CCEA GCSE CHEMISTRY

CHEMISTRY



EXAM QUESTION PACK

UNIT C2 HIGHER TIER GCH22 PAPERS

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Rewarding Learning

Centre Number

Candidate Number

General Certificate of Secondary Education
2016

GCSE Chemistry

Unit 2

Higher Tier

[GCH22]

GCH22

WEDNESDAY 22 JUNE, MORNING

TIME

1 hour 45 minutes.

INSTRUCTIONS TO CANDIDATES

Write your Centre Number and Candidate Number in the spaces provided at the top of this page.
You must answer the questions in the spaces provided.
Do not write outside the boxed area on each page or on blank pages.
Complete in blue or black ink only. **Do not write with a gel pen.**
Answer **all six** questions.

INFORMATION FOR CANDIDATES

The total mark for this paper is 115.
Figures in brackets printed down the right-hand side of pages indicate the marks awarded to each question or part question.
Quality of written communication will be assessed in Question **2(c)(iii)** and **4(a)**.
A Data Leaflet, which includes a Periodic Table of the Elements, is included in this question paper.

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1 **(a)** The first national report examining the impact of water fluoridation on children was published in 2014. The dental health of five year olds and twelve year olds living in fluoridated water and non-fluoridated water areas was measured.

Data from this report is shown in the table below.

	In fluoridated water areas	In non-fluoridated water areas
% of twelve year olds with tooth decay	22	37
% of five year olds with tooth decay	13	42
% of hospital admissions for children aged 1–4 for tooth decay	2	20

(i) **Use the data** in the table to deduce the effect, if any, of the presence of fluoride in water on the dental health of children.

_____

_____

_____

_____

_____ [2]

(ii) State one reason why some people are against the fluoridation of drinking water.

_____

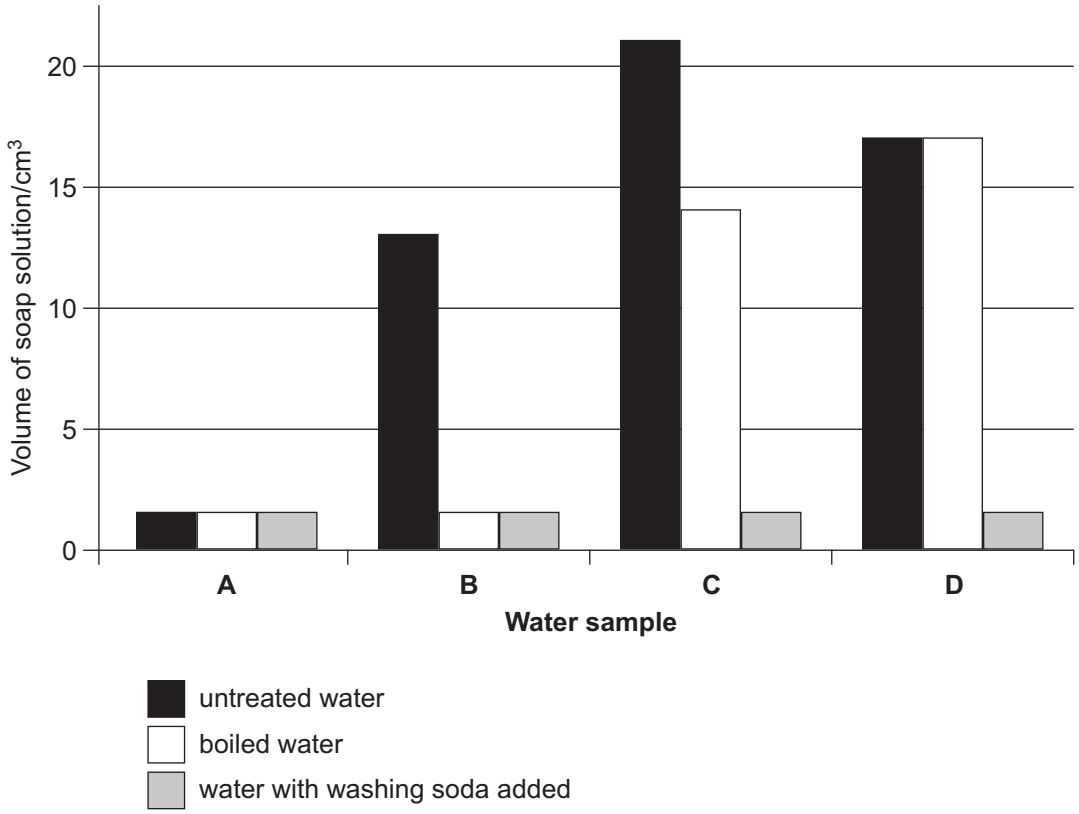
_____ [1]

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28GCH2203

(b) Four samples of water, A, B, C and D, were tested for hardness. Soap solution was added, with shaking, to each of the four 20.0 cm^3 samples of water. The volume of soap solution required to produce 1 cm height of lather was recorded.

The experiment was repeated, with fresh boiled samples of water and then again with fresh samples of water which had been treated with washing soda. The results of the experiment are shown below.



(i) What is meant by the term hard water?

_____

_____ [1]

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(ii) Which one of the samples, A, B, C or D is the hardest water? Explain your answer.

Sample: _____

_____

_____

_____ [2]

(iii) What type of hardness is present in the following samples?

Sample B _____

Sample D _____ [2]

(iv) Name a substance which could cause the hardness in the following samples.

Sample B _____

Sample D _____ [2]

(v) What is the chemical name for washing soda?

_____ [1]

(vi) Explain why hard water is considered to be good for your health.

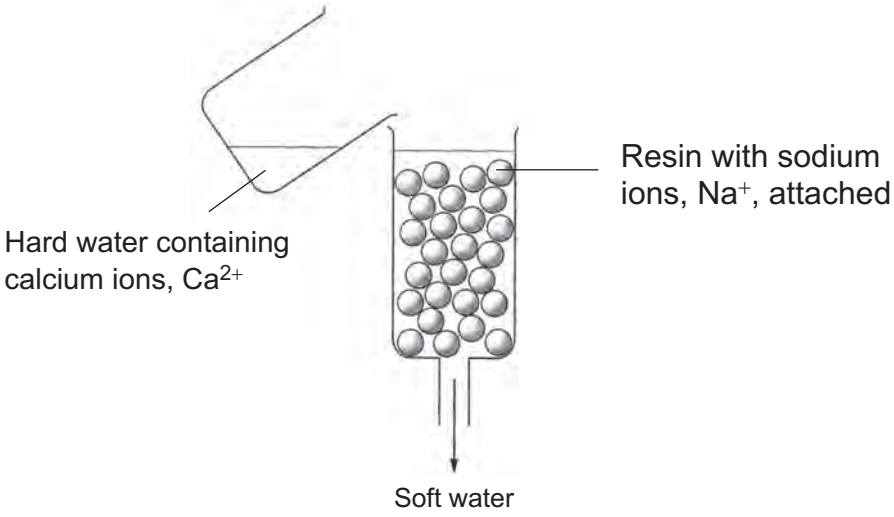
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(c) The diagram below shows a method used to soften hard water.



(i) What is the name for this method of softening hard water?

_____ [1]

(ii) Explain how this method softens hard water.

_____

_____

_____ [2]

(iii) Explain why this method will stop working after continued use.

_____

_____ [1]

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2 Cyclohexene, cyclohexanol and ethanoic acid are colourless liquids at room temperature. Each one belongs to a different homologous series.

(a) What is meant by the term homologous series?

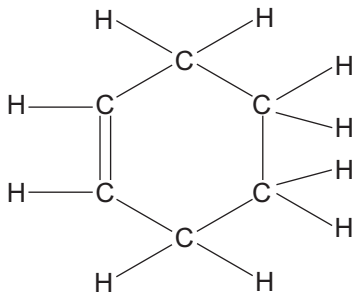
_____

_____

_____

_____ [3]

(b) The colourless liquid cyclohexene is a hydrocarbon with the molecular formula C_6H_{10}. The structural formula of cyclohexene is shown below. It undergoes similar reactions to ethene and propene.



(i) What is the functional group in cyclohexene?

_____ [1]

(ii) Why is cyclohexene described as a hydrocarbon?

_____

_____ [1]

[Turn over

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(iii) Name the two **compounds** formed when cyclohexene is burned in a limited supply of oxygen.

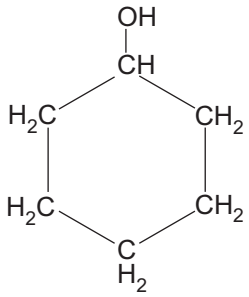
1. _____

2. _____ [2]

(iv) What is the empirical formula of cyclohexene?

_____ [1]

(c) The colourless liquid cyclohexanol has the molecular formula $C_6H_{11}OH$ and the structural formula is shown below. It undergoes similar reactions to ethanol and methanol.



(i) What is the functional group in cyclohexanol?

_____ [1]

(ii) Write a balanced symbol equation for the complete combustion of cyclohexanol ($C_6H_{11}OH$).

_____ [3]

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(iii) Describe, giving practical details, the chemical tests you would use to identify cyclohexene and cyclohexanol.

Your answer should include:

- Names of the chemicals used to carry out the tests
- Conditions if appropriate
- Observations for each test.

In this question you will be assessed on your written communication skills including the use of specialist scientific terms.

[6]

[Turn over

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(d) The colourless liquid ethanoic acid has a sharp smell and is used, in solution, as vinegar to flavour food.

(i) Write the molecular formula of ethanoic acid.

_____ [1]

(ii) Draw the structural formula of ethanoic acid.

[1]

(iii) Why is ethanoic acid described as a weak acid?

_____ [1]

(iv) Write a balanced symbol equation for the reaction of solid sodium carbonate with ethanoic acid.

_____ [3]

(v) State **two** observations which would occur when solid sodium carbonate reacts with ethanoic acid.

1. _____

2. _____ [2]

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3 Hydrogen peroxide decomposes rapidly into water and oxygen in the presence of a catalyst. A catalyst works by lowering the minimum energy required for a reaction to occur.

(a) (i) Write a balanced symbol equation for the decomposition of hydrogen peroxide.

_____ [3]

(ii) Name the catalyst used for this reaction in the laboratory.

_____ [1]

(iii) What is meant by the term catalyst?

_____

_____

_____

_____ [3]

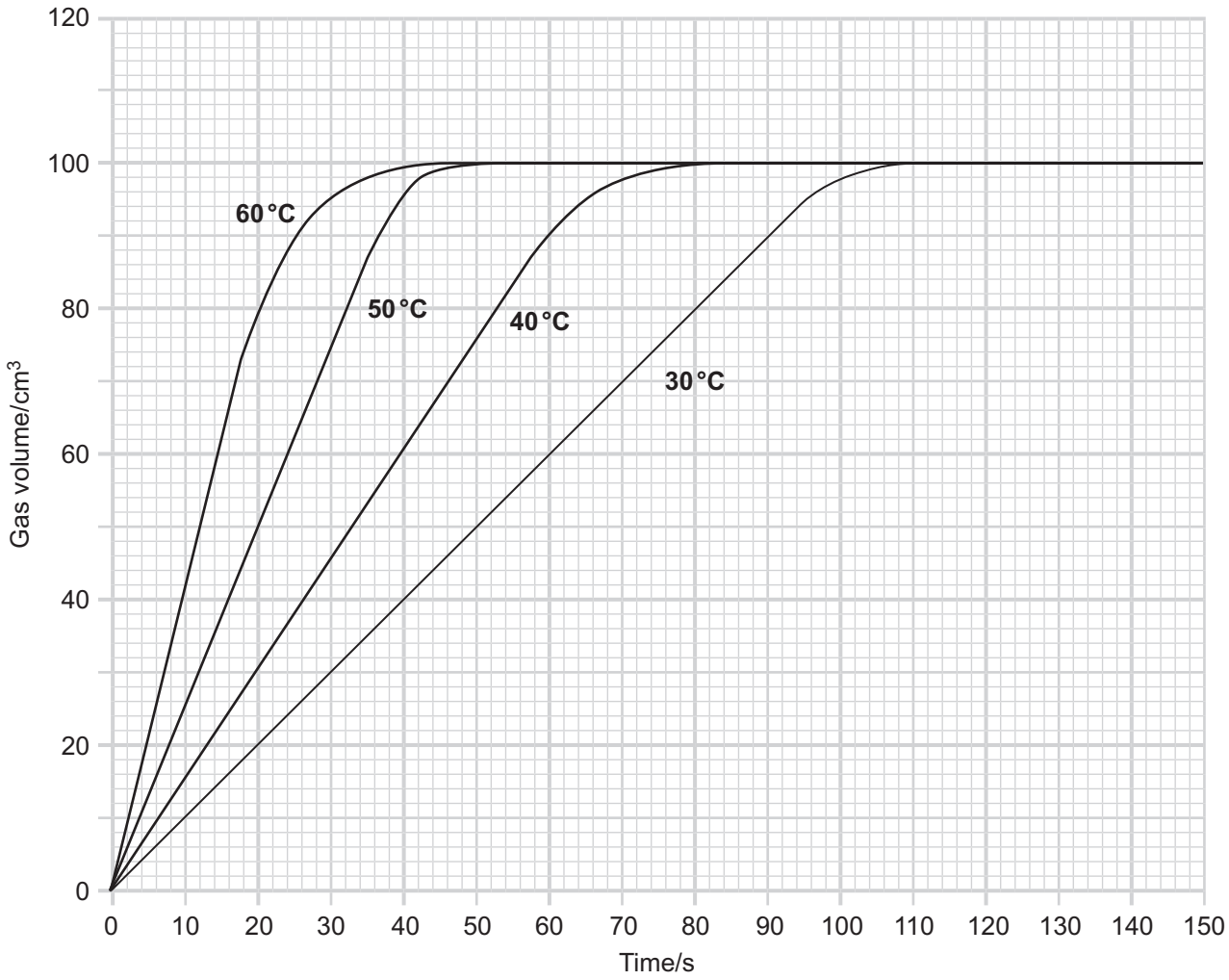
(iv) What is the name given to the minimum energy required for a reaction to occur?

_____ [1]

[Turn over

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(b) The volume of gas produced by the catalytic decomposition of hydrogen peroxide was measured at four different temperatures. The results were plotted on the graph below.



10002

(i) Complete the table below giving the time taken for the reaction to finish at 60°C. Calculate the rate based on this time.

