pages will not be marked.
- 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 45.
- You are expected to use a calculator where appropriate.
- You are reminded of the need for good English and clear presentation in your answers.

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

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Areas outside the box will not be scanned for marking

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

1 Read the following information and then answer the questions.

Chlorine – for better, for worse?



Chlorine is used to make bleaches, plastics and medicines. Swimming pool water is often treated with chlorine.

Chlorine is used to make water safe to drink. It is relatively cheap and easy to use. People who drink untreated water risk dying from typhoid and cholera.

However, chlorine is a poisonous chemical. It causes breathing difficulties and can kill people. Some people are also allergic to chlorine.

1 (a) How does chlorine make water safe to drink?

.....

.....

(1 mark)

1 (b) The amount of chlorine in swimming pool water should be carefully monitored and controlled.

Explain why.

.....

.....

.....

.....

(2 marks)

Areas outside the box will not be scanned for marking

1 (c) Developing countries are likely to choose chlorination as their method of making water safe to drink.

Suggest why.

.....

.....

.....

(1 mark)

1 (d) A government is setting up an enquiry into the safety of using chlorine.

1 (d) (i) Suggest why people from all political parties should be represented.

.....

.....

.....

(1 mark)

1 (d) (ii) Suggest why the opinion of a well-respected scientist might change the outcome of any discussion.

.....

.....

.....

(1 mark)

1 (d) (iii) The decision taken about the safety of using chlorine should be based on evidence and data rather than on hearsay and opinion.

Suggest why.

.....

.....

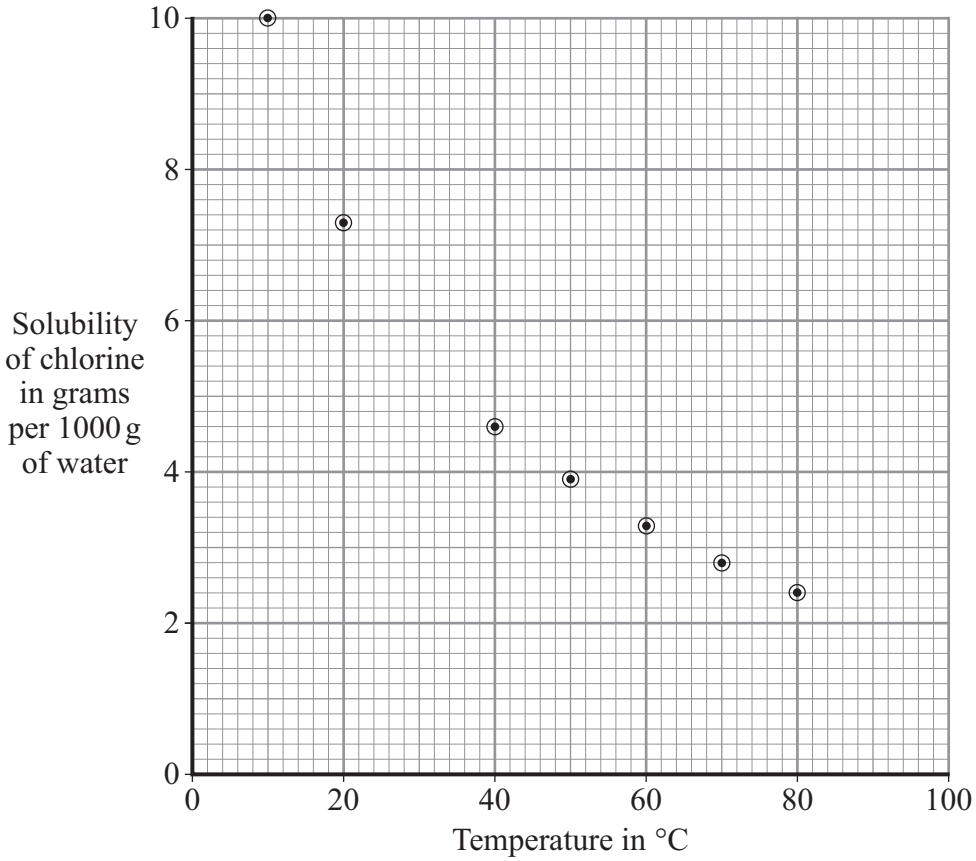
.....

(1 mark)

7

Areas outside the box will not be scanned for marking

2 The points on the graph show the mass of chlorine that dissolves in 1000 g of water at different temperatures.



Use the graph to answer the following questions.

2 (a) Draw a smooth curve through all the points.

(1 mark)

2 (b) What is the mass of chlorine that dissolves in 1000 g of water at 30 °C?

Mass = ... g

(1 mark)

2 (c) Calculate the mass of chlorine that bubbles out of 1000 g of water when the temperature increases from 10 °C to 80 °C.

.....

.....

Mass = ... g

(2 marks)

4

Areas outside the box will not be scanned for marking

3 Go Grease is a drain and oven cleaner.



The active ingredient in Go Grease is the alkali sodium hydroxide (NaOH).

3 (a) Name or give the formula of the ion that makes solutions alkaline.

.....

(1 mark)

3 (b) Sodium hydroxide is a *strong* alkali.

In terms of ionisation, what is meant by the word *strong*?

.....

.....

