Rewarding Learning

General Certificate of Secondary Education

Chemistry

Unit 3: Practical Skills
Practical Booklet B
Higher Tier

[GCM34]

Assessment

MARK SCHEME

General Marking Instructions

Introduction

Mark schemes are intended to ensure that the GCSE examinations are 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 which they should apply in allocating marks to candidates' responses.

Assessment objectives

Below are the assessment objectives for GCSE Chemistry.

Candidates must:

AO1 Demonstrate knowledge and understanding of:
- scientific ideas;
- scientific techniques and procedures.

AO2 Apply knowledge and understanding of and develop skills in:
- scientific ideas;
- scientific enquiry, techniques and procedures.

AO3 Analyse scientific information and ideas to:
- interpret and evaluate;
- make judgements and draw conclusions;
- develop and improve experimental procedures.

Quality of candidates' responses

In marking the examination papers, examiners should be looking for a quality of 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, then examiners should seek the guidance of the Supervising Examiner.

Positive marking

Examiners are encouraged to be positive in their marking, giving appropriate credit for what candidates know, understand and can do rather than penalising candidates for errors or omissions. The exception to this for GCSE Chemistry is when examiners are marking complex calculations when the examiners are briefed to mark by error or omission. Examiners should make use of the whole of the available mark range for 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.

Marking Calculations

In marking answers involving calculations, examiners should apply the 'carry error through' rule so that candidates are not penalised more than once for a computational error. To avoid a candidate being penalised, marks can be awarded where correct conclusions or inferences are made from their incorrect calculations.

Types of mark schemes

Mark schemes for tasks or 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.

Levels of response

In deciding which level of response to award, examiners should look for the number of indicative content points in candidate responses to ensure that the answer has been written to coincide with the question. In deciding which mark within a particular level to award to any response, quality of communication will be assessed and examiners are expected to use their professional judgement.

The following guidance is provided to assist examiners.

- ***Threshold performance:*** Response which just merits inclusion in the level and should be awarded a mark at or near the bottom of the range.
- ***High performance:*** Response which fully satisfies the level description and should be awarded a mark at or near the top of the range.

Quality of written communication

Quality of written communication is taken into account in assessing candidates' responses to all tasks and questions that require them to respond in extended written form. These tasks and questions are marked on the basis of bands of response. The description for each band of response includes reference to the quality of written communication.

For conciseness, quality of written communication is distinguished within bands of response as follows:

Band A: Quality of written communication is excellent.
Band B: Quality of written communication is good.
Band C: Quality of written communication is basic.
Band D: Response not worthy of credit

In interpreting these band descriptions, examiners should refer to the more detailed guidance provided below:

Band A (Excellent): Excellent reference to scientific terminology. The candidate successfully selects and uses the most appropriate form and style of writing. Relevant material is organised with a high degree of clarity and coherence. There is widespread and accurate use of appropriate specialist vocabulary. Presentation, spelling, punctuation and grammar are of a sufficiently high standard to make meaning clear.

Band B (Good): Good reference to scientific terminology. The candidate makes a reasonable selection and use of an appropriate form and style of writing. Relevant material is organised with some clarity and coherence. There is some use of appropriate specialist vocabulary. Presentation, spelling, punctuation and grammar are sufficiently competent to make meaning clear.

Band C (Basic): Basic reference to scientific terminology. The candidate makes only a limited selection and use of an appropriate form and style of writing. The organisation of material may lack clarity and coherence. There is little use of specialist vocabulary. Presentation, spelling, punctuation and grammar may be such that intended meaning is not clear.

General marking guidance for GCSE Chemistry

1. Alternative responses

- A solidus (/) used in mark schemes indicates alternative answers. Where a solidus may be confused with part of the answer (for example as a division sign or as part of units) "or" may be used to show alternatives.

Example: What is meant by the term element? [1]
MS: A substance which contains only one type of atom/substance which cannot be broken down into anything simpler by chemical means [1]

- Either answer as a response would be acceptable. If both are given this is accepted.

2. Brackets in a response

- Normal parentheses used in a response means that a term is **not required** for the response to be marked correct.