Temperature (°C)	Time taken for reaction to finish (s)	Rate = $\frac{1}{\text{time}}$ (s^{-1})
30	108	0.00926
40	79	0.01266
50	48	0.02083
60		

[2]

(ii) From the table, state how rate changes as temperature changes.

_____

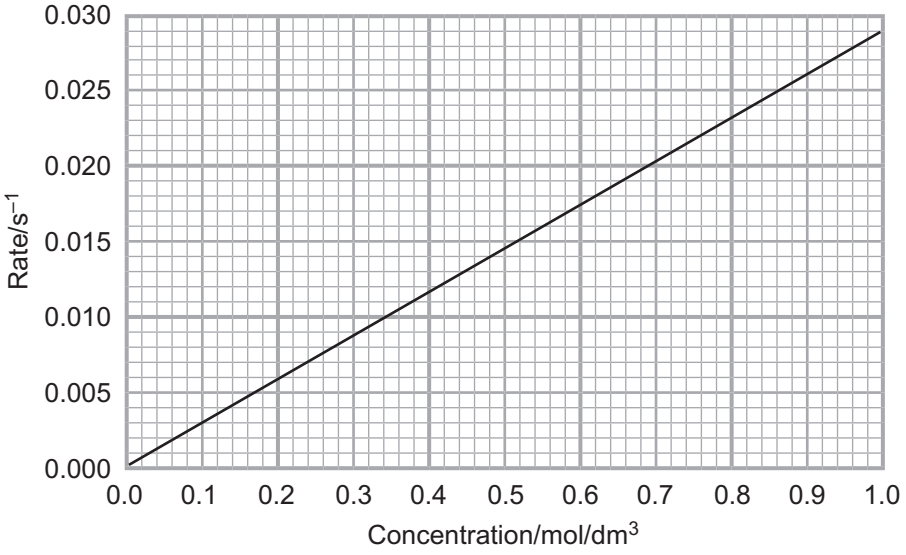
_____

_____ [1]

[Turn over

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(c) The graph below shows the relationship between the concentration of hydrogen peroxide solution and the rate of the reaction at 20° C.



(i) What is the rate when the concentration of hydrogen peroxide is 0.34 mol/dm^3? State the units.

_____ [1]

(ii) From the graph, state how rate changes as concentration changes.

_____

_____

_____ [1]

(iii) On the axes above, sketch the graph you would expect to obtain if the experiment were repeated at 10 °C. [2]

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(Questions continue overleaf)

[Turn over

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4 **(a)** Acid rain has been a major environmental problem for decades. Sulfur impurities in fossil fuels contribute to acid rain.

Describe in detail how these sulfur impurities lead to the formation of acid rain. Describe the effects of acid rain and methods used to prevent it.

Your answer should include:

- A description of how sulfur impurities lead to the formation of acid rain. (Include balanced symbol equations.)
- At least two detrimental effects of acid rain on the environment.
- At least two methods used to prevent acid rain.

In this question you will be assessed on your written communication skills including the use of specialist scientific terms.

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[9]

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28GCH2217

(b) The presence of nitrogen dioxide, NO_2, in the atmosphere can also cause acid rain. Nitrogen dioxide is formed naturally by the reaction between atmospheric nitrogen and oxygen in an endothermic reaction.

$$N_2 + 2O_2 \rightarrow 2NO_2$$

Explain in terms of bonds why this reaction is endothermic.

[5]

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(Questions continue overleaf)

[Turn over

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5 **(a)** The reactivity of metals can be studied using displacement reactions. If a displacement reaction occurs there is a temperature rise.

In an experiment the following method was used:

- Pour some copper(II) sulfate solution into a polystyrene cup and record the temperature of the solution.
- Add a known mass of metal and stir.
- Record the maximum temperature of the mixture.
- Repeat the experiment.

The results of this experiment are shown in the table below.

Metal	Temperature increase (°C)		Average temperature rise (°C)
	Experiment 1	Experiment 2	
magnesium	11.5	16.5	14.0
silver	0.0	0.0	0.0
iron	3.0	4.0	3.5
gold	0.0	0.0	0.0
zinc	7.0	8.0	7.5

(i) State two factors which should be kept the same in this experiment to make it a fair test.

1. _____

2. _____ [2]

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(ii) State and explain which of the metals gave the least reliable temperature rise.

_____

_____ [1]

(iii) State and explain which of the metals used in the experiment is the most reactive.

_____

_____ [2]

(iv) Explain why there is no temperature rise when silver is added to copper(II) sulfate solution.

_____ [1]

(v) Why do the results make it impossible to decide which of the metals is the least reactive?

_____

_____ [1]

(vi) Write a balanced symbol equation for the displacement reaction between zinc and copper(II) sulfate solution.

_____ [2]

[Turn over

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(b) Metals are extracted from their ores using different methods. In the extraction of iron, haematite, coke and limestone are added to the Blast Furnace.

(i) Name the chemical compound present in:

haematite _____

limestone _____ [2]

(ii) The following equations represent reactions which occur in the Blast Furnace.

Reaction A $C + O_2 \rightarrow CO_2$

Reaction B $CaCO_3 \rightarrow CaO + CO_2$

Reaction C $C + CO_2 \rightarrow 2CO$

Reaction D $Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$

Reaction E $CaO + SiO_2 \rightarrow CaSiO_3$

Which reaction (A, B, C, D or E) represents a reaction which best matches the descriptions below?

Each letter can be used once, more than once or not at all.

A decomposition reaction _____

A reaction to form the reducing agent _____

A neutralisation reaction _____

A reaction that is used to produce heat _____ [4]

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(c) Aluminium is extracted from its ore by electrolysis.

(i) Name an ore of aluminium.

_____ [1]

(ii) Write a half equation for the production of aluminium at the cathode.

_____ [3]

(iii) Write a half equation for the reaction which happens at the anode during this electrolysis.

_____ [3]

[Turn over

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28GCH2223

6 This question is about the experimental reactions of some carbonates.

(a) Ammonium carbonate decomposes on heating to produce ammonia, carbon dioxide and water. Write a balanced symbol equation for this reaction.

_____ [3]

(b) Copper(II) carbonate reacts with hydrochloric acid according to the equation:

$$CuCO_3 + 2HCl \rightarrow CuCl_2 + CO_2 + H_2O$$

0.868 g of copper(II) carbonate were reacted with 0.175 mol/dm^3 hydrochloric acid.

(i) Calculate the number of moles of copper(II) carbonate used.
(Relative atomic masses: C = 12; O = 16; Cu = 64.)

_____ [2]

(ii) Calculate the number of moles of hydrochloric acid required to react with all of the copper(II) carbonate.

_____ [2]

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(iii) Calculate the volume (in cm^3) of 0.175 mol/dm^3 hydrochloric acid required to react with the copper(II) carbonate.

_____ cm^3 [2]

[Turn over

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28GCH2225

(c) A sample of 2.52 g of hydrated sodium carbonate, $Na_2CO_3.xH_2O$, was dissolved in deionised water.

The solution was transferred to a 250 cm^3 volumetric flask and the volume made up to 250 cm^3 using deionised water.

25.0 cm^3 portions of this solution were titrated against 0.175 mol/dm^3 hydrochloric acid using methyl orange indicator. The results of the titration are given below.

The equation for the reaction is:

$$Na_2CO_3 + 2HCl \rightarrow 2NaCl + CO_2 + H_2O$$

Titration	Initial burette volume (cm^3)	Final burette volume (cm^3)	Titre (cm^3)
Rough	0.0	18.6	18.6
First Accurate Titration	18.6	36.6	18.0
Second Accurate Titration	0.0	18.0	18.0

(i) State the colour change observed at the end point.

From _____ to _____ [2]

(ii) Calculate the average titre.

_____ cm^3 [2]

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(iii) Calculate the number of moles of hydrochloric acid used.

_____ [2]

(iv) Calculate the number of moles of sodium carbonate present in 25.0 cm^3 of the solution.

_____ [2]

(v) Calculate the number of moles of sodium carbonate present in 250 cm^3 of the solution.

_____ [1]

(vi) Using the initial mass of $Na_2CO_3.xH_2O$ added and the answer to part **(v)**, calculate the relative formula mass (RFM) of $Na_2CO_3.xH_2O$.

_____ [2]

(vii) Calculate the value of x.
(Relative atomic masses: H = 1; C = 12; O = 16; Na = 23)

_____ [2]

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Question Number	Marks
1	
2	
3	
4	
5	
6	
Total Marks	

Examiner Number

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SYMBOLS OF SELECTED IONS

Positive ions

Name	Symbol
Ammonium	NH_4^+
Chromium(III)	Cr^{3+}
Copper(II)	Cu^{2+}
Iron(II)	Fe^{2+}
Iron(III)	Fe^{3+}
Lead(II)	Pb^{2+}
Silver	Ag^+
Zinc	Zn^{2+}

Negative ions

Name	Symbol
Carbonate	CO_3^{2-}
Dichromate	$Cr_2O_7^{2-}$
Ethanoate	CH_3COO^-
Hydrogen carbonate	HCO_3^-
Hydroxide	OH^-
Methanoate	$HCOO^-$
Nitrate	NO_3^-
Sulfate	SO_4^{2-}
Sulfite	SO_3^{2-}

SOLUBILITY IN COLD WATER OF COMMON SALTS, HYDROXIDES AND OXIDES

Soluble
All sodium, potassium and ammonium salts
All nitrates
Most chlorides, bromides and iodides EXCEPT silver and lead chlorides, bromides and iodides
Most sulfates EXCEPT lead and barium sulfates Calcium sulfate is slightly soluble

Insoluble
Most carbonates EXCEPT sodium, potassium and ammonium carbonates
Most hydroxides EXCEPT sodium, potassium and ammonium hydroxides
Most oxides EXCEPT sodium, potassium and calcium oxides which react with water

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DATA LEAFLET

For the use of candidates taking
Science: Chemistry,
Science: Double Award
or Science: Single Award

Copies must be free from notes or additions of any kind. No other type of data booklet or information sheet is authorised for use in the examinations.

Contents **Page**

Periodic Table of the Elements 2–3
Symbols of Selected Ions 4
Solubility of Common Salts 4

gcse
science
chemistry
double award
single award

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THE PERIODIC TABLE OF ELEMENTS

Group

1	2											3	4	5	6	7	0
							1 H Hydrogen 1										4 He Helium 2
7 Li Lithium 3	9 Be Beryllium 4											11 B Boron 5	12 C Carbon 6	14 N Nitrogen 7	16 O Oxygen 8	19 F Fluorine 9	20 Ne Neon 10
23 Na Sodium 11	24 Mg Magnesium 12											27 Al Aluminium 13	28 Si Silicon 14	31 P Phosphorus 15	32 S Sulfur 16	35.5 Cl Chlorine 17	40 Ar Argon 18
39 K Potassium 19	40 Ca Calcium 20	45 Sc Scandium 21	48 Ti Titanium 22	51 V Vanadium 23	52 Cr Chromium 24	55 Mn Manganese 25	56 Fe Iron 26	59 Co Cobalt 27	59 Ni Nickel 28	64 Cu Copper 29	65 Zn Zinc 30	70 Ga Gallium 31	73 Ge Germanium 32	75 As Arsenic 33	79 Se Selenium 34	80 Br Bromine 35	84 Kr Krypton 36
85 Rb Rubidium 37	88 Sr Strontium 38	89 Y Yttrium 39	91 Zr Zirconium 40	93 Nb Niobium 41	96 Mo Molybdenum 42	99 Tc Technetium 43	101 Ru Ruthenium 44	103 Rh Rhodium 45	106 Pd Palladium 46	108 Ag Silver 47	112 Cd Cadmium 48	115 In Indium 49	119 Sn Tin 50	122 Sb Antimony 51	128 Te Tellurium 52	127 I Iodine 53	131 Xe Xenon 54
133 Cs Caesium 55	137 Ba Barium 56	139 La* Lanthanum 57	178 Hf Hafnium 72	181 Ta Tantalum 73	184 W Tungsten 74	186 Re Rhenium 75	190 Os Osmium 76	192 Ir Iridium 77	195 Pt Platinum 78	197 Au Gold 79	201 Hg Mercury 80	204 Tl Thallium 81	207 Pb Lead 82	209 Bi Bismuth 83	210 Po Polonium 84	210 At Astatine 85	222 Rn Radon 86
223 Fr Francium 87	226 Ra Radium 88	227 Ac† Actinium 89	261 Rf Rutherfordium 104	262 Db Dubnium 105	263 Sg Seaborgium 106	262 Bh Bohrium 107	265 Hs Hassium 108	266 Mt Meitnerium 109	269 Ds Darmstadtium 110	272 Rg Roentgenium 111	285 Cn Copernicium 112						

140 Ce Cerium 58	141 Pr Praseodymium 59	144 Nd Neodymium 60	147 Pm Promethium 61	150 Sm Samarium 62	152 Eu Europium 63	157 Gd Gadolinium 64	159 Tb Terbium 65	162 Dy Dysprosium 66	165 Ho Holmium 67	167 Er Erbium 68	169 Tm Thulium 69	173 Yb Ytterbium 70	175 Lu Lutetium 71
232 Th Thorium 90	231 Pa Protactinium 91	238 U Uranium 92	237 Np Neptunium 93	242 Pu Plutonium 94	243 Am Americium 95	247 Cm Curium 96	245 Bk Berkelium 97	251 Cf Californium 98	254 Es Einsteinium 99	253 Fm Fermium 100	256 Md Mendelevium 101	254 No Nobelium 102	257 Lr Lawrencium 103

* 58 – 71 Lanthanum series
† 90 – 103 Actinium series

a / b x
a = relative atomic mass (approx)
x = atomic symbol
b = atomic number

Rewarding Learning

General Certificate of Secondary Education
2016

GCSE Chemistry

Unit 2

Higher Tier

[GCH22]

WEDNESDAY 22 JUNE, MORNING

MARK SCHEME

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General Marking Instructions and Mark Grids

Introduction
Mark schemes are intended to ensure that the GCSE examination is marked consistently and fairly. The mark schemes provide markers with an indication of the nature and range of candidates' responses likely to be worthy of credit. They also set out the criteria that they should apply in allocating marks to candidates' responses. The mark schemes should be read in conjunction with these marking instructions.

Quality of candidates' responses
In marking the examination papers, examiners should be looking for a quality response reflecting the level of maturity which may reasonably be expected of a 16-year-old which is the age at which the majority of candidates sit their GCSE examinations.