(1 mark)

3 (c) You are given solutions of sodium hydroxide and ammonia of the same concentration.

Describe and give the results of a test to show that sodium hydroxide is a stronger alkali than ammonia solution.

.....

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(2 marks)

4

Turn over ▶

Areas outside the box will not be scanned for marking

4 Alums are salts. They have been used since ancient times in dyeing and medicine and still have many uses today.

Three alums are shown in the table:

Name	Ions present		
Ammonium alum	NH_4^+	Al^{3+}	SO_4^{2-}
Potassium alum	K^+	Al^{3+}	SO_4^{2-}
Sodium alum	Na^+	Al^{3+}	SO_4^{2-}

4 (a) These alums contain sulfate ions (SO_4^{2-}).

Describe and give the result of a chemical test to show this.

Test .....

.....

Result .....

.....

(2 marks)

4 (b) These alums contain aluminium ions (Al^{3+}).

Describe how sodium hydroxide solution can be used to show this.

.....

.....

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.....

(2 marks)

Areas outside the box will not be scanned for marking

4 (c) Aluminium ions do not give a colour in flame tests. However, flame tests can be used to distinguish between these three alums.

Explain how these three alums could be identified from the results of flame tests.

.....

.....

.....

.....

.....

(2 marks)

6

Turn over for the next question

Areas outside the box will not be scanned for marking

5 (a) Dimitri Mendeleev was one of the first chemists to classify the elements by arranging them in order of their atomic weights. His periodic table was published in 1869.

The photograph of Dimitri Mendeleev is not reproduced here due to third-party copyright constraints.

How did Mendeleev know that there must be undiscovered elements and how did he take this into account when he designed his periodic table?

.....

.....

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(2 marks)

5 (b) By the early 20th century protons and electrons had been discovered.

Describe how this discovery allowed chemists to place elements in their correct order and correct group.

.....

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(3 marks)

Areas outside the box will not be scanned for marking

5 (c) The transition elements are a block of elements between Groups 2 and 3 of the periodic table.

5 (c) (i) Transition elements have similar properties.

Explain why in terms of electronic structure.

.....

.....

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(2 marks)

5 (c) (ii) There are **no** transition elements between the Group 2 element magnesium and the Group 3 element aluminium.

Explain why in terms of electronic structure.

.....

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(1 mark)

8

Turn over for the next question

Areas outside the box will not be scanned for marking

6 During a thunderstorm lightning strikes the Eiffel Tower.

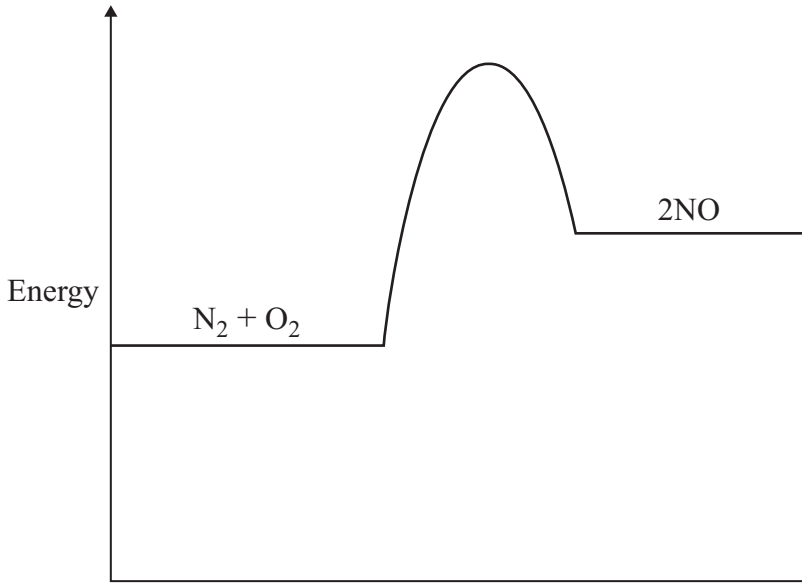


In lightning the temperature can reach 30 000 °C. This causes nitrogen and oxygen in the air to react, producing nitrogen oxide. This reaction has a high *activation energy* and is *endothermic*.

An equation that represents this endothermic reaction is:

$$N_2 + O_2 \rightarrow 2NO$$

The energy level diagram for this reaction is given below.



6 (a) The energy level diagram shows that this reaction is *endothermic*.

Explain how.

.....

.....

(1 mark)

Areas outside the box will not be scanned for marking

6 (b) What is meant by the term *activation energy*?

.....

.....

(1 mark)

6 (c) The equation showing the structural formulae of the reactants and products is

$$N \equiv N \quad + \quad O = O \quad \rightarrow \quad 2\ N = O$$

Bond	Bond energy in kJ
N ≡ N	945
O = O	498
N = O	630

6 (c) (i) Use the bond energies in the table to calculate the energy change for this reaction.

.....

.....

.....

.....

Energy change = ... kJ

(3 marks)

6 (c) (ii) In terms of bond energies, explain why this reaction is endothermic.

.....

.....

.....

(1 mark)

6

Areas outside the box will not be scanned for marking

7 Aminoethanoic acid (glycine), NH_2CH_2COOH, is an amino acid. It is found in fish, meat, beans and dairy produce. It can behave both as an acid and as a base.