Example: Name the chemical used to test for carbon dioxide. [1]
MS: limewater/calcium hydroxide (solution) [1]

Response	Candidate Response	Marks awarded	Notes
1	limewater	1	Correct response
2	calcium hydroxide	1	Correct response
3	calcium hydroxide solution	1	Correct response

- Calcium hydroxide on its own is an acceptable response to this question as the focus is on the chemical as opposed to solution.
- *Note that in a practical style question, solution may be expected if the candidate chooses to describe limewater as "calcium hydroxide solution".*

3. Marking of lists

- Where candidates give extra responses, additional correct responses can be ignored.
- Additional neutral responses can also be ignored. A neutral response is one which does not have a bearing on the question but is not incorrect.
- Additional incorrect responses **cancel out** a correct response to the marking point to which they pertain.

Example: Name the ore from which iron is extracted. [1]
MS: haematite [1]

Response	Candidate Response	Marks awarded	Notes
1	haematite (bauxite)	0	Bauxite is incorrect
2	haematite (iron oxide)	1	Iron oxide is a neutral answer
3	iron oxide	0	Not the correct answer
4	iron(III) oxide	0	Not the correct answer
5	haematite (iron(III) oxide)	1	Iron(III) oxide is a neutral answer
6	Bauxite (iron(III) oxide)	0	Bauxite is incorrect

4. Marking values where a range is given

- Where a numerical range is given, correct responses are any value in the range, the range itself or any other range given which falls within the MS range.

Example: What is the pH of a solution of hydrochloric acid? [1]
MS: 0–2 [1]

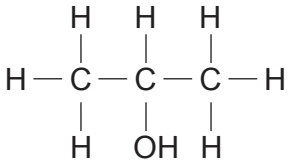
Response	Candidate Response	Marks awarded	Notes
1	0	1	A single value within the accepted range
2	1.5	1	A single value within the accepted range
3	2	1	A single value within the accepted range
4	0-2	1	The accepted range
5	1-2	1	A range given within the accepted range
6	1-3	0	Range given outside the accepted range
7	2.5	0	A single value not within the accepted range

5. Names and chemical formulae

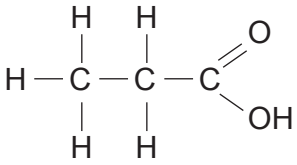
(a) Names, formulae and identification

- If a candidate writes a symbol for an element or chemical formula to **identify** an element or compound this can be marked correct **unless** a name is specifically required as detailed in the question.
- If the command word "*Identify*" is used, a candidate may provide either the name or symbol/formula. When the command word "*Name*" is used, only the correct name will be awarded the mark.

Example: Name compounds E and F.



E



F [2]

MS: E = propan-2-ol [1]
F = propanoic acid [1] [2]

Chemical formulae for these compounds would **not** be accepted as the command word is "***name***". With names such as these the full name with number and dashes for propan-2-ol is required.

(b) Both name and formula provided by candidate

- If a name is required and a candidate gives both a name and a chemical formula, the formula can be ignored even if it is incorrect.
- If a name is required and a candidate gives an incorrect name and a correct chemical formula the answer must be marked wrong.
- If a formula is required and both the name and formula are given, the name can be ignored even if it is incorrect.

Example: Name the salt produced when sodium hydroxide reacts with hydrochloric acid. [1]
MS: sodium chloride [1]

Response	Candidate Response	Marks awarded	Notes
1	sodium chloride $NaCl_2$	1	Incorrect formula ignored
2	sodium chlorate NaCl	0	Name is incorrect

(c) Formula asked for but equation containing the correct formula given

- If a question asks for a formula and the candidate writes an equation on the answer line, then even if the formula in that equation is correct there is no credit because the candidate has not answered the question correctly.

Example: Give the formula of the salt formed when magnesium reacts with nitric acid. [1]
MS: $Mg(NO_3)_2$ [1]

- A response such as: $Mg + 2HNO_3 \rightarrow Mg(NO_3)_2 + H_2$
  would not be credited because the candidate has provided an equation (with four formulae).