Flexibility in marking
Mark schemes are not intended to be totally prescriptive. No mark scheme can cover all the responses which candidates may produce. In the event of unanticipated answers, examiners are expected to use their professional judgement to assess the validity of answers. If an answer is particularly problematic, the examiners should seek the guidance of the Supervising Examiner.

Positive marking
Examiners must be positive in their marking, giving appropriate credit for description, explanation and analysis, using knowledge and understanding and for the appropriate use of evidence and reasoned argument to express and evaluate personal responses, informed insights and differing viewpoints. Examiners should make use of the whole of the available mark range of any particular question and be prepared to award full marks for a response which is as good as might reasonably be expected of a 16-year-old GCSE candidate.

Awarding zero marks
Marks should only be awarded for valid responses and no marks should be awarded for an answer which is completely incorrect or inappropriate.

Types of mark scheme
Mark schemes for questions which require candidates to respond in extended written form are marked on the basis of levels of response which take account of the quality of written communication.

Other questions which require only short answers are marked on a point for point basis with marks awarded for each valid piece of information provided.

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				AVAILABLE MARKS
1	(a)	(i)	fluoride reduces tooth decay/less tooth decay in fluoridated areas [1] use of any data to compare [1] [2]	
		(ii)	Any **one** from: no freedom of choice mass medication effects of fluoride in drinking water unknown [1]	
	(b)	(i)	water which does not lather readily with soap [1]	
		(ii)	Sample C [1] requires the greatest volume of soap to obtain a lather [1] [2]	
		(iii)	Sample B – temporary (hardness) [1] Sample D – permanent (hardness) [1] [2]	
		(iv)	Sample B – calcium or magnesium hydrogencarbonate [1] Sample D – calcium or magnesium sulfate/chloride [1] [2]	
		(v)	hydrated sodium carbonate [1]	
		(vi)	contains calcium (ions) so good for teeth/bones/prevent heart disease [1]	
	(c)	(i)	ion exchange [1]	
		(ii)	calcium ions in the hard water removed [1] calcium ions replaced by sodium ions [1] sodium ions do not cause hardness [1] max [2]	
		(iii)	no sodium ions left on column/column filled with calcium ions [1]	16

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AVAILABLE MARKS

2 **(a)** same general formula [1]
similar chemical properties [1]
gradation in physical properties [1]
differ by a 'CH_2' unit [1] max [3]

(b) **(i)** C═C/carbon-carbon double bond/allow circled C═C on diagram [1]

(ii) it contains carbon and hydrogen (atoms) only [1]

(iii) carbon monoxide [1] water [1] [2]

(iv) C_3H_5 [1]

(c) **(i)** OH/hydroxyl/allow circled OH on diagram [1]

(ii) $C_6H_{11}OH + 8\frac{1}{2}O_2 \rightarrow 6CO_2 + 6H_2O$
allow correct multiple of balancing numbers
correct formulae of reactants [1]
correct formulae of products [1]
correct balancing [1] [3]

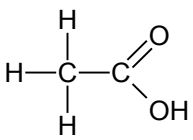
(iii) **Indicative content**

bromine water [1]
red-brown/orange/brown [1] to colourless [1] with cyclohexene
acidified potassium dichromate [1] (solution)
warming [1]
orange [1] to green [1] with cyclohexanol

Response	Mark
Candidates must use appropriate specialist terms to explain chemical tests (using 6–7 points of indicative content). They use good spelling, punctuation and grammar and the form and style are of a high standard.	[5]–[6]
Candidates must use appropriate specialist terms to describe the chemical tests (using 4–5 points of indicative content). They use satisfactory spelling, punctuation and grammar and the form and style are of a satisfactory standard.	[3]–[4]
Candidates partially describe chemical tests (using 2–3 points of indicative content). They use limited spelling, punctuation and grammar and they make little use of specialist terms. The form and style are of a limited standard.	[1]–[2]
Response not worthy of credit	0

[6]

(d) **(i)** CH_3COOH [1]

(ii)


[1]

(iii) only partially ionised in water [1]

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				AVAILABLE MARKS
	(iv)	$2CH_3COOH + Na_2CO_3 \rightarrow 2CH_3COONa + H_2O + CO_2$ correct formulae of reactants [1] correct formulae of products [1] correct balancing [1]	[3]	
	(v)	bubbles [1] solid/sodium carbonate disappears [1] solution remains colourless [1]	max [2]	26
3 **(a)**	**(i)**	$2H_2O_2 \rightarrow 2H_2O + O_2$ correct formula of reactant [1] correct formulae of products [1] correct balancing [1]	[3]	
	(ii)	manganese(IV) oxide/manganese dioxide	[1]	
	(iii)	substance which speeds up (or increases the rate) [1] of a (chemical) reaction [1] without being used up/remains chemically unchanged at the end [1]	[3]	
	(iv)	activation energy	[1]	
(b)	**(i)**			

Temperature (°C)	Time for reaction to finish (s)	Rate = $\frac{1}{\text{time}}$ (s^{-1})
60	42–46 [1]	0.0217–0.0238 [1]

[2]

	(ii)	as temperature increases, rate increases **or** as temperature decreases, rate decreases	[1]	
(c)	**(i)**	$0.01(0)\ s^{-1}$	[1]	
	(ii)	as concentration increases, rate increases **or** as concentration decreases, rate decreases	[1]	
	(iii)	straight line through origin [1] lower than one drawn [1]	[2]	15

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4 (a) Indicative content

AVAILABLE MARKS

Formation

- sulfur (present in fossil fuels) reacts with oxygen (in the air)/undergoes combustion to form sulfur dioxide [1]
- $S + O_2 \rightarrow SO_2$ [2]
- sulfur dioxide reacts with water in the air to form sulfurous acid [1]
- $SO_2 + H_2O \rightarrow H_2SO_3$ [2]

Environmental effects

- corrosion of limestone buildings and statues [1]
- kills fish in rivers and lakes [1]
- defoliates trees [1]

Prevention

- remove sulfur from fossil fuels before combustion [1]
- burn less fossil fuels/use renewable energy sources [1]
- remove sulfur dioxide from industrial waste gases [1]

Response	Mark
Candidates must use appropriate specialist terms to explain fully the formation of acid rain (using 10–12 points of indicative content) including two balanced symbol equations. They use good spelling, punctuation and grammar and the form and style are of a high standard.	[7]–[9]
Candidates must use appropriate specialist terms to explain fully the formation of acid rain (using 6–9 points of indicative content) including one balanced symbol equation. They use satisfactory spelling, punctuation and grammar and the form and style are of a satisfactory standard.	[4]–[6]
Candidates describe briefly and partially the formation of acid rain (using 2–5 points of indicative content). They use limited spelling, punctuation and grammar and they make little use of specialist terms. The form and style are of a limited standard.	[1]–[3]
Response not worthy of credit	0

[9]

(b)

- Bonds broken in N_2 and O_2 [1]
- Bond breaking requires energy [1]
- Bond making in NO_2 [1]
- Bond making releases energy [1]
- Less energy is released when bonds form than is taken in to break bonds [1]

[5]

14

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				AVAILABLE MARKS
5	(a)	(i)	same volume of copper(II) sulfate [1] same concentration of copper(II) sulfate [1] same mass of metal/same number of moles of metal [1] max [2]	
		(ii)	magnesium the repeat result was not similar/far apart [1]	
		(iii)	magnesium [1] temperature rise was greatest [1] [2]	
		(iv)	no reaction/silver cannot displace copper/silver below copper in the reactivity series [1]	
		(v)	two metals/gold and silver give the same result [1]	
		(vi)	$Zn + CuSO_4 \rightarrow ZnSO_4 + Cu$ correct formulae of reactants [1] correct formulae of products [1] [2]	
	(b)	(i)	iron(III) oxide [1] calcium carbonate [1] [2]	
		(ii)	B [1] C [1] E [1] A [1] [4]	
	(c)	(i)	bauxite [1]	
		(ii)	$Al^{3+} + 3e^- \rightarrow Al$ $Al^{3+} \rightarrow Al$ [1] correct e^- [1] correct balancing [1] [3]	
		(iii)	$2O^{2-} \rightarrow O_2 + 4e^-$ $O^{2-} \rightarrow O_2$ [1] correct e^- [1] correct balancing [1] [3]	22

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				AVAILABLE MARKS
6	**(a)**	$(NH_4)_2CO_3 \rightarrow 2NH_3 + CO_2 + H_2O$ [1] for correct formula of reactant [1] for correct formulae of products [1] for correct balancing	[3]	
	(b)	**(i)** $\frac{0.868}{124}$ [1] = 0.007 [1]	[2]	
		(ii) 0.007 × 2 [1] = 0.014 [1]	[2]	
		(iii) $\frac{0.014 \times 1000}{0.175}$ [1] = 80 [1]	[2]	
	(c)	**(i)** yellow/orange [1] to red/orange [1]	[2]	
		(ii) 18.0/18 [2] 18.2 [1]	[2]	
		(iii) $\frac{18 \times 0.175}{1000}$ [1] = 0.00315 [1]	[2]	
		(iv) $\frac{0.00315}{2}$ [1] = 0.001575 [1] use of any other ratio apart from 2:1 = [0] × 2 gains [1]	[2]	
		(v) 0.001575 × 10 = 0.01575 [1]	[1]	
		(vi) $\frac{2.52}{0.01575}$ [1] = 160 [1]	[2]	
		(vii) 160 – 106 = 54 [1]/18 = 3 [1]	[2]	22
			Total	**115**

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Rewarding Learning

General Certificate of Secondary Education
2015

GCSE Chemistry

Unit 2

Higher Tier

[GCH22]

WEDNESDAY 17 JUNE, MORNING

MARK SCHEME

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General Marking Instructions and Mark Grids

Introduction
Mark schemes are intended to ensure that the GCSE examination is marked consistently and fairly. The mark schemes provide markers with an indication of the nature and range of candidates' responses likely to be worthy of credit. They also set out the criteria that they should apply in allocating marks to candidates' responses. The mark schemes should be read in conjunction with these marking instructions.

Quality of candidates' responses
In marking the examination papers, examiners should be looking for a quality response reflecting the level of maturity which may reasonably be expected of a 16-year-old which is the age at which the majority of candidates sit their GCSE examinations.

Flexibility in marking
Mark schemes are not intended to be totally prescriptive. No mark scheme can cover all the responses which candidates may produce. In the event of unanticipated answers, examiners are expected to use their professional judgement to assess the validity of answers. If an answer is particularly problematic, the examiners should seek the guidance of the Supervising Examiner.

Positive marking
Examiners must be positive in their marking, giving appropriate credit for description, explanation and analysis, using knowledge and understanding and for the appropriate use of evidence and reasoned argument to express and evaluate personal responses, informed insights and differing viewpoints. Examiners should make use of the whole of the available mark range of any particular question and be prepared to award full marks for a response which is as good as might reasonably be expected of a 16-year-old GCSE candidate.

Awarding zero marks
Marks should only be awarded for valid responses and no marks should be awarded for an answer which is completely incorrect or inappropriate.

Types of mark scheme
Mark Schemes for questions which require candidates to respond in extended written form are marked on the basis of levels of response which take account of the quality of written communication.

Other questions which require only short answers are marked on a point for point basis with marks awarded for each valid piece of information provided.

					AVAILABLE MARKS
1	(a)	(i)	water which does not lather readily with soap water which does not lather with soap = [1]	[2]	
		(ii)	deliquescent	[1]	
		(iii)	temporary hardness removed by boiling [1] permanent hardness is not removed by boiling [1]	[2]	
	(b)	(i)	washing soda	[1]	
		(ii)	$Ca^{2+}(aq) + CO_3^{2-}(aq) \rightarrow CaCO_3(s)$ correct formulae of reactants [1] correct formula of product [1] correct state symbols [1]	[3]	
		(iii)	ion exchange/distillation	[1]	
		(iv)	tastes better/better for **specified** health benefit, e.g. teeth, bones	[1]	11

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AVAILABLE MARKS

2 (a) Indicative content

- sugar/glucose (or source of sugar such as fruit)
- in solution
- yeast (or zymase)
- absence of air/anaerobic conditions
- warm conditions
- carbon dioxide also produced

Response	Mark
Candidates must use appropriate specialist terms to explain fully the process of fermentation (5–6 points of indicative content). They use good spelling, punctuation and grammar and the form and style are of a high standard.	[5]–[6]
Candidates must use appropriate specialist terms to explain fully the process of fermentation (using 3–4 points of indicative content). They use satisfactory spelling, punctuation and grammar and the form and style are of a satisfactory standard.	[3]–[4]
Candidates explain briefly and partially the process of fermentation (using 2 points of indicative content). They use limited spelling, punctuation and grammar and they have made little use of specialist terms. The form and style are of limited standard.	[1]–[2]
Response not worthy of credit	[0]

[6]

(b) (i) C_nH_{2n+2} [1]

(ii) compound containing **only** carbon and hydrogen atoms [1]

(iii) $C_8H_{18} + 12\frac{1}{2}O_2 \rightarrow 8CO_2 + 9H_2O$

correct formulae of reactants [1]
correct formulae of products [1]
correct balancing allow multiples [1] [3]

(c) (i) A = ethene [1]
B = ethanol [1]
C = ethanoic acid [1] [3]

(ii) steam [1]

(iii) orange to green [1]

(iv) A [1] 17

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					AVAILABLE MARKS
3	(a)	(i)	80 (s) (allow 78–82)	[1]	
		(ii)	$\frac{1}{80}$ [1] = 0.0125 [1] allow consequential marking from **(a)(i)**	[2]	
	(b)	(i)	D	[1]	
			faster reaction/steeper slope [1] finishes at same gas volume [1]	[2]	
		(ii)	B	[1]	
		(iii)	A [1] half mass used so half volume produced/less gas produced [1]	[2]	
		(iv)	Effect: (increasing concentration) increases rate	[1]	
			Explanation: more particles (in same volume) [1] more collisions in a given time [1] with the activation energy/successful collisions [1]	[3]	
	(c)	(i)	cobalt nitrate [1] shortest time/fastest reaction [1]	[2]	
		(ii)	minimum energy particles need to react	[1]	16

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AVAILABLE MARKS

4 **(a)** **(i)**

Property \ Gas	Sulfur dioxide	Nitrogen
Colour	colourless [1]	colourless [1]
Acidic, basic or neutral	acidic [1]	neutral