7 (a) Explain, in terms of Brønsted and Lowry's ideas, why aminoethanoic acid behaves as:

an acid when it reacts with sodium hydroxide

$$NH_2CH_2COOH + Na^+OH^- \rightarrow NH_2CH_2COO^-Na^+ + H_2O$$

.....

.....

.....

a base when it reacts with hydrochloric acid.

$$NH_2CH_2COOH + H^+Cl^- \rightarrow NH_3^+CH_2COOH + Cl^-$$

.....

.....

.....

(3 marks)

Areas outside the box will not be scanned for marking

7 (b) In a titration, 25.00 cm^3 of a solution of aminoethanoic acid reacted with 18.40 cm^3 of sodium hydroxide solution of concentration 0.15 moles per cubic decimetre.

The equation which represents the reaction is:

$$NH_2CH_2COOH + Na^+OH^- \rightarrow NH_2CH_2COO^-Na^+ + H_2O$$

7 (b) (i) Calculate the concentration of aminoethanoic acid in moles per cubic decimetre.

.....

.....

.....

.....

Concentration = ... moles per cubic decimetre

(2 marks)

7 (b) (ii) Name an indicator used for weak acid-strong alkali titrations.

.....

(1 mark)

6

Turn over for the next question

Areas outside the box will not be scanned for marking

8 In the United Kingdom, water companies supply drinking water to our homes. However, some people are concerned about the taste and quality of the water that is supplied.

Describe one method that people can use at home to improve the taste and quality of the tap water supplied. Explain how this method works.

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(4 marks)

4

END OF QUESTIONS

There are no questions printed on this page

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General Certificate of Secondary Education

Chemistry 4421

CHY3H Unit Chemistry 3

Mark Scheme

2010 examination – January series

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Dr Michael Cresswell Director General

MARK SCHEME

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 lines 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.)

3. Marking points

3.1 Marking of lists

This applies to questions requiring a set number of responses, but for which candidates 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.

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

Candidate	Response	Marks awarded
1	4,8	0
2	green, 5	0
3	red*, 5	1
4	red*, 8	0

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

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

3.2 Use of chemical symbols / formulae

If a candidate 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, as shown in the column 'answers', 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;

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.

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CHY3H

Question 1

question	answers	extra information	mark
1(a)	sterilise / disinfect (water) **or** kill bacteria / micro-organisms / microbes / germs / pathogens	ignore removes bacteria / impurities / disease ignore cleans the water / makes (water) safe allow destroy bacteria **or** gets rid of bacteria	1
1(b)	any **two** from: • chlorine is toxic / poisonous • so (too much) will be dangerous / harmful / kill people / cause illness / health problems • cause breathing difficulties **or** cause (more) allergic reactions / skin **or** eye irritation • too little will not kill bacteria	ignore reference to safe / unsafe allow causes damage allow bacteria still there	2
1(c)	cheap / easy / quick to use (process)	accept prevents typhoid / cholera ignore reference to specialists or equipment	1
1(d)(i)	fair / more ideas / views / opinions **or** less chance of bias **or** more democratic	allow idea of different points of view / balanced view allow avoids undue influence owtte	1

Question 1 continues on next page

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CHY3H

Question 1 continued

question	answers	extra information	mark
1(d)(ii)	(more likely) to have support / influence / convince people	ignore well respected allow ideas about trust e.g. people will have more confidence in their views / more likely to be believed allow ideas about expertise e.g. more likely to know what they are talking about / have done experiments / tests allow have knowledge / understanding allow (more) reliable	1
1(d)(iii)	(more likely) to be correct / less likely to be incorrect **or** reliable / factual / accurate / based on proof / based on experiments or tests / based on validation	owtte ignore based on evidence unqualified allow hearsay / opinion can be biased	1
Total			**7**

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CHY3H

Question 2

question	answers	extra information	mark
2(a)	reasonable <u>smooth</u> curve through all the points over the range 10 - 80	ignore outside range do **not** accept multiple lines	1
2(b)	5.7	range 5.5–5.9 if outside range check graph	1
2(c)	7.6	correct answer with or without working = **2** marks if answer incorrect 10 **or** 2.4 gains **1** mark	2
Total			**4**

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CHY3H

Question 3

question	answers	extra information	mark
3(a)	hydroxide (ion) / OH^- / OH^-(aq)	ignore OH	1
3(b)	fully / all / completely ionised / dissociated	ignore strongly ionised **or** more ions **or** concentration ignore all 'noise' do **not** accept ions are fully ionised / dissociated	1
3(c)	any valid test linked comparison eg UI **or** full range indicator **or** pH paper / solution / (pH) meter (1) NaOH has higher pH **or** correct comparison of colours (1) **or** conductivity test (1) NaOH conducts better / more **or** bulb brighter (1)	assume it = sodium hydroxide incorrect test / titration = **0** marks for question correct result / reference to pH with no test = **1** mark allow converse for weak(er) pH values must be above 7 NaOH – purple, Ammonia – blue allow correct comparison of blue or purple	1 1
Total			**4**