(d) Oxidation states

- Where an element has variable oxidation states, the oxidation state should be given where this is indicated in the mark scheme. However, with copper(II) compounds, the (II) can be omitted in the name.
- Where an element has variable oxidation states and a name is required, the oxidation state should be given, e.g. iron(III) oxide; iron(II) chloride; iron(III) hydroxide etc.
- Where an element is not normally given with its oxidation state but one is given by candidates, this must be correct, e.g. zinc(II) bromide for $ZnBr_2$ is correct but zinc(I) bromide is incorrect.

Example: Name the catalyst used in the decomposition of hydrogen peroxide. [1]
MS: manganese(IV) oxide/manganese dioxide [1]

- Manganese oxide would not be accepted.
- The (IV) is required unless manganese dioxide is given.
- Where an oxidation state is required, an incorrect oxidation state, such as manganese(II) oxide, would be incorrect.
- Manganese(IV) dioxide would also be incorrect.

6. Marking equations

Some general points about formulae and equations:

- A missing → in any equation is penalised by 1 mark.
- Mark the equation on the line or the equation closest to the line if several are given and not crossed out.
- Do **not** penalise a cursive A (for example for Al) or N (for example for N or Na).
- Do **not** penalise lower case single symbols such as S or O unless it is **extremely** clear that it is lower case.
- Penalise use of capital letter for second letter of element symbols: CL is incorrect if it is a clear right-angle capital; NA is incorrect even if the A is smaller.
- Only penalise letter errors once in an equation (or even in a paper) if a symbol is repeated so mark the equation as normal but penalise 1 mark if there is a very clear symbol error which would appear on both sides of the equation.
- Ignore state symbols, unless they are asked for in the question, even if incorrect.
- For standalone formulae of ionic compounds or when written in an equation, two charges are acceptable, e.g. Na^+Cl^- is acceptable but Na^+Cl is **not** acceptable.
- A bracket is acceptable around a molecular ion even if only one is required, Na(OH) is accepted but a bracket is **not** accepted around a single element so $(H)_2O$ is **not** correct.

(a) Balanced symbol equations and ionic equations

- A balanced symbol equation or ionic equation without state symbols is either worth 2 marks or 3 marks. State symbols are an additional mark.
- Multiple or fractional balancing numbers which are correct are accepted.

(i) A 2 mark balanced symbol equation does not require balancing numbers.
[1] mark is awarded for the correct formula(e) of the reactants OR the correct formulae of the products.
[1] mark is awarded for the correct formula(e) of the other side of the equation AND the balancing.

(ii) A 3 mark balanced symbol equation requires balancing numbers.
[1] mark is awarded for the correct formula(e) of the reactants.
[1] mark is awarded for the correct formula(e) of the products.
The third mark, the balancing mark, is only available if all formulae are correct; if they are and balancing is correct, award [3] in total.

Example: Write a balanced symbol equation for the reaction of magnesium with sulfuric acid. [2]

MS: $Mg + H_2SO_4 \rightarrow MgSO_4 + H_2$ [2]

correct formulae of reactants (LHS) OR correct formulae of products (RHS) [1]
correct formula for other side of the equation AND balancing correct [1] [2]

- When considering the **first** mark only look at the formulae; ignore any balancing; if one side of the equation has the correct formula(e), the first mark is awarded.
- When considering the **second** mark look at the formulae on the other side of the equation (from that credited with the first mark) AND at the balancing – the second mark is only awarded if all the formula(e) are correct and the balancing is also correct.

Response	Candidate Response	Marks awarded	Notes
1	$Mg_2 + H_2SO_4 \rightarrow MgSO_4 + H_2O$	0	Both LHS and RHS of equation have incorrect formulae so no marks awarded.
2	$Mg_2 + H_2SO_4 \rightarrow 2MgSO_4 + H_2$	1	The RHS has both formulae correct so first mark is awarded; the LHS has an incorrect formula so second mark is not awarded.
3	$Mg + H_2SO_4 \rightarrow 2MgSO_4 + H_2$	1	The LHS has both formulae correct so first mark awarded; the RHS has both formulae correct but balancing is wrong overall so second mark is not awarded.
4	$2Mg + 2H_2SO_4 \rightarrow 2MgSO_4 + 2H_2$	2	All formulae correct; multiple balancing numbers do not negate the balancing mark.