[3]

(ii) triple covalent bond [1]
requires substantial energy to break/strong bond [1] [2]

(b) **(i)** nitrogen [1]

(ii) hydrogen [1]

(iii) 200 atm–1000 atm [1]

(iv) $N_2 + 3H_2 \rightleftharpoons 2NH_3$
correct formulae of reactants [1]
correct formula of product [1]
correct balancing [1] [3]

(v) iron [1]

(vi) 450 °C (350 °C–550 °C) [1]

(vii) **Ammonia** condenses/changes to a liquid [1]

(viii) Idea of increase (total) yield of ammonia/prevent waste/reduce cost as less raw materials need to be purchased [1]

(c) $(NH_4)_2SO_4 + 2NaOH \rightarrow 2NH_3 + 2H_2O + Na_2SO_4$
correct formulae of reactants [1]
correct formulae of products [1]
correct balancing [1] [3]

(d) add ammonia solution [1]
red-brown [1] ppt [1] [3]

21

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AVAILABLE MARKS

5 **(a)** **(i)** continental drift [1]

(ii) Idea that Wegener could not explain how it happened [1]

(b) **(i)** $FeCl_2$ [1]

(ii) rust [1]

(iii) iron gains oxygen/iron loses electrons [1]
gain of oxygen is oxidation/loss of electrons is oxidation [1] [2]

(iv) apply lit splint [1] pop [1] [2]

(v) $Fe + CuSO_4 \rightarrow FeSO_4 + Cu$
correct formulae of reactants [1]
correct formulae of products [1] [2]

(vi) **Indicative content**

- iron loses electrons [1]/$Fe \rightarrow Fe^{2+} + 2e^-$ [2]
- loss of electrons is oxidation
- copper **ions** gain electrons [1]/$Cu^{2+} + 2e^- \rightarrow Cu$ [2]
- gain of electrons is reduction
- redox is oxidation and reduction occurring simultaneously

Response	Mark
Candidates must use appropriate specialist terms to explain why this reaction is a redox reaction (6–7 points of indicative content). They use good spelling, punctuation and grammar and the form and style are of a high standard.	[5]–[6]
Candidates must use appropriate specialist terms to explain fully why this reaction is a redox reaction (using 3–5 points of indicative content). They use satisfactory spelling, punctuation and grammar and the form and style are of a satisfactory standard.	[3]–[4]
Candidates explain briefly and partially why this reaction is a redox reaction (using at **least 2** points of indicative content). They use limited spelling, punctuation and grammar and they have made little use of specialist terms. The form and style are of limited standard.	[1]–[2]
Response not worthy of credit	[0]

[6] 16

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					AVAILABLE MARKS
6	**(a)**	haematite		[1]	
	(b)	**(i)** coke/carbon [1] reacts (with oxygen) to form carbon dioxide [1] carbon dioxide reacts with (more) coke/carbon to form carbon monoxide [1]		[3]	
		(ii) $Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$			
		correct formulae of reactants	[1]		
		correct formulae of products	[1]		
		correct balancing	[1]	[3]	
		(iii) $CaCO_3 \rightarrow CaO + CO_2$			
		correct formula of reactant	[1]		
		correct formulae of products	[1]		
		$CaO + SiO_2 \rightarrow CaSiO_3$			
		correct formulae of reactants	[1]		
		correct formula of product	[1]		
		The SiO_2/silicon dioxide/sand is the impurity	[1]		
		The slag is tapped off at the bottom of the furnace	[1]	[6]	
	(c)	bauxite		[1]	
	(d)	decomposition (of an ionic compound)	[1]		
		using (a direct current of) electricity	[1]	[2]	
	(e)	$Al^{3+} + 3e^- \rightarrow Al$			
		correct ion and electron on left hand side	[1]		
		correct atom on right hand side	[1]		
		correct balancing of electrons	[1]	[3]	19

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					AVAILABLE MARKS
7	**(a)**	**(i)**	pipette	[1]	
		(ii)	any **four** from: rinse with **distilled** water [1] rinse with (sodium hydroxide) solution [1] fill (using filter funnel) [1] ensure jet is filled/ensure no air bubbles [1]	[4]	
		(iii)	colourless [1] to pink [1]	[2]	
	(b)	**(i)**	$\frac{26.5 \times 0.2}{1000} = 0.0053$	[1]	
		(ii)	1:1 ratio so 0.0053	[1]	
		(iii)	$0.0053 \times 40 = 0.212$	[1]	
		(iv)	60 [1] $0.212 \times 60 = 12.72$ (g/dm^3) [1]	[2]	
	(c)		$\frac{12}{60} = 0.2$ [1] $\frac{0.2 \times 1000}{50}$ [1] = 4 [1] mol/dm^3	[3]	15
				Total	**115**

Rewarding Learning

Centre Number

Candidate Number

General Certificate of Secondary Education
2014

GCSE Chemistry

Unit 2

Higher Tier

[GCH22]

GCH22

THURSDAY 19 JUNE, AFTERNOON

TIME

1 hour 45 minutes.

INSTRUCTIONS TO CANDIDATES

Write your Centre Number and Candidate Number in the spaces provided at the top of this page.
You must answer the questions in the spaces provided. Do not write outside the box, around each page or on blank pages.
Complete in blue or black ink only. **Do not write with a gel pen.**
Answer **all seven** questions.

INFORMATION FOR CANDIDATES

The total mark for this paper is 115.
Figures in brackets printed down the right-hand side of pages indicate the marks awarded to each question or part question.
Quality of written communication will be assessed in Questions **2** and **4(a)**.
A Data Leaflet, which includes a Periodic Table of the Elements, is included in this question paper.

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Examiner Only	
Marks	Remark

1 Many multivitamin supplements are produced as tablets which effervesce when added to water. The label of a multivitamin supplement is shown below.

Multivitamin Supplement

Niacin
Calcium carbonate
Vitamin B12
Sweeteners
Salt
Orange flavouring
Citric acid

In an experiment one multivitamin tablet was added to 50 cm^3 of water in a conical flask at a temperature of 20 °C. The flask was loosely stoppered with a cotton wool plug and placed on an electronic balance. A stopclock was started as soon as the tablet made contact with the water. The mass was recorded every 20 seconds.

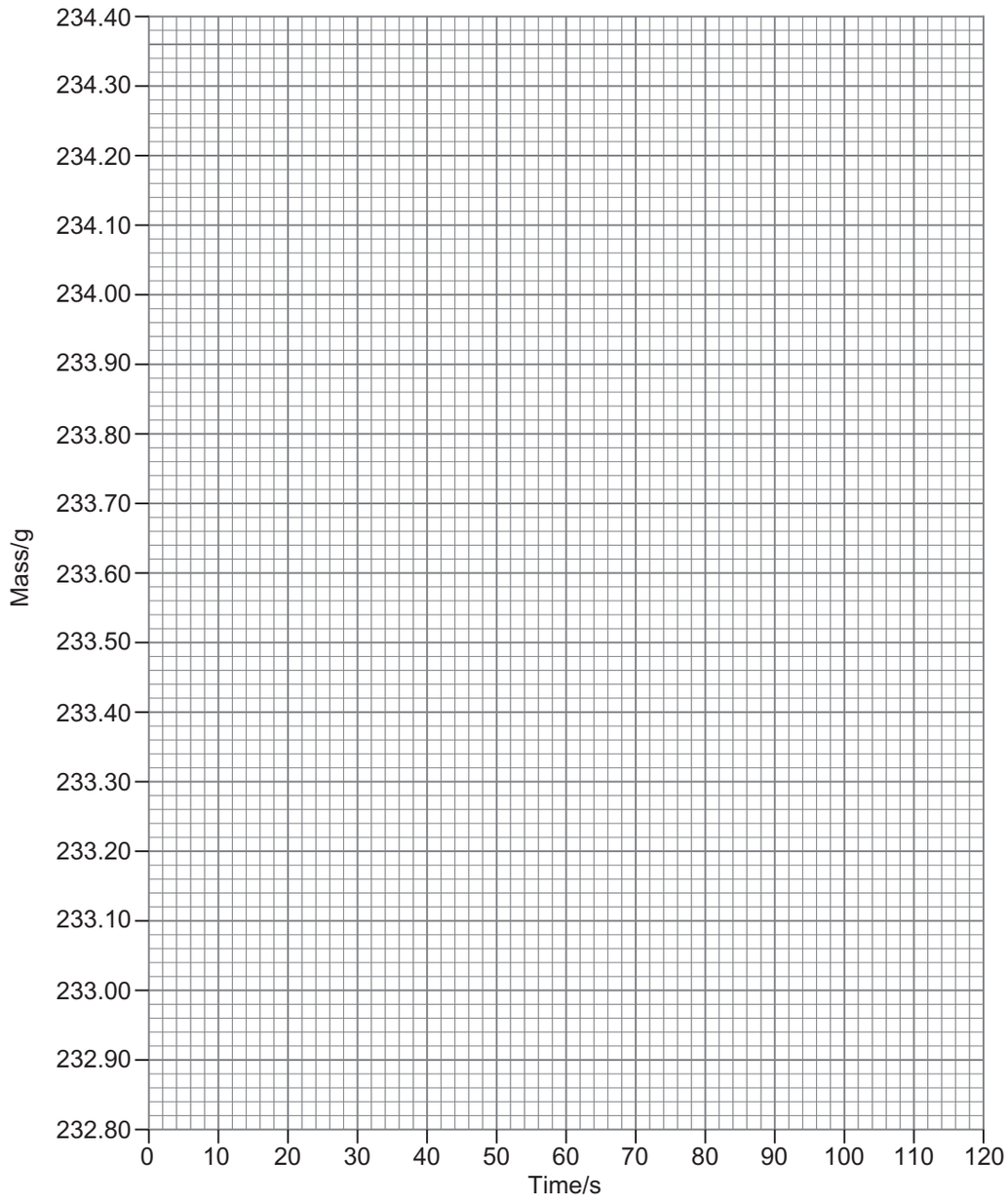
(a) Draw a labelled diagram of the assembled apparatus used to carry out this experiment. **Include all apparatus**.

[4]

(b) The results obtained from the experiment are shown below.

Time/s	0	20	40	60	80	100	120
Mass/g	234.10	233.70	233.40	233.20	233.05	233.00	233.00

(i) Plot these results on the graph below. [4]



Examiner Only	
Marks	Remark

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Using the graph answer the following questions.

(ii) At what time does the reaction stop?

_____ [1]

(iii) Calculate the total loss in mass.

_____ [1]

(iv) The experiment was repeated using one tablet and 50 cm^3 of water at 40 °C. On the same axes, sketch the graph for this experiment and label it B. [3]

(v) State and explain, in terms of particles, the effect of increasing temperature on the rate of a chemical reaction.

_____

_____

_____

_____

_____

_____ [3]

(c) Explain what you understand by the term activation energy.

_____

_____

_____ [2]

Examiner Only	
Marks	Remark
Total Question 1	

[Turn over

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2 Concentrated sulfuric acid is manufactured industrially by the Contact Process. This process occurs in four stages, one of which requires three specific conditions.

Describe the chemistry of the Contact Process. Your answer should include the following:

- balanced symbol equations for each of the four stages
- names of all reactants and products in each reaction
- identification of the stage which requires specific conditions
- details of these conditions

In this question you will be assessed on your written communication skills including the use of specialist scientific terms.

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Marks	Remark

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[12]

Examiner Only	
Marks	Remark
Total Question 2	

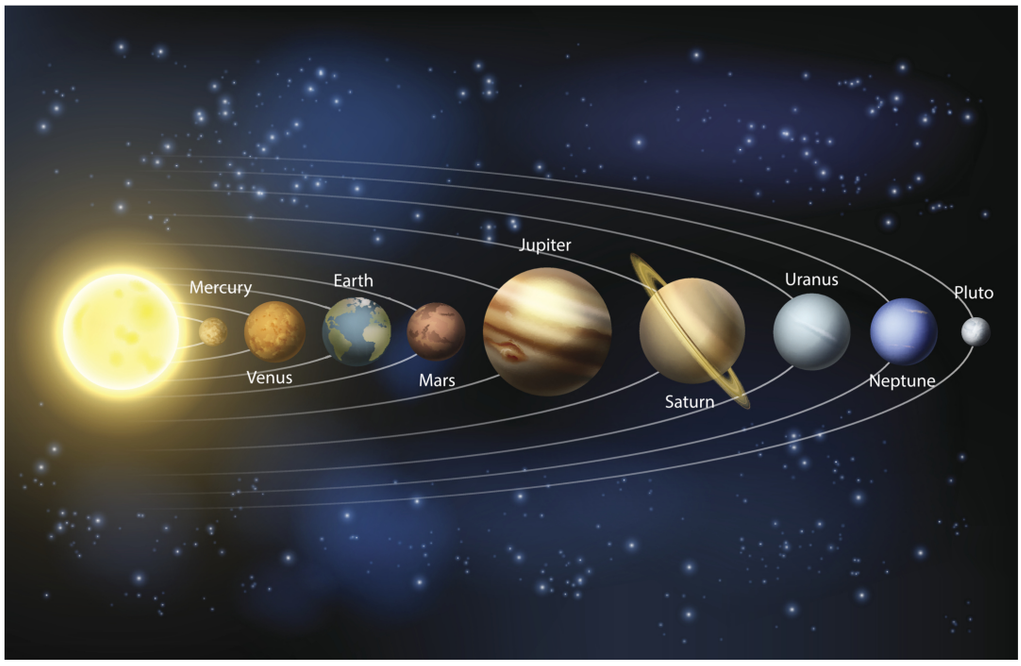
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3 The diagram below shows the Earth's solar system.



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(a) Mars is often called the red planet due to the presence of haematite on its surface. A recent study of the Huygens Crater on Mars has also shown the presence of iron(III) hydroxide and calcium carbonate.

(i) Calcium carbonate and iron(III) hydroxide undergo thermal decomposition. What is meant by the term thermal decomposition?

_____

_____ [2]

(ii) Write a balanced symbol equation for the thermal decomposition of iron(III) hydroxide into iron(III) oxide and water.

_____ [3]

Examiner Only	
Marks	Remark

[Turn over

(b) Mars does not have tectonic plates but Earth does. What may occur at the boundaries between tectonic plates?