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CHY3H

Question 4

question	answers	extra information	mark
4(a)	(acidified) barium chloride / nitrate	incorrect reagent **or** no reagent = **0** marks do **not** accept acidified with sulfuric acid (still allow result mark if correct) allow solution of barium ions / salt **not** barium solution **do not** accept barium hydroxide	1
	(white) precipitate / solid	do **not** accept incorrect colour for precipitate allow barium sulfate (formed) ignore 'it goes white / cloudy'	1
4(b)	(white) precipitate / solid	allow aluminium hydroxide (formed) **do not** allow incorrect colour for precipitate	1
	(precipitate) dissolves (in excess)	allow sodium aluminate (formed) allow goes clear / colourless if incorrect colour precipitate then allow dissolves (in excess)	1
4(c)	any **two** from: • yellow = sodium (alum) • lilac = potassium (alum) • colourless = ammonium (alum)	apply list principle allow orange **or** yellow orange allow purple if no colours given, allow 'different coloured flames' for **1** mark	2
Total			**6**

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CHY3H

Question 5

question	answers	extra information	mark
5(a)	left gaps if placed consecutively, then elements would be in wrong group / have wrong properties / owtte	 allow some elements didn't fit pattern	1 1
5(b)	(elements placed in) atomic / proton number order (elements in) same group have same number of <u>outer</u> electrons any **one** from: • number of protons = number of electrons • reactions (chemical) properties depend on the (outer) electrons • number of shells gives the period	 allow number of shells increases down the group	1 1 1
5(c)(i)	(transition elements usually) have same / similar number of outer / 4th shell electrons inner (3rd) shell / energy level is being filled	 ignore shells overlap	1 1
5(c)(ii)	<u>2nd</u> shell / energy level can (only) have maximum of 8 electrons **or** <u>2nd</u> shell / energy level cannot have 18 electrons		1
Total			**8**

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CHY3H

Question 6

question	answers	extra information	mark
6(a)	energy of product greater than energy of reactants	allow converse allow energy = heat do **not** accept temperature for energy allow product / nitrogen oxide is higher than reactants allow less energy / heat given out than taken in allow energy / heat is taken in / gained allow ΔH is positive	1
6(b)	(minimum) energy needed to start the reaction / overcome energy barrier	accept (minimum) energy needed for a collision to be successful	1
6(c)(i)	bonds broken = 945 + 498 = 1443 (kJ) bonds made = 2 ×630 = 1260 (kJ) energy change = 1443 – 1260 = (+) 183	correct answer with or without working = **3** marks ignore sign allow ecf	1 1 1
6(c)(ii)	energy released forming new bonds is less than energy needed to break existing bonds owtte	allow converse accept energy change(ΔH) is + / positive do **not** accept energy <u>needed to form new bonds</u> is less than energy needed to break existing bonds	1
Total			**6**

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CHY3H

Question 7

question	answers	extra information	mark
7(a)	some mention that a proton is a hydrogen ion / H^+ (as an acid) it / aminoethanoic acid has lost / donated a proton / hydrogen ion (as a base) it / aminoethanoic acid has gained / accepted a proton / hydrogen ion	this mark can be gained in either part	1 1 1
7(b)(i)	0.11(04)	correct answer with or without working = **2** marks if answer incorrect (0.15 × 18.4) / 25 gains **1** mark	2
7(b)(ii)	phenolphthalein	allow any correct single acid-base indicator that changes colour in the appropriate pH range (8 – 10) do **not** accept UI / litmus / methyl orange	1
Total			**7**

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CHY3H

Question 8

question	answers	extra information	mark
8	use of (water) filters / ion exchange		1
	containing carbon / charcoal / silver / resins	ignore other substances	1
	any **two** from: • carbon / charcoal removes chlorine • carbon / charcoal removes soluble / dissolved substances • silver kills / prevents growth of microorganisms • ion exchange removes calcium ions / magnesium ions / metal ions • ion exchange replaces (metal ions) with H^+ / Na^+ • ion exchange removes hardness	allow exchange for replace	2
Total			**4**

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Surname		Other Names	
Centre Number			Candidate Number				
Candidate Signature									

For Examiner's Use

General Certificate of Secondary Education
January 2009

CHEMISTRY
Unit Chemistry C3

CHY3H

H

Higher Tier

Thursday 15 January 2009 1.30 pm to 2.15 pm

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

You may use a calculator.

Time allowed: 45 minutes

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. Answers written in margins or on blank pages will not be marked.
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information
- The maximum mark for this paper is 45.
- The marks for questions are shown in brackets.
- You are expected to use a calculator where appropriate.
- You are reminded of the need for good English and clear presentation in your answers.

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

For Examiner's Use			
Question	Mark	Question	Mark
1		3	
2		4	
		5	
		6	
Total (Column 1) →			
Total (Column 2) →			
TOTAL			
Examiner's Initials			

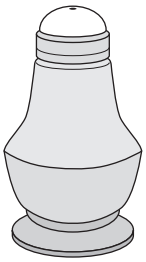
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Areas outside the box will not be scanned for marking

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

1 The label is from a packet of Low Sodium Salt.

LOW SODIUM SALT



INGREDIENTS

potassium chloride
sodium chloride

Anti-caking agent: magnesium carbonate

1 (a) A student tested some Low Sodium Salt to show that it contains carbonate ions and chloride ions.

1 (a) (i) Describe and give the result of a test for carbonate ions.