(iii) A 3 mark balanced symbol equation requires balancing numbers.
The mark for balancing numbers is **dependent** on all the formulae being correct.

Example: Write a balanced symbol equation for the reaction between copper(II) carbonate and hydrochloric acid. [3]

MS: $CuCO_3 + 2HCl \rightarrow CuCl_2 + CO_2 + H_2O$
correct formulae of reactants (LHS) [1]
correct formulae of products (RHS) [1]
correct balancing [1] [3]

Response	Candidate Response	Marks awarded	Notes
1	$CuCO_3 + HCl \rightarrow CuCl_2 + CO_2 + H_2O$	2	LHS and RHS marks awarded but balancing mark not awarded.
2	$Cu_2CO_3 + 2HCl \rightarrow CuCl_2 + CO_2 + H_2O$	1	LHS mark not awarded as formula incorrect so balancing mark cannot be awarded. RHS mark awarded.
3	$CaCO_3 + 2HCl \rightarrow CaCl_2 + CO_2 + H_2O$	2	There is a symbol error in this equation so if Cu was correct on both sides it would be worth 3 marks but the single symbol error is penalised by 1 mark.
4	$CuCO_3 + HCl \quad CuCl_2 + H_2O + CO_2$	1	Equation is not balanced and the arrow is missing. 2 marks awarded for LHS and RHS but 1 error for missing arrow so worth 1 overall.

(b) Half equations

- Note that e is acceptable for e^-.
- Half equations marking details are provided within the mark schemes for each specific question and in general they are marked as follows:
  - correct atom/ion/molecule on LHS, with arrow and correct atom/ion/molecule on RHS [1]
  - $+e^-$ on the correct side (or $-e^-$ on the other side) [1]
  - correct balancing [1]

- Note that each mark is dependent on the previous one so if the first mark is not awarded the candidate scores zero.

Example: Write a half equation for the formation of oxygen during the electrolysis of dilute sulfuric acid. [1]

MS: $4OH^- \rightarrow O_2 + 2H_2O + 4e^-$

OH^- on LHS and O_2 and H_2O on RHS [1]

$+e^-$ on RHS (or $-e^-$ on LHS) [1]

correct balancing (if all formulae correct and e^- position correct) [1] [3]

Response	Candidate Response	Marks awarded	Notes
1	$4OH^- - 4e^- \rightarrow 2H_2O + O_2$	3	All marks awarded as correct with $-e^-$ on LHS.
2	$OH^- \rightarrow O_2 + H_2O$	1	First mark only awarded as e^- missing.
3	$4OH^- \rightarrow O_2 + 2H_2O$	1	First mark only awarded as e^- missing. Balancing numbers are correct for what is present but balancing mark is dependent on first and second mark being awarded.
4	$4OH^- + 4e^- \rightarrow O_2 + 2H_2O$	1	The first mark is awarded but as the electrons are in incorrect position with $+e^-$ on the LHS, the second mark is not awarded. The balancing mark is not awarded as it is dependent.
5	$2OH^- - 2e^- \rightarrow O_2 + H_2O$	2	First and second marks awarded but balancing is incorrect.

7. QWC

- Quality of written communication is marked using indicative content and a banded mark scheme.
- The initial marking is for the indicative content. The number of indicative content marks places a candidate in a specific band. The total marks awarded will be one of the two mark options in that band based on the standard of written communication.
- A typical banded grid from a mark scheme which would have 8 indicative content points is shown below:

Band	Response	Mark
A	Candidates must use appropriate specialist terms including a minimum of 7 points of indicative content. They use good spelling, punctuation and grammar and the form and style are of a high standard.	[5]–[6]
B	Candidates must use appropriate specialist terms including a minimum of 5 points of indicative content. They use satisfactory spelling, punctuation and grammar and the form and style are of a satisfactory standard.	[3]–[4]
C	Candidates provide a brief and partial response including a minimum of 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 a limited standard.	[1]–[2]
D	Response not worthy of credit.	[0]

[6]

- A candidate who provides 5 indicative content points is placed in band B and can be awarded 3 or 4 overall marks out of 6 for their response.
- Responses would normally only be given the lower mark in the band if there were multiple spelling, punctuation and grammar errors.