_____

_____ [2]

(c) Atmosphere is the term used to describe the collection of gases that surround a planet. The composition of the atmosphere of Mars is shown in the table below.

Gas	Composition
Carbon dioxide	95.0%
Nitrogen	3.0%
Noble gases	1.6%
Oxygen	trace
Methane	trace

Compare the composition of the Earth's atmosphere today, with that of the planet Mars.

_____

_____

_____

_____

_____

_____

_____

_____ [5]

Examiner Only	
Marks	Remark

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(d) Changes in the atmosphere of the Earth occurred slowly over millions of years due to photosynthesis and other processes.

(i) An unbalanced symbol equation for the production of glucose ($C_6H_{12}O_6$) in photosynthesis is shown below. Balance this equation.

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

[1]

(ii) Photosynthesis is an endothermic reaction. In terms of bonds, explain why this reaction is endothermic.

[5]

Examiner Only	
Marks	Remark
Total Question 3	

[Turn over

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Examiner Only	
Marks	Remark

4 The water supply in some parts of Northern Ireland may be described as being hard water.

(a) Describe in detail how a sample of water may be tested for hardness.

Your answer should include:

- how to determine that hardness is present in the water
- how to determine if the hardness present is temporary or permanent
- all practical details

In this question you will be assessed on your written communication skills including the use of specialist scientific terms.

[6]

(b) Temperary hard water is found in areas where limestone rock is common.

(i) Write a balanced symbol equation to show the formation of temporary hard water.

_____ [2]

(ii) Describe in detail how temporary hardness arises in water.

_____

_____

_____

_____

_____

_____

_____ [3]

(iii) State two methods which may be used to remove permanent hardness from water.

1. _____

_____

2. _____

_____ [2]

Examiner Only	
Marks	Remark
Total Question 4	

Examiner Only	
Marks	Remark

5 **(a)** A homologous series is a family of organic compounds that have the same general formula and show a gradation in physical properties.

(i) State one other feature of a homologous series.

_____

_____ [1]

(ii) Alkanes and alkenes are examples of homologous series. Complete the following table.

Name of homologous series	General formula	Molecular formula of compound with three carbon atoms
Alkanes		C_3H_8
Alkenes	C_nH_{2n}	

[2]

(iii) Name the alkane with the molecular formula C_3H_8.

_____ [1]

(b) Alkanes and alkenes undergo combustion reactions.

(i) What is meant by the term combustion?

_____

_____

_____ [3]

(ii) Write a balanced symbol equation for the complete combustion of methane.

_____ [3]

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(c) Alkenes contain the C═C functional group.

(i) What do you understand by the term functional group?

_____

_____ [1]

(ii) Describe a chemical test which may be used to confirm the presence of the C═C in an alkene. State the result you would expect for a positive test.

_____

_____

_____

_____ [3]

(d) Alkenes undergo addition polymerisation to form polymers such as polythene and PVC (polyvinyl chloride).

(i) Write a structural equation to show the formation of PVC.

[4]

(ii) State one reason why PVC is used to make window frames in preference to wood.

_____

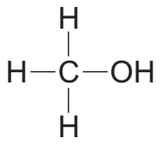
_____ [1]

Examiner Only	
Marks	Remark

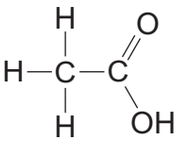
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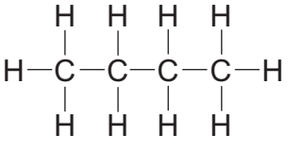
(e) The structures of four organic compounds are shown below.



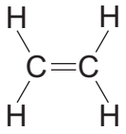
A



B



C



D

(i) Name compound **A**.

_____ [1]

(ii) What is the functional group in compound **B**?

_____ [1]

(iii) Explain why compound **C** is a hydrocarbon.

_____

_____ [1]

(iv) Which compound (**A**, **B**, **C** or **D**) reacts with sodium carbonate?

_____ [1]

Examiner Only	
Marks	Remark
Total Question 5	

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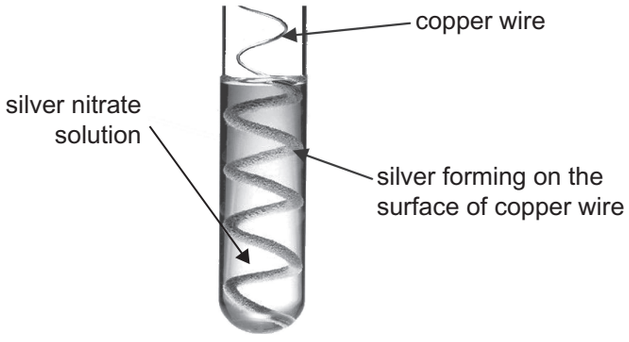
Examiner Only	
Marks	Remark

6 A reactivity series of some metals is shown below:

potassium
sodium
calcium
magnesium
aluminium
iron
copper



(a) Silver metal does not appear on the above reactivity series. Copper metal will react with silver nitrate solution to form silver as shown below.



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(i) Write a balanced symbol equation for the reaction of copper with silver nitrate forming silver and copper(II) nitrate.

_____ [3]

(ii) Indicate the position of silver on the reactivity series shown above. [1]

[Turn over

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(iii) Silver nitrate solution is colourless. What is the colour of the solution at the end of this reaction?

_____ [1]

(iv) Explain why copper displaces silver from a solution of silver nitrate.

_____

_____ [2]

(b) Silver particles of size 1 to 100 nanometres (nm) are used to kill bacteria in wound dressings.

(i) Explain what you understand by a nanometre.

_____ [1]

(ii) Describe one risk which has been associated with the use of silver particles of this size.

_____

_____ [1]

(c) Aluminium is a very useful metal due to its high electrical conductivity, relatively low density and lack of reactivity.

(i) Explain why aluminium shows a lack of reactivity even though the reactivity series would suggest it is a moderately reactive metal.

_____

_____

_____

_____ [3]

Examiner Only	
Marks	Remark

(ii) A balanced symbol equation for a reaction of aluminium is shown below:

$$2Al + 3CuO \rightarrow Al_2O_3 + 3Cu$$

Write a word equation for this reaction.

_____ [2]

Examiner Only	
Marks	Remark
Total Question 6	

Examiner Only	
Marks	Remark

7 Homemade wines contain acids such as tartaric acid.

(a) Tartaric acid has the molecular formula $C_4H_6O_6$. Calculate the percentage of oxygen present in tartaric acid.

Percentage of oxygen _____ [3]

(b) To find the concentration of acid in their homemade wine, wine makers can use a wine testing kit. The label of a wine testing kit is shown below.

WINE TESTING KIT

- 25 cm^3 syringe
- 30 cm^3 syringe
- 0.1 mol/dm^3 sodium hydroxide solution
- Phenolphthalein indicator
- Plastic beaker

The instructions on the wine testing kit are:

Measure out 25 cm^3 of wine into the plastic beaker using the 25 cm^3 syringe.
Add 3 drops of phenolphthalein indicator.
Slowly add sodium hydroxide from the other syringe until the indicator changes colour.

State the colour change observed for the phenolphthalein indicator.

From _____ to _____ [2]

(c) This method can be carried out more accurately in a laboratory using titration apparatus.

Examiner Only	
Marks	Remark

(i) Name the piece of apparatus used to measure out accurately 25.0 cm^3 of wine.

_____ [1]

(ii) Name the piece of apparatus used to accurately add the sodium hydroxide solution to the wine in a titration.

_____ [1]

(iii) This method is suitable for white wine. Suggest why it is not used to find the concentration of acid in red wine.

_____ [1]

QUESTION 7 CONTINUES OVERLEAF

Examiner Only	
Marks	Remark

(d) In a laboratory experiment 25.0 cm^3 of white wine were placed in a conical flask and a few drops of phenolphthalein indicator added. Sodium hydroxide solution of concentration 0.1 mol/dm^3 was then added slowly to the conical flask. The results of the titration are shown in the table below.

	Initial reading (cm^3)	**Final reading (cm^3)**	**Titre (cm^3)**
Titration 1 (rough)	0.0	20.0	20.0
Titration 2	0.0	18.9	18.9
Titration 3	0.0	19.1	19.1

(i) Calculate the average titre.

Average titre _____ cm^3 [2]

(ii) Calculate the number of moles of sodium hydroxide solution used in this titration.

Moles of sodium hydroxide _____ [2]

(iii) The equation for the reaction of the tartaric acid in the white wine with sodium hydroxide is shown below. Use this equation to calculate the number of moles of tartaric acid which reacted with the sodium hydroxide solution.

$$C_4H_6O_6 + 2NaOH \rightarrow C_4H_4O_6Na_2 + 2H_2O$$

Moles of tartaric acid _____ [2]

(iv) Calculate the concentration of the tartaric acid in mol/dm^3.

Concentration of tartaric acid _____ mol/dm^3 [2]

(v) Calculate the concentration of the tartaric acid in g/dm^3.

Concentration of tartaric acid _____ g/dm^3 [1]

Examiner Only	
Marks	Remark
Total Question 7	

THIS IS THE END OF THE QUESTION PAPER

DO NOT WRITE ON THIS PAGE

For Examiner's use only	
Question Number	**Marks**
1	
2	
3	
4	
5	
6	
7	
Total Marks	

Examiner Number

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Rewarding Learning

General Certificate of Secondary Education
2014

GCSE Chemistry

Unit 2

Higher Tier

[GCH22]

THURSDAY 19 JUNE, AFTERNOON

MARK SCHEME

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General Marking Instructions and Mark Grids

Introduction
Mark schemes are intended to ensure that the GCSE examination is marked consistently and fairly. The mark schemes provide markers with an indication of the nature and range of candidates' responses likely to be worthy of credit. They also set out the criteria that they should apply in allocating marks to candidates' responses. The mark schemes should be read in conjunction with these marking instructions.

Quality of candidates' responses
In marking the examination papers, examiners should be looking for a quality response reflecting the level of maturity which may reasonably be expected of a 16-year-old which is the age at which the majority of candidates sit their GCSE examinations.

Flexibility in marking
Mark schemes are not intended to be totally prescriptive. No mark scheme can cover all the responses which candidates may produce. In the event of unanticipated answers, examiners are expected to use their professional judgement to assess the validity of answers. If an answer is particularly problematic, the examiners should seek the guidance of the Supervising Examiner.

Positive marking
Examiners must be positive in their marking, giving appropriate credit for description, explanation and analysis, using knowledge and understanding and for the appropriate use of evidence and reasoned argument to express and evaluate personal responses, informed insights and differing viewpoints. Examiners should make use of the whole of the available mark range of any particular question and be prepared to award full marks for a response which is as good as might reasonably be expected of a 16-year-old GCSE candidate.

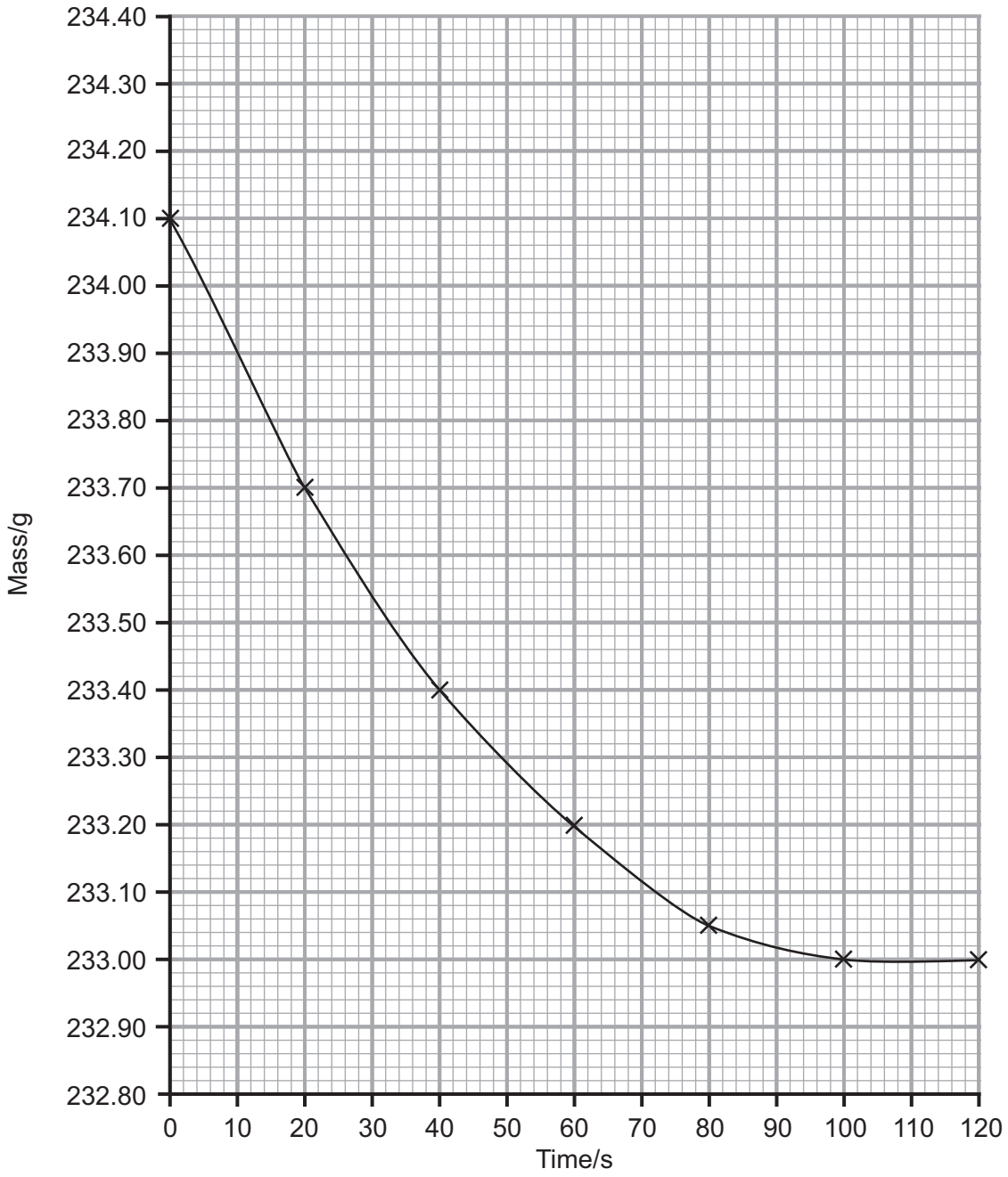
Awarding zero marks
Marks should only be awarded for valid responses and no marks should be awarded for an answer which is completely incorrect or inappropriate.