.....

.....

.....

.....

(2 marks)

1 (a) (ii) A student identified chloride ions using acidified silver nitrate solution.

State what you would **see** when acidified silver nitrate solution is added to a solution of Low Sodium Salt.

.....

(1 mark)

Areas outside the box will not be scanned for marking

1 (a) (iii) Flame tests can be used to identify potassium ions and sodium ions.

Suggest why it is difficult to identify **both** of these ions in Low Sodium Salt using a flame test.

.....

.....

(1 mark)

1 (b) Read the following information and then answer the questions.

Salt – friend or foe?

Sodium chloride (salt) is an essential mineral for our health. It is used to flavour and preserve foods. Too much sodium in our diet may increase the risk of high blood pressure and heart disease. Heart disease is the biggest cause of death in the United Kingdom. Some people claim that excess sodium is a poison that can cause cancer, while others say that more evidence is needed.

Many processed foods contain salt, so it is easy to exceed the recommended daily upper limit of about 5 g of salt per person. A 'healthier' amount should be about 3 g. In the United Kingdom many people consume over 10 g of salt each day.

One way to reduce sodium in our diet is to use Low Sodium Salt. This has two thirds of the sodium chloride replaced by potassium chloride.

A national newspaper asked readers for their views on two options.

Option **1**: Ban the use of sodium chloride in foods.

Option **2**: Reduce the amount of sodium chloride in **all** foods to a 'healthier' level.

1 (b) (i) Suggest why Option **1** was rejected.

.....

.....

(1 mark)

Question 1 continues on the next page

Areas outside the box will not be scanned for marking

1 (b) (ii) Suggest **two** advantages and **one** disadvantage of Option **2**.

.....

.....

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(3 marks)

8

Turn over for the next question

DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED

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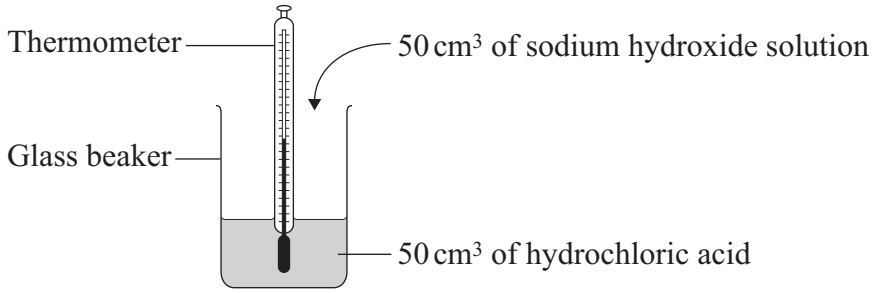
2 Read the information about energy changes and then answer the questions.

A student did an experiment to find the energy change when hydrochloric acid reacts with sodium hydroxide.

The equation which represents the reaction is:

$$HCl + NaOH \rightarrow NaCl + H_2O$$

The student used the apparatus shown in the diagram.



The student placed 50 cm^3 of hydrochloric acid in a glass beaker and measured the temperature.

The student then quickly added 50 cm^3 of sodium hydroxide solution and stirred the mixture with the thermometer. The highest temperature was recorded.

The student repeated the experiment, and calculated the temperature change each time.

	Experiment 1	**Experiment 2**	**Experiment 3**	**Experiment 4**
Initial temperature in °C	19.0	22.0	19.2	19.0
Highest temperature in °C	26.2	29.0	26.0	23.5
Temperature change in °C	7.2	7.0	6.8	4.5

Areas outside the box will not be scanned for marking

2 (a) The biggest error in this experiment is heat loss.

Suggest how the apparatus could be modified to reduce heat loss.

.....

.....

(1 mark)

2 (b) Suggest why it is important to stir the chemicals thoroughly.

.....

(1 mark)

2 (c) Which **one** of these experiments was probably carried out on a different day to the others?

Explain your answer.

.....

.....

(1 mark)

2 (d) Suggest why experiment 4 should **not** be used to calculate the average temperature change.

.....

.....

(1 mark)

2 (e) Calculate the average temperature change from the first three experiments.

.....

Answer = ... °C

(1 mark)

2 (f) Use the following equation to calculate the energy change for this reaction.

energy change in joules = 100 × 4.2 × average temperature change

.....

Answer = ... J

(1 mark)

Question 2 continues on the next page

Turn over ▶

Areas outside the box will not be scanned for marking

2 (g) Which **one** of these energy level diagrams, **A** or **B**, represents the energy change for this reaction?

Explain why.

Diagram A

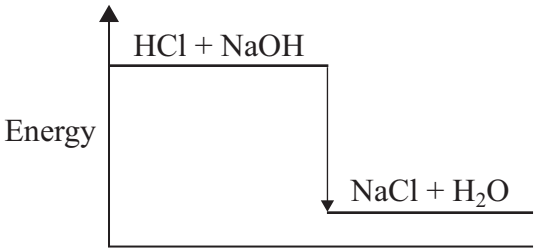
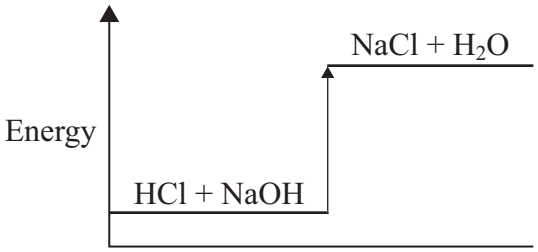


Diagram B



.....