Types of mark scheme
Mark Schemes for questions which require candidates to respond in extended written form are marked on the basis of levels of response which take account of the quality of written communication.

Other questions which require only short answers are marked on a point for point basis with marks awarded for each valid piece of information provided.

					AVAILABLE MARKS
1	**(a)**	conical flask with cotton wool plug	[1]		
		placed on electronic balance	[1]		
		tablet in contact with water	[1]		
		timer/stopclock/stopwatch	[1]	[4]	
		No labels = [0]			
	(b)	**(i)** 5–7 points plotted correctly	[3]		
		2–4 points plotted correctly	[2]		
		1 point plotted correctly	[1]		
		smooth **curve**	[1]	[4]	
		(ii) 95–100 seconds units essential		[1]	
		(iii) 1.10 g units essential allow 1.1 g		[1]	
		(iv) graph starts at (0, 234.1) **and** remains lower	[1]		
		levels off earlier	[1]		
		levels off at same mass reading as initial graph	[1]	[3]	
		(v) particles have more energy/move faster	[1]		
		idea of more **successful** collisions	[1]		
		per unit time	[1]	[3]	
	(c)	**minimum** energy [1] which (reactant) particles need to react [1] (energy which particles need to react [1])		[2]	18

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AVAILABLE MARKS

AVAILABLE MARKS

2 Indicative content

- sulfur burns in (oxygen from) **air** producing sulfur dioxide
- $S + O_2 \rightarrow SO_2$ [2]
- sulfur dioxide **reacts** with (more) oxygen (from air) forming sulfur trioxide
- $2SO_2 + O_2 \rightleftharpoons 2SO_3$ [3]
- in the presence of a vanadium(V) oxide catalyst
- at 450 °C and 2 atm pressure (1–10 accepted)
- sulfur trioxide reacts with **concentrated** sulfuric acid to form oleum
- $SO_3 + H_2SO_4 \rightarrow H_2S_2O_7$ [2]
- oleum diluted to form sulfuric acid
- $H_2S_2O_7 + H_2O \rightarrow 2H_2SO_4$ [3]

Response	Mark
Candidates must use appropriate specialist terms to explain fully the industrial manufacture of sulfuric acid (using a minimum of 11 points of indicative content) including at least **three** balanced symbol equations and a logical sequence. They use good spelling, punctuation and grammar and the form and style are of a high standard.	[9]–[12]
Candidates must use appropriate specialist terms to explain fully the industrial manufacture of sulfuric acid (using a minimum of 6 points of indicative content) including at least **two** balanced symbol equations and a logical sequence. They use satisfactory spelling, punctuation and grammar and the form and style are of a satisfactory standard.	[5]–[8]
Candidates explain briefly and partially the industrial manufacture of sulfuric acid (using a minimum of 2 points of indicative content) including at least **one** balanced symbol equation. They use limited spelling, punctuation and grammar and they have made little use of specialist terms. The form and style are of a limited standard.	[1]–[4]
Response not worthy of credit	[0]

[12] 12

Award indicative content marks for catalyst and conditions only if referring to correct stage.

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					AVAILABLE MARKS
3	**(a)**	**(i)**	breaking down (a substance) [1] using heat [1]	[2]	
		(ii)	$2Fe(OH)_3 \rightarrow Fe_2O_3 + 3H_2O$ [1] for correct formula of reactant [1] for correct formulae of products [1] for correct balancing	[3]	
	(b)		Any **two** from: volcanoes/earthquakes/mountain **formation**	[2]	
	(c)		A comparison of three of the following gases: Nitrogen [1] Oxygen [1] Carbon dioxide [1] Noble gases [1] max [3] Two correct percentages of gases in Earth's atmosphere [2]	[5]	
	(d)	**(i)**	$\mathbf{6}CO_2 + \mathbf{6}H_2O \rightarrow C_6H_{12}O_6 + \mathbf{6}O_2$ [1] for correct balancing	[1]	
		(ii)	energy taken in to break bonds [1] in carbon dioxide **and** water [1] is more than [1] energy released when bonds are made [1] in $C_6H_{12}O_6$ (glucose) **and** oxygen [1]	[5]	18

AVAILABLE MARKS

4 (a) Indicative content

- Add soap (solution) to sample of water **and shake**
- If scum forms/there is no immediate lather, the water is hard
- Take another sample of the water
- Boil it
- Add soap solution and shake
- If a lather forms – temporary hardness
- If no lather – permanent hardness

Response	Mark
Candidates must use appropriate specialist terms throughout to describe fully how a sample of water is tested for hardness and how to determine if the hardness is temporary or permanent (6–7 points from the indicative content above) in a logical sequence. They use good spelling, punctuation and grammar and the form and style are of a high standard.	[5]–[6]
Candidates use some appropriate specialist terms to describe how a sample of water is tested for hardness and/or how to determine if the hardness is temporary or permanent (3–5 points from the indicative content above) in a logical sequence. They use satisfactory spelling, punctuation and grammar and the form and style are of a satisfactory standard.	[3]–[4]
Candidates describe how to test a sample of water for hardness and/or how to determine if the hardness is temporary or permanent (1–2 points from the indicative content above) which may not be in a logical sequence. They use limited spelling, punctuation and grammar and they have made little use of specialist terms. The form and style are of a limited standard.	[1]–[2]
Response not worthy of credit	[0]

[6]

(b) (i) $CaCO_3 + CO_2 + H_2O \rightarrow Ca(HCO_3)_2$
[1] for correct formulae of reactants
[1] for correct formula of product [2]

(ii) calcium carbonate reacts with (rain)water [1]
containing dissolved carbon dioxide [1]
forming **soluble** calcium hydrogen carbonate/forms
calcium hydrogen carbonate **solution** [1] [3]

(iii) ion exchange [1]
addition of washing soda [1]
(allow distillation) [2]

13

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AVAILABLE MARKS

5 **(a)** **(i)** show **similar** chemical properties/differ by a CH_2 (unit/group) [1]

(ii)

Name of homologous series	General formula	Molecular formula of compound with three carbon atoms
Alkanes	C_nH_{2n+2} [1]	C_3H_8
Alkenes	C_nH_{2n}	C_3H_6 [1]

[2]

(iii) propane [1]

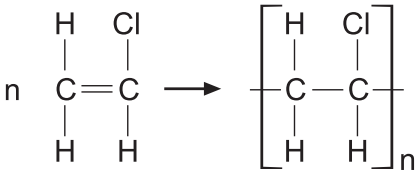
(b) **(i)** reaction of a fuel [1]
reaction with oxygen [1]
forming oxides [1]
and releasing heat [1]
max [3] [3]

(ii) $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$
[1] for correct formulae of reactants
[1] for correct formulae of products
[1] for correct balancing [3]

(c) **(i)** a reactive group in a molecule [1]

(ii) bromine water [1]
(changes from) red-brown/orange/yellow [1] to colourless [1] [3]

(d) **(i)**



[1] for correct structure of the monomer
[1] for n before the monomer structure
[1] for correct structure of the polymer in [ ] with bonds through the [ ]
[1] for repeat indicated in polymer [4]

(ii) more durable/does not rot [1]

(e) **(i)** methanol [1]

(ii) COOH/carboxyl accept carboxylic acid [1]

(iii) only contains carbon and hydrogen (atoms) [1]

(iv) **B** accept CH_3COOH/ethanoic acid [1]

23

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					AVAILABLE MARKS
6	**(a)**	**(i)**	$2AgNO_3 + Cu \rightarrow Cu(NO_3)_2 + 2Ag$ [1] for correct formulae of reactants [1] for correct formulae of products [1] for correct balancing	[3]	
		(ii)	silver indicated below copper	[1]	
		(iii)	blue	[1]	
		(iv)	copper is more reactive/higher in reactivity series [1] than silver [1]	[2]	
	(b)	**(i)**	1×10^{-9} **m or** other suitable idea of length, e.g. 1×10^{-6} **mm**	[1]	
		(ii)	unknown effects/absorbed through skin/discolour skin/allergic reaction/damage organs	[1]	
	(c)	**(i)**	A layer [1] of (aluminium) oxide [1] forms on surface of aluminium which prevents aluminium reacting [1]	[3]	
		(ii)	aluminium + copper(II) oxide → aluminium oxide + copper [1] for reactants and [1] for products allow copper oxide for copper(II) oxide	[2]	14
7	**(a)**		$\frac{96\,[1]}{150\,[1]} \times 100 = 64$ [1] %	[3]	
	(b)		colourless [1] to pink [1] award [1] for wrong way round	[2]	
	(c)	**(i)**	pipette	[1]	
		(ii)	burette	[1]	
		(iii)	cannot see **the colour** change of the indicator in red wine	[1]	
	(d)	**(i)**	19.0 [2] cm^3 allow 19[1]cm^3 use of rough gives 19.33 [1]	[2]	
		(ii)	$\frac{19 \times 0.1}{1000}$ [1] = 0.0019 [1]	[2]	
		(iii)	$\frac{0.0019}{2}$ [1] = 0.00095 (9.5×10^{-4}) [1]	[2]	
		(iv)	$\frac{0.00095 \times 1000}{25}$ [1] = 0.038 [1] mol/dm^3	[2]	
		(v)	$0.038 \times 150 = 5.7$ [1] g/dm^3	[1]	17
			Apply consequential marking throughout **(d)**		
				Total	**115**

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Rewarding Learning

Centre Number

Candidate Number

General Certificate of Secondary Education
2013

Science: Chemistry

Unit C2

Higher Tier

[GCH22]

GCH22

THURSDAY 20 JUNE, AFTERNOON

TIME

1 hour 45 minutes.

INSTRUCTIONS TO CANDIDATES

Write your Centre Number and Candidate Number in the spaces provided at the top of this page.
You must answer the questions in the spaces provided. Do not write outside the box, around each page or on blank pages.
Complete in blue or black ink only. **Do not write with a gel pen**.
Answer **all** questions.

INFORMATION FOR CANDIDATES

The total mark for this paper is **115**.
Figures in brackets printed down the right-hand side of pages indicate the marks awarded to each question or part question.
Quality of written communication will be assessed in question **5(a)**.
A Data Leaflet, which includes a Periodic Table of the Elements, is included in this question paper.

7952

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Examiner Only	
Marks	Remark

1 Fireworks contain the three ingredients shown in the box below.

colouring agent
fuel
oxidiser

(a) Magnesium is often used in fireworks as the colouring agent.

(i) What is the colour of the flame observed when magnesium burns?

_____ [1]

(ii) Write a balanced symbol equation for magnesium burning in air.

_____ [3]

(b) Carbon in the form of charcoal is often used as the fuel in fireworks.

(i) What is observed when a sample of carbon burns?

_____

_____

_____ [2]

(ii) Name the product formed when carbon burns in a limited supply of oxygen.

_____ [1]

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(c) Oxidisers provide the oxygen needed to allow the firework to burn effectively. A common oxidiser is potassium nitrate, which thermally decomposes to produce potassium oxide, nitrogen and oxygen.

Write a balanced symbol equation for this reaction.

_____ [3]

(d) Sparklers are hand held fireworks which contain a fuel, an oxidiser and iron powder. Often the iron powder is mixed with linseed oil to prevent it rusting.

(i) What conditions are required for iron to rust?

_____

_____ [2]

(ii) What is the chemical name for rust?

_____ [2]

Examiner Only	
Marks	Remark

[Turn over



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(e) In industry, iron is manufactured in the Blast Furnace.

A redox reaction which occurs in the Blast Furnace is given below:

$$Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$$

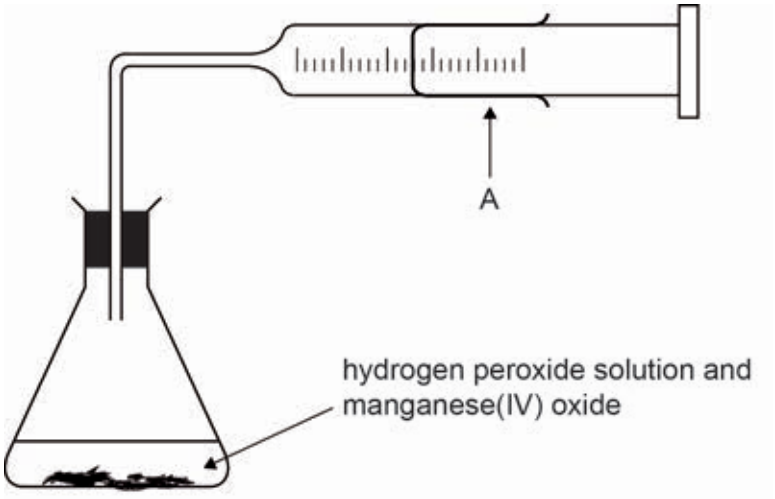
Explain fully, in terms of change in oxygen content, why this reaction is described as a redox reaction.

[5]

Examiner Only	
Marks	Remark
Total Question 1	

Examiner Only	
Marks	Remark

2 **(a)** The rate of decomposition of a solution of hydrogen peroxide using manganese(IV) oxide (manganese dioxide) can be measured using the apparatus shown below. The manganese(IV) oxide is a catalyst for the reaction.



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(i) Name the piece of apparatus labelled A.

_____ [1]

(ii) What is meant by the term catalyst?