.....

(1 mark)

7

Areas outside the box will not be scanned for marking

3 Water is a natural resource.

3 (a) Describe the processes involved in the water cycle.

.....

.....

.....

.....

.....

.....

(3 marks)

3 (b) In some parts of the world the water is hard, but in other parts the water is soft.

3 (b) (i) Name an ion that causes water to be hard.

.....

(1 mark)

3 (b) (ii) Describe how these ions get into the water.

.....

.....

.....

.....

(2 marks)

3 (b) (iii) Sodium carbonate makes hard water soft.

Explain how.

.....

.....

.....

.....

(2 marks)

8

Turn over ▶

Areas outside the box will not be scanned for marking

4 Read the information about the development of the periodic table and answer the questions that follow:



Johann Döbereiner was a chemist who realised there was a link between atomic weight and chemical properties. Although it was difficult to measure atomic weights accurately, by 1829 Döbereiner had arranged many elements with similar chemical reactions in groups of three. He noticed that the middle element had an atomic weight that was approximately the average of the other two. These groupings were known as triads. Three of these triads are shown below:

Li	7	S	32	Cl	35.5
Na	23	Se	79	Br	80
K	39	Te	128	I	127

As new elements were discovered, it became difficult to group them in triads, and it was left to others to build on Döbereiner's work. The result was the first periodic table, suggested by Dimitri Mendeleev in 1869.

Our modern periodic table has evolved from Mendeleev's Table. Lithium, sodium and potassium are still together in Group 1, and chlorine, bromine and iodine are in Group 7.

It was many years before chemists understood the nature of the transition elements.

The modern periodic table on the Data Sheet may help you to answer these questions.

4 (a) Döbereiner suggested that calcium (Ca), strontium (Sr) and barium (Ba) were also a triad.

Use relative atomic masses to explain why.

.....

.....

.....

.....

(1 mark)

Areas outside the box will not be scanned for marking

4 (b) Suggest why Döbereiner's ideas were replaced by those of Mendeleev.

.....

.....

(1 mark)

4 (c) Lithium, sodium and potassium are in Group 1. All these elements react with water.

Describe what you **see** when potassium is added to water.

.....

.....

.....

(2 marks)

4 (d) In terms of electronic structure, explain why:

4 (d) (i) elements in the same group of the periodic table have similar chemical properties

.....

.....

(1 mark)

4 (d) (ii) transition elements have similar properties even though they are not in the same group

.....

.....

.....

.....

(2 marks)

4 (d) (iii) in Group 1, lithium is **less** reactive than potassium.

.....

.....

.....

.....

(2 marks)

9

Turn over ▶

Areas outside the box will not be scanned for marking

5 In 1884 Svante Arrhenius, a Swedish chemist, put forward ideas to explain acid-base behaviour.



It was known that chemicals such as hydrochloric acid, sodium hydroxide and water were all compounds containing hydrogen. Arrhenius suggested why they had different acid-base properties.

5 (a) Using the ideas of Arrhenius, explain why:

5 (a) (i) hydrochloric acid, HCl, is an acid

.....

.....

(1 mark)

5 (a) (ii) sodium hydroxide, NaOH, is a base

.....

.....

(1 mark)

5 (a) (iii) water, H_2O, is neutral.

.....

.....

(1 mark)

Areas outside the box will not be scanned for marking

5 (b) In 1923, Johannes Brønsted and Thomas Lowry extended Arrhenius' ideas on acids and bases.

Complete this sentence: Brønsted and Lowry defined an acid as

.....

.....

(1 mark)

5 (c) Why did Arrhenius' ideas take longer to be accepted than those of Brønsted and Lowry?

.....

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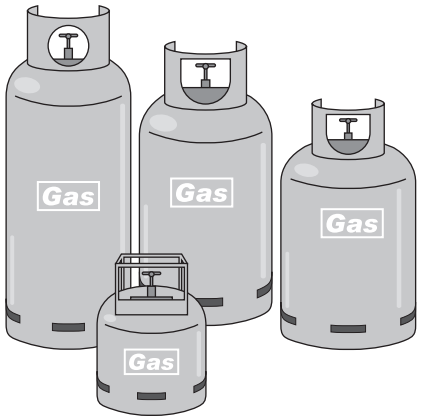
(1 mark)

5

Turn over for the next question

Areas outside the box will not be scanned for marking

6 Liquefied petroleum gases such as propane and butane are used as heating fuels for caravans, boats and barbecues.



6 (a) These gases often contain small amounts of unsaturated hydrocarbons.

Describe and give the result of a chemical test for unsaturated hydrocarbons.

.....

.....

.....

.....

(2 marks)

6 (b) Propane and butane have no smell, so for safety reasons a very small amount of thioethanol – the smelliest substance known – is added, even though it is toxic in large concentrations.

Suggest **one** safety reason why thioethanol is added to propane and butane.

.....

.....

(1 mark)

Areas outside the box will not be scanned for marking

6 (c) Suggest how mass spectrometry could be used to distinguish between propane (C_3H_8) and butane (C_4H_{10}).

.....

.....

(1 mark)

6 (d) When 0.4 g of a hydrocarbon gas was completely burned in oxygen, 1.1 g of carbon dioxide and 0.9 g of water were the only products.

Relative formula masses: $CO_2 = 44$; $H_2O = 18$.

Use this information to calculate the number of moles of carbon dioxide and of water produced in this reaction. Use your answers to calculate the empirical formula of this hydrocarbon.

You must show all your working to gain full marks.

.....

.....

.....

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.....

.....

.....

Empirical formula is .....

(4 marks)

8

END OF QUESTIONS

There are no questions printed on this page

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ASSESSMENT and QUALIFICATIONS ALLIANCE

General Certificate of Secondary Education

Chemistry 4421

CHY3H Unit Chemistry 3

Mark Scheme

2009 examination – January series

STEMUP.CO.UK

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 meeting attended by all examiners and is the scheme which was used by them in this examination. The standardisation meeting ensures that the mark scheme covers the candidates' responses to questions and that every examiner understands and applies it in the same correct way. As preparation for the standardisation meeting each examiner analyses a number of candidates' scripts: alternative answers not already covered by the mark scheme are discussed at the meeting and legislated for. If, after this meeting, examiners encounter unusual answers which have not been discussed at the meeting 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 candidates' 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 to download from the AQA Website: www.aqa.org.uk

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Registered address: AQA, Devas Street, Manchester M15 6EX
Dr Michael Cresswell Director General

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Candidate	Response	Marks awarded
1	4,8	0
2	green, 5	0
3	red*, 5	1
4	red*, 8	0

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

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

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3.3 Marking procedure for calculations

Full marks can be given for a correct numerical answer, as shown in the column 'answers', 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;

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.

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COMPONENT NAME: Chemistry

STATUS: Final

DATE: January 2009

question	answers	extra information	mark
1(a)(i)	hydrochloric acid / HCl carbon dioxide / CO_2	accept any (named) acid accept bubbles / fizz / gas **or** limewater gets milky ignore 'add limewater' do **not** accept other named gases 2^{nd} mark dependant on first mark accept for this answer only heat gives CO_2 / limewater milky = **1** mark	1 1
1(a)(ii)	(white) precipitate / solid	ignore names of substances even if incorrect accept white deposit / substance do **not** accept any coloured precipitate	1
1(a)(iii)	eg flame colour of (Na) and flame colour of (K) interfere / mask / mix with each other	accept 'can't see the colours' **or** 'difficult to determine the colour' **or** 'both produce different colours' **or** a correct statement of colours **or** hard to distinguish	1
1(b)(i)	eg essential (mineral) **or** everyone needs it / some (salt) **or** problems with health if have no salt	accept preservative / flavouring / taste it = salt (all) foods contain / use it / sodium chloride / salt	1

Question 1 continued on the next page...

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Question 1 continued...

question	answers	extra information	mark
1(b)(ii)	advantages any **two** from: • more people will be healthier • (should have) less heart disease • (should have) less cancer • (more people with) lower blood pressure disadvantages any **one** from: • not everyone affected • not enough evidence • does not provide choice • undemocratic • less taste / flavour • shorter shelf life / not preserved (as long) • too much potassium chloride might be bad	mark positively ie no list principle ignore economic arguments throughout **or** people eat less salt ignore references to too much / too little (salt) ignore no flavour / taste ignore references to sell by dates	2 1
Total			**8**

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question	answers	extra information	mark
2(a)	eg plastic (beaker) / insulation / lid / cover **or** any mention of enclosed	any sensible modification to reduce heat loss ignore prevent draughts ignore references to gas loss	1
2(b)	all the substances react **or** all (the substances) react fully / completely **or** heat evolved quickly **or** distribute heat	accept to mix them 'so they react' is insufficient for the mark accept increase chances of (successful) collisions / collision rate increase do **not** accept rate of reaction increase / make reaction faster	1
2(c)	experiment 2 **and** different / higher / initial / starting temperature	accept experiment 2 **and** the room is hotter / at higher temperature do **not** accept temperature change / results higher	1
2(d)	temperature change does not fit pattern	accept anomalous / odd **or** it is the lowest **or** it is lower than the others **or** it is different to the others 'results are different' is insufficient	1
2(e)	7 / 7.0		1
2(f)	(100 × 4.2 × 7) = 2940	ecf from (e)	1
2(g)	diagram A **and** reaction exothermic / heat evolved / Δ H is negative / temperature rises	accept energy is lost (to the surroundings)	1
Total			**7**

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question	answers	extra information	mark
3(a)		starting point of description does not have to start with evaporation references to steam / boiling max **2** marks	
	evaporation	accept liquid turns to vapour	1
	condensation	accept vapour turns into liquid 'cloud forms' is insufficient	1
	any **one** from: • (evaporation) by sun • water vapour / clouds rise / cool • water falls as rain / snow / hail / sleet / "precipitation" • water flows from river to the sea		1
3(b)(i)	calcium (ion) / Ca^{2+}	ignore any formula if ion only must be correct accept magnesium (ion) / Mg^{2+} do **not** accept named compounds	1
3(b)(ii)	contact with rocks	accept named rocks ignore ground / deposits / soil / minerals / ores	1
	(ions / substances) dissolved / soluble / leached / reacts	ignore erode / corrode / picks up / absorb	1
3(b)(iii)	(ions / substances / they) react / replace / remove	accept displace	1
	forms precipitate / insoluble / solid	if ion exchange (column) = max **1** mark	1
Total			**8**