_____

_____

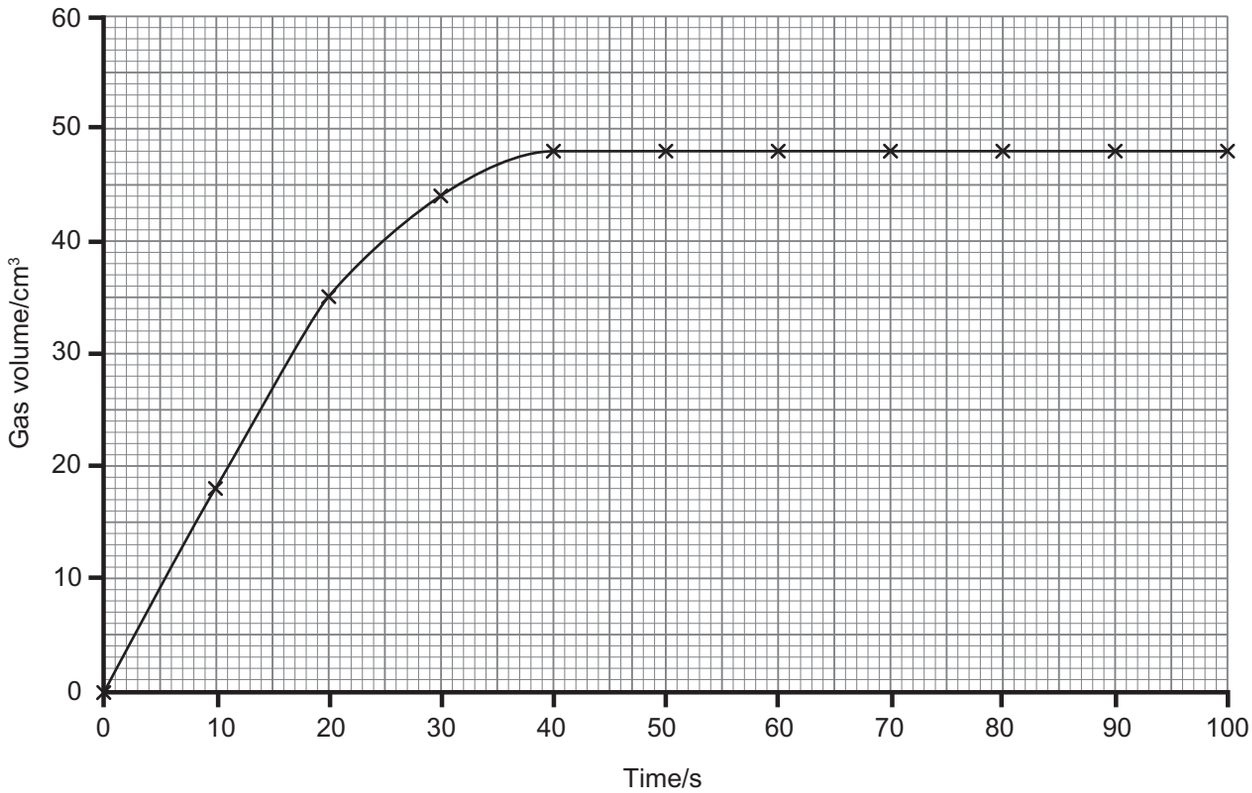
_____ [3]

(iii) Write a balanced symbol equation for the decomposition of hydrogen peroxide.

_____ [3]

[Turn over

(b) The graph below shows data obtained at 25 °C using 25.0 cm^3 of 0.16 mol/dm^3 hydrogen peroxide solution with 1.0 g of solid powdered manganese(IV) oxide.



(i) Apart from the apparatus shown in the diagram in part **(a)**, name one other piece of equipment which would be required to collect the results used to draw the graph.

_____ [1]

(ii) What was the total volume of gas collected?

_____ [1]

(iii) The reaction was repeated at 40 °C with all other factors being kept the same. Sketch the graph you would expect to obtain on the axes above. [3]

Examiner Only	
Marks	Remark

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(c) The table below shows the time taken for the decomposition of hydrogen peroxide solution to be completed. 25.0 cm^3 of 0.16 mol/dm^3 hydrogen peroxide solution was used with 1.0 g of different powdered metal oxides as catalysts.

Metal oxide	Time for decomposition to be completed/s	Rate of decomposition/s^{-1} rate = $\left(\frac{1}{\text{time}}\right)$
Manganese(IV) oxide		
Copper(II) oxide	127	0.00787
Zinc oxide	360	0.00277

(i) Using the graph at 25 °C in part **(b)**, complete the table above. [2]

(ii) State which of the metal oxides in the table is the **least** effective catalyst and explain your answer.

_____

_____

_____

_____ [2]

Examiner Only	
Marks	Remark
Total Question 2	

[Turn over

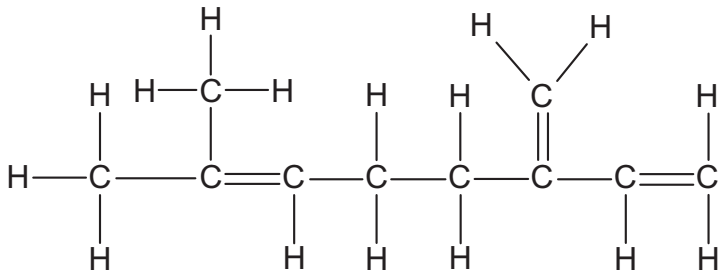
Examiner Only	
Marks	Remark

3 Perfume is a mixture of essential oils dissolved in a solvent. One of the essential oils used in making perfume is called myrcene.



© *iStockphoto / Thinkstock*

(a) The structural formula of a molecule of myrcene is shown below.



(i) Explain why a molecule of myrcene can be classified as a hydrocarbon.

_____

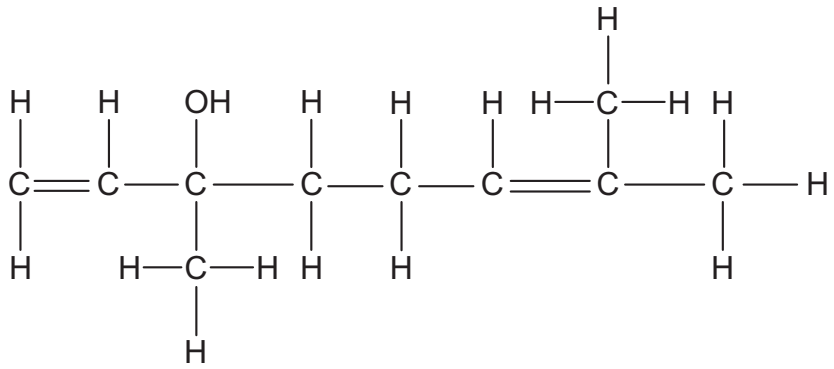
_____ [1]

(ii) Identify the functional group present in myrcene.

_____ [1]

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(b) Linalool is another essential oil used in perfume making. It gives a sweet, lavender-like smell. The structural formula of linalool is shown below.



(i) On the structure of linalool shown above, draw a circle around the **alcohol** functional group. [1]

(ii) Like all alcohols, linalool ($C_{10}H_{17}OH$) undergoes complete combustion in excess air. Complete and balance the symbol equation below for this reaction.

$C_{10}H_{17}OH + \quad O_2 \longrightarrow$ [2]

(iii) When linalool is warmed with acidified potassium dichromate solution it is oxidised in the same way as ethanol. State the colour change which is observed in this reaction.

from _____ to _____ [2]

Examiner Only	
Marks	Remark

[Turn over

(c) Ethanol is an alcohol which is often used as a solvent in perfumes.

Examiner Only	
Marks	Remark

(i) Write the general formula for alcohols.

_____ [1]

(ii) Draw the structural formula of ethanol.

[1]

(iii) Ethene can be used to manufacture the ethanol used in perfumes. Complete the table below to give information about ethene.

Name	Molecular formula	Structural formula	State at room temperature and pressure
Ethene			

[3]

(d) Ethanoic acid is a carboxylic acid which can be used to make other solvents. These solvents are also used in perfumes.

(i) Draw the structural formula of ethanoic acid.

[1]

(ii) State two observations you would make when magnesium reacts with ethanoic acid.

_____

_____

_____ [2]

(iii) Write a balanced symbol equation for the reaction of magnesium with ethanoic acid.

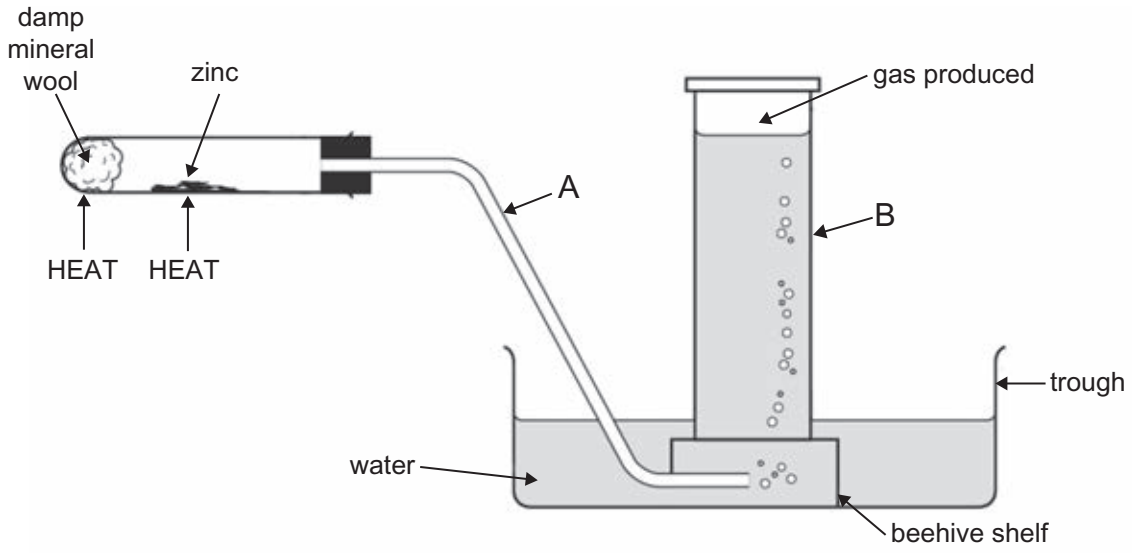
_____ [3]

Examiner Only	
Marks	Remark
Total Question 3	

Examiner Only	
Marks	Remark

4 Metals may be placed in a reactivity series by observing their reactions with air, water, steam and dilute acid.

(a) The apparatus below may be used to react zinc metal with steam.



© *Barking Dog Art*

(i) What labels should be placed at A and B on the diagram?

A _____

B _____ [2]

(ii) Explain why the damp mineral wool is heated.

_____ [1]

(iii) Name the gas produced in this experiment.

_____ [1]

(iv) Name a metal which does not react when heated with steam.

_____ [1]

(b) X is an unknown metal. The table below gives details of some reactions of the three metals X, sodium and zinc.

Metal	Reaction when heated in oxygen	Reaction with cold water	Reaction with dilute hydrochloric acid
X	Black coating forms on metal without burning	No reaction	No reaction
Sodium	Burns very vigorously with a yellow flame		Dangerous reaction not carried out in school laboratory
Zinc	Burns forming a yellow solid which changes to white on cooling	No reaction	Reacts steadily

(i) Suggest the name of metal X.

_____ [1]

(ii) Describe what you would observe when sodium reacts with cold water.

_____

_____

_____

_____

_____ [3]

(iii) Write a balanced symbol equation for the reaction of sodium with water.

_____ [3]

Examiner Only

Marks	Remark

[Turn over

(c) Aluminium is a metal which is extracted from its ore (bauxite) by electrolysis.

(i) What is meant by the term electrolysis?

_____

_____ [2]

(ii) What is the name of the **purified** bauxite which is used in the production of aluminium by electrolysis?

_____ [1]

(iii) Write a half equation to represent the production of aluminium during this electrolysis process.

_____ [3]

(iv) At what temperature is this electrolysis carried out?

_____ [1]

(v) Explain why the carbon anodes need to be replaced periodically during this electrolysis.

_____

_____

_____

_____ [3]

Examiner Only	
Marks	Remark
Total Question 4	

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5 Alkaline batteries contain one particular metal hydroxide. The metal hydroxide can be represented as MOH.



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3.92 g of this solid metal hydroxide were dissolved in 1000 cm^3 of deionised water in a volumetric flask. 25.0 cm^3 of this solution were placed in a conical flask using a pipette.

(a) Describe in detail how you would prepare and use a pipette to transfer 25.0 cm^3 of the MOH solution into a conical flask, ensuring accuracy and safety.

In this question you will be assessed on using your written communication skills including the use of specialist scientific terms.

[6]

Examiner Only	
Marks	Remark

[Turn over

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Examiner Only	
Marks	Remark

(b) 25.0 cm^3 of the MOH solution were titrated with hydrochloric acid of concentration 0.125 mol/dm^3 using phenolphthalein indicator. The results are shown in the table below.

	Initial burette volume/cm^3	**Final burette volume/cm^3**	**Titre/cm^3**
Rough titration	0.0	14.9	14.9
First accurate titration	14.9	28.9	14.0
Second accurate titration	28.9	42.9	14.0

(i) Calculate the average titre.

_____ cm^3 [2]

(ii) State the colour change at the end-point.

From _____ to _____ [2]

(iii) Calculate the number of moles of hydrochloric acid used in the titration.

_____ [2]

The balanced symbol equation for the reaction is:

$$MOH + HCl \rightarrow MCl + H_2O$$

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(iv) Calculate the number of moles of MOH present in 25.0 cm^3 of the solution in the conical flask.

_____ [1]

(v) Calculate the number of moles of MOH present in 1000 cm^3 of the solution.

_____ [2]

(vi) Using the fact that 3.92 g of MOH were dissolved in 1000 cm^3 and the answer to question **(b)(v)** above, determine the relative formula mass of MOH.

_____ [2]

Examiner Only	
Marks	Remark

[Turn over

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(vii) Determine the relative atomic mass of M using your answer to question **(b)(vi)**.
(Relative atomic masses: H = 1; O = 16)

_____ [2]

(viii) Identify the metal, M.

_____ [1]

Examiner Only	
Marks	Remark
Total Question 5	

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Examiner Only	
Marks	Remark

6 **(a)** An investigation was carried out to compare the hardness of water samples from three towns A, B and C.

$25\,cm^3$ of each water sample were placed into three separate conical flasks and labelled A, B and C. A sample of deionised water was also tested.

Soap solution was added, $1\,cm^3$ at a time, to each conical flask with shaking until a lasting lather formed. The total volume of soap solution added to each flask was recorded.

The experiment was repeated with fresh samples of A, B and C which had been boiled and allowed to cool, before adding the soap solution.

The results are shown in the table below.

Water sample	Volume of soap solution required to form a lather	
	before boiling (cm^3)	after boiling (cm^3)
Deionised water	2	2
A	6	6
B	8	2
C	11	7

(i) Which of the three water samples (A, B or C) is the hardest water?

_____ [1]

(ii) Which of the three water samples (A, B or C) contains **only** temporary hardness?

_____ [1]

(iii) Which of the three water samples (A, B or C) contains both temporary and permanent hardness?

_____ [1]

[Turn over



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(b) Permanent hardness may be removed from water by the addition of washing soda. Explain, in terms of ions, how washing soda can soften hard water.

_____

_____

_____

_____

_____

_____

_____ [3]

(c) State two disadvantages of hard water.

1. _____

_____

2. _____

_____ [2]

Examiner Only	
Marks	Remark
Total Question 6	

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Examiner Only	
Marks	Remark

7 Nitrogenous fertilisers contain ammonium compounds such as ammonium nitrate which is produced when ammonia reacts with nitric acid.

(a) (i) Write a balanced symbol equation for the reaction of ammonia with nitric acid.

_____ [2]

(ii) Describe how you would carry out a chemical test for the presence of ammonia gas, stating the observations you would make for a positive test.

_____

_____

_____

_____

_____ [4]

(iii) State one disadvantage of using nitrogenous fertilisers.

_____ [1]

(b) In industry ammonia gas is produced by the Haber process which involves a reversible reaction between the gases nitrogen and hydrogen.

$$N_2 + 3H_2 \rightleftharpoons 2NH_3$$

(i) Explain what you understand by the term reversible reaction.

_____ [1]

(ii) Name the catalyst used in the Haber process.

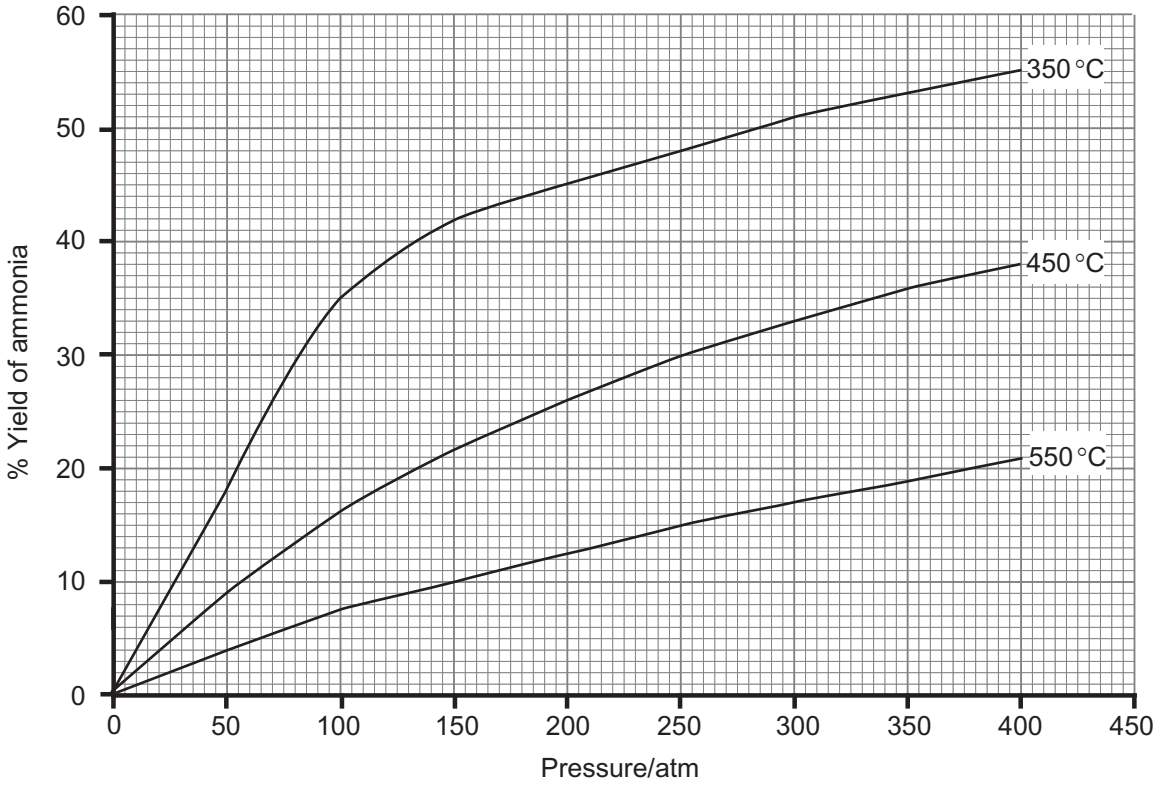
_____ [1]

[Turn over

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Examiner Only	
Marks	Remark

(c) The percentage yield of ammonia produced in the Haber Process is affected by both the temperature and the pressure. The graph below shows how the percentage yield of ammonia changes with temperature and pressure.



Use the graph to answer the following questions.

(i) State the effect of increasing temperature on the yield of ammonia at constant pressure.

_____

_____ [1]

(ii) 450 °C and 250 atm are commonly used conditions for the Haber Process. What is the percentage yield of ammonia using these conditions?

_____ [1]

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(iii) Suggest why industry uses 450 °C and 250 atm when it is possible to obtain a higher yield of ammonia using a lower temperature and a higher pressure.

_____

_____

_____ [1]

Examiner Only	
Marks	Remark
Total Question 7	

THIS IS THE END OF THE QUESTION PAPER

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Question Number	Marks
1	
2	
3	
4	
5	
6	
7	
QWC	
Total Marks	

Examiner Number

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Rewarding Learning

General Certificate of Secondary Education
2013

Science: Chemistry

Unit C2

Higher Tier

[GCH22]

THURSDAY 20 JUNE, AFTERNOON

MARK SCHEME

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General Marking Instructions

Introduction

Mark schemes are published to assist teachers and students in their preparation for examinations. Through the mark schemes teachers and students will be able to see what examiners are looking for in response to questions and exactly where the marks have been awarded. The publishing of the mark schemes may help to show that examiners are not concerned about finding out what a student does not know but rather with rewarding students for what they do know.

The Purpose of Mark Schemes

Examination papers are set and revised by teams of examiners and revisers appointed by the Council. The teams of examiners and revisers include experienced teachers who are familiar with the level and standards expected of students in schools and colleges.

The job of the examiners is to set the questions and the mark schemes; and the job of the revisers is to review the questions and mark schemes commenting on a large range of issues about which they must be satisfied before the question papers and mark schemes are finalised.

The questions and the mark schemes are developed in association with each other so that the issues of differentiation and positive achievement can be addressed right from the start. Mark schemes, therefore, are regarded as part of an integral process which begins with the setting of questions and ends with the marking of the examination.

The main purpose of the mark scheme is to provide a uniform basis for the marking process so that all the markers are following exactly the same instructions and making the same judgements in so far as this is possible. Before marking begins a standardising meeting is held where all the markers are briefed using the mark scheme and samples of the students' work in the form of scripts. Consideration is also given at this stage to any comments on the operational papers received from teachers and their organisations. During this meeting, and up to and including the end of the marking, there is provision for amendments to be made to the mark scheme. What is published represents this final form of the mark scheme.

It is important to recognise that in some cases there may well be other correct responses which are equally acceptable to those published: the mark scheme can only cover those responses which emerged in the examination. There may also be instances where certain judgements may have to be left to the experience of the examiner, for example, where there is no absolute correct response – all teachers will be familiar with making such judgements.

					AVAILABLE MARKS
1	**(a)**	**(i)**	white	[1]	
		(ii)	$2Mg + O_2 \rightarrow 2MgO$ [1] for correct formulae of reactants [1] for correct formula of product [1] for correct balancing	[3]	
	(b)	**(i)**	• black solid (at beginning) [1] • flame/glows/sparks [1] appropriate colour [1] • sooty/smoky [1] • (white/grey) ash formed/no solid remaining [1] • heat released [1]	**max** [2]	
		(ii)	carbon monoxide	[1]	
	(c)		$4KNO_3 \rightarrow 2K_2O + 5O_2 + 2N_2$ [1] for correct formula of reactant [1] for correct formulae of products [1] for correct balancing	[3]	
	(d)	**(i)**	water/moisture [1] air/oxygen [1]	[2]	
		(ii)	hydrated [1] iron(III) oxide [1]	[2]	
	(e)		**iron oxide** loses oxygen [1] reduction is loss of oxygen [1] **carbon monoxide** gains oxygen [1] oxidation is the gain of oxygen [1] redox is oxidation and reduction occurring simultaneously [1]	[5]	19

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					AVAILABLE MARKS
2	(a)	(i)	**gas** syringe	[1]	
		(ii)	substance which increases [1] the **rate of a (chemical) reaction** [1] without being used up/without being chemically changed **at the end** [1]	[3]	
		(iii)	$2H_2O_2 \rightarrow 2H_2O + O_2$ [1] for correct formula of reactant [1] for correct formulae of products [1] for correct balancing	[3]	
	(b)	(i)	any second accurate timing device, e.g. (stop)clock/(stop)watch	[1]	
		(ii)	48 (cm^3)	[1]	
		(iii)	starts at (0,0) and remains higher throughout/steeper gradient [1] finishes at same gas volume/48 cm^3 [1] finishes in less time/earlier [1]	[3]	
	(c)	(i)	time is 38–40 [1] rate is 0.02631 to 0.025 [1]	[2]	
		(ii)	zinc oxide [1] largest time/smallest or lowest rate [1] second mark dependent on first mark	[2]	16

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AVAILABLE MARKS

3 **(a)** **(i)** (the molecule of myrcene) contains **only** carbon and hydrogen [1]

(ii) C═C [1]

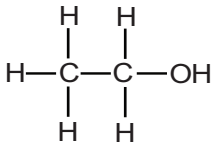
(b) **(i)** OH group identified [1]

(ii) $C_{10}H_{17}OH + 14\ O_2 \rightarrow 10\ CO_2 + 9\ H_2O$
[1] for correct formulae of products
[1] for balancing [2]

(iii) orange [1] to green [1] [2]

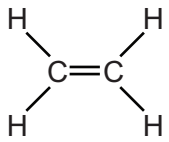
(c) **(i)** $C_nH_{2n+1}OH$ [1]

(ii)



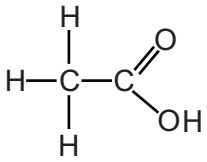
[1]

(iii)

Name	Molecular formula	Structural formula	State at room temperature and pressure
Ethene	C_2H_4 [1]	 [1]	gas [1]

[3]

(d) **(i)**



[1]

(ii) bubbles/effervescence [1]
magnesium disappears [1]
heat released [1]
colourless solution remains [1] **max** [2]

(iii) $Mg + 2CH_3COOH \rightarrow (CH_3COO)_2Mg + H_2$ [3]

18

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					AVAILABLE MARKS
4	(a)	(i)	A delivery tube [1] B gas jar [1]	[2]	
		(ii)	generate steam	[1]	
		(iii)	hydrogen	[1]	
		(iv)	copper/silver/gold/platinum/palladium	[1]	
	(b)	(i)	copper	[1]	
		(ii)	any **three** from: floats/on surface moves about melts to form a silvery ball fizzing/gas produced colourless solution formed metal disappears heat released	[3]	
		(iii)	$2Na + 2H_2O \rightarrow 2NaOH + H_2$ [1] for correct formulae of reactants [1] for correct formulae of products [1] for correct balancing	[3]	
	(c)	(i)	decomposition [1] using (a direct current of) electricity [1]	[2]	
		(ii)	alumina	[1]	
		(iii)	$Al^{3+} + 3e^- \rightarrow Al$ [1] for Al^{3+} and e^- on left hand side [1] for Al on right hand side [1] for correct balancing of electrons	[3]	
		(iv)	900–1000 °C	[1]	
		(v)	anode/carbon reacts with oxygen [1] forming carbon dioxide [1] carbon anodes are worn away [1]	[3]	22

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AVAILABLE MARKS

5 (a) Indicative content

safety
- pipette filler used

rinse
- pipette rinsed with (deionised) water
- pipette rinsed with MOH solution

filling
- fill with MOH solution
- until **bottom of meniscus** on the line

transfer
- release into conical flask
- touch tip of pipette onto surface of liquid

Accept alternative appropriate responses

Response	Mark
Candidates must use appropriate specialist terms throughout to discuss fully the preparation and use of a pipette with regard to safety and accuracy in a logical sequence **(6–7 points)**. They use good spelling, punctuation and grammar and the form and style are of a high standard.	[5]–[6]
Candidates use some appropriate specialist terms to discuss the preparation and use of a pipette with regard to safety and accuracy **(3–5 points)**. They use satisfactory spelling, punctuation and grammar and the form and style are of a satisfactory standard.	[3]–[4]
Candidates describe the preparation and use of a pipette with regard to safety and accuracy which may not be in a logical sequence **(using a minimum of 2 points)**. They use limited spelling, punctuation and grammar and form and style are of a limited standard.	[1]–[2]
Response not worthy of credit	[0]

[6]

(b) (i) 14.0 [2] [2]
award [1] for 14.3 which includes use of rough titration value

(ii) pink [1] to colourless [1] [2]
(wrong way round [1])

(iii) $\frac{14 \times 0.125}{1000}$ [1] = 0.00175 [1] [2]

(iv) 0.00175 [1]

(v) 0.00175 × 40 [1] = 0.07 [1] [2]

(vi) $\frac{3.92}{0.07}$ [1] = 56 [1] [2]

(vii) OH = 17 [1]
M = 56 – 17 = 39 [1] [2]

(viii) potassium/K [1]

20

					AVAILABLE MARKS
6	**(a)**	**(i)**	C	[1]	
		(ii)	B	[1]	
		(iii)	C	[1]	
	(b)		Ca^{2+}/calcium ions/Mg^{2+}/magnesium ions react [1] reaction with CO_3^{2-}/carbonate ions [1] forming insoluble/solid $CaCO_3$/magnesium carbonate [1]	[3]	
	(c)		• wastes soap • produces limescale in kettles/hot water pipes/irons etc. • qualified cost (more electricity used, purchase of ion exchanger/ dishwasher salt) • forms scum with soap	**max** [2]	8
7	**(a)**	**(i)**	$NH_3 + HNO_3 \rightarrow NH_4NO_3$	[2]	
		(ii)	dip glass rod [1] into concentrated hydrochloric acid [1] apply to gas white [1] smoke/solid [1]	[4]	
		(iii)	blue baby syndrome/stomach cancer/eutrophication	[1]	
	(b)	**(i)**	idea that reaction can move from right to left as well as from left to right	[1]	
		(ii)	iron	[1]	
	(c)	**(i)**	decreases	[1]	
		(ii)	30%	[1]	
		(iii)	compromise between temperature and pressure/rate and yield/ catalyst does not work at low temperatures/pressure expensive to apply	[1]	12
				Total	**115**

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