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question	answers	extra information	mark
4(a)	40 (Ca) + 137 (Ba) ÷ 2 = 88.5	accept a recognition that the average is near 88 **or** it is the average of the other two accept Sr is midway between Ca and Ba	1
4(b)	eg newly discovered elements / atoms didn't fit (into triads) **or** didn't apply to all elements / atoms **or** lot of exceptions	he = Döbereiner ignore Mendeleev left spaces **or** not enough evidence	1
4(c)	any **two** from: • fizzes / bubbles / gas • violent / vigorous / explodes / very fast reaction • floats / on surface • moves (very quickly) • melts (into a ball) • bursts into flame • gets smaller / (reacts to) form a solution / dissolves / disappears etc • steam / gets hot (owtte)	 hydrogen alone is insufficient ignore incorrect name if 'gas' stated accept container explodes ignore strong reaction ignore sinks accept (bright) light ignore colour / glow ignore alkaline solutions **or** change in colour etc	2
4(d)(i)	same number of electrons in outer shell	accept energy level for shell accept a correct reference to a specific group eg (all) have one electron in outershell / (all) lose one electron (when they react)	1

Question 4 continues on the next page...

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Question 4 continued...

question	answers	extra information	mark
4(d)(ii)	electrons fill an inner / 3rd shell	accept energy level for shell accept d-level being filled accept specific reference to 3rd shell accept descriptions in terms of 3d & 4s etc	1
	(usually) same number of outer / 4th shell electrons		1
4(d)(iii)		it = lithium accept energy level for shell **or** converse reasoning for potassium	
	outer shell electron closer to nucleus	accept fewer shells / smaller atom	1
	more (electrostatic) attraction (to nucleus) / electrons less likely to be lost	accept less shielding / isn't much shielding ignore nucleus has more influence but accept nucleus has more influence over the outer electron(s) do **not** accept magnetic / gravitational attraction	1
Total			**9**

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question	answers	extra information	mark
5(a)(i)	(HCl / acid has) hydrogen ions / H^+	accept H ions do **not** accept H^- / protons / proton donor	1
5(a)(ii)	(NaOH / base / alkali has) hydroxide ions / hydroxyl ions / OH^-	accept OH ions do **not** accept proton acceptor	1
5(a)(iii)	equal numbers of H^+ and OH^- **or** H^+ cancel OH^- out	accept (H_2O) contains H^+ and OH^- accept $H^+ + OH^- \rightarrow H_2O$ accept H^+ has neutralised OH^- **or** converse ignore ionic charge is balanced ignore acid and basic species equal	1
5(b)	proton donor	ignore base / alkali is a proton acceptor	1
5(c)	any **one** from the following ideas: • no previously (proven) theory of ion formation • not enough evidence / not enough proof / lack of information • lack of communication / technology • his (scientific) reputation questioned **or** not regarded highly • ideas ahead of his time / subatomic particles not known	accept 'he thought of it first' ignore no evidence / proof accept evidence increased over time ignore he spoke a foreign language ignore 'because he was young / a student' accept his ideas did not work for ammonia (gas)	1
Total			**5**

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question	answers	extra information	mark
6(a)	bromine (water) / Br_2	accept iodine / I_2	1
	decolourised / goes (from orange / red brown/ brown / yellow) colourless	dependent on first mark ignore goes clear / discoloured do **not** accept wrong colours	1
6(b)	(smell) warns of a leak / gas escape	accept leak / gas escape by implication ignore smell alone	1
6(c)	eg (mass spectrometry gives) different molecular ions / *M*r / formula mass **or** shows that one has mass 44 and the other 58	' mass of butane is more than mass of propane' is insufficient accept different fragmentation / pattern do **not** accept A_r / RAM accept references to butane deflects less or converse	1

Question 6 continued on the next page...

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Question 6 continued...

question	answers	extra information	mark
6(d)			max 4
	CO_2 $\quad$ $2H_2O$ $\frac{1.1}{44}$ $\quad$ $\frac{0.9}{18}$		1
	$= 0.025$ $\quad$ $= 0.05$		1
	1 (mole) CO_2 $\quad$ 2 (moles) H_2O		1
	1 $\quad$ 4		1
	or		
	CH_4		
	or alternative method		
	Mass of C = $\frac{12}{44}$ x 1.1 = 0.3g (1)		
	Mass of H = $\frac{2}{18}$ x 0.9 = 0.1g (1)		
	C : H $\frac{\text{mass}}{M_r}$ $\quad$ $\frac{0.3}{12} : \frac{0.1}{1}$		
	proportions 0.025 : 0.1 (1)		
	whole number 1 : 4 (1)		
	or		
	CH_4	correct formula with no working is only 1 mark M3 can be awarded from the formula if steps one and two are clear correct formula from their incorrect ratio gets 1 mark if fraction is wrong way around e.g. M_r / mass, then lose M1 and M2 but accept ecf for M3 and M4	
Total			**8**