8. Marking calculations

- Any errors in a single calculation or between parts of a multipart calculation may be carried forward. ECF may be used to indicate where an error is carried forward. For example, the incorrect use of the ratio/no ratio used in a reacting mass calculation could be awarded 2 out of the 3 marks available, provided all other steps are carried out correctly.
- Full marks can be awarded for a correct numerical answer to any calculation even if no working out is shown **apart** from degree of hydration and empirical formula calculations for which working out is required.
- Candidates should avoid excessive rounding such as to 1 decimal place unless appropriate or when it does not greatly affect the answer to the question. Any required number of decimal places will be asked for in the question.
- Units are required where they are not provided at the end of an answer line.

Example: Calculate the mass of aluminium oxide formed when a sample of 2.42 g of aluminium is heated to constant mass.

The equation for the reaction is:

$4Al + 3O_2 \rightarrow 2Al_2O_3$ [3]

MS: moles of Al = $\frac{2.42}{27}$ = 0.0896 [1]

moles of Al_2O_3 = $\frac{0.0896}{2}$ = 0.0448 [1]

mass of Al_2O_3 = 0.0448 × 102 = 4.57 [1] g [3]

- Note that the space where the answer is to be written will have g at the end of the line so g after the final [1] as this is not required in the answer.
- The marks are allocated to the numerical answers at the end of each line, not the working out.
- Responses do not need to include “moles of Al” as it may be presented below the equation or just have “Al” or be clear from the layout of the answer.

Response	Candidate Response	Marks awarded	Notes
1	$Al = \frac{2.42}{27} = 0.1$ $Al_2O_3 = 0.05$ $Al_2O_3 = 0.05 \times 102 = 5.1\,g$	2	The rounding in the first line has a significant effect on the answer so the first mark is not awarded. The second and third marks are awarded as this rounding error is carried forward.
2	$Al = \frac{2.42}{27} = 0.09$ $Al_2O_3 = 0.045$ $Al_2O_3 = 0.045 \times 102 = 4.59\,g$	3	All marks are awarded as the rounding here does not have a significant effect on the answer.
3	moles of Al = 0.048 moles of Al_2O_3 = 0.024 mass of Al_2O_3 = 2.448 g	2	The first mark is not awarded but the second and third marks are awarded as the error is carried through
4	4.57	3	All marks are awarded for the correct numerical answer. Units are not required as they would be provided at the end of the answer line in the question.
5	moles of Al = 0.0896 moles of Al_2O_3 = 0.1792 mass of Al_2O_3 = 18.3 g	2	The ratio is not applied correctly here so the second mark is not awarded but the first and third steps in the calculation are carried out correctly.

9. Colours and colour changes

- The colours and colour changes are given in the mark schemes. Shades (such as light and dark) are ignored except where they are clearly part of the mark scheme.
- Incorrect colours with the correct colour will lose the mark as this is an example of listing.

10. Definitions

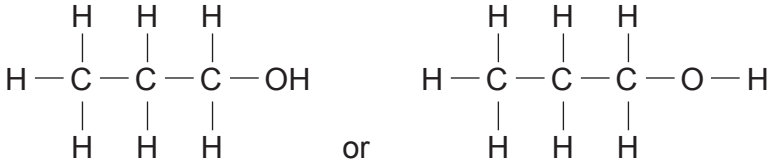
- Definitions are often worth 1 mark but those that have multiple parts are marked based on the distribution of marks detailed in the mark scheme.
- Minor errors with prepositions and conjunctions within the wording should not be penalised if they do not change the meaning of the answer given.

11. Organic structures

- Each organic structure is generally worth 1 mark.
- Any omission of a bond or an atom from the structure will lose the candidate the mark.
- Connectivity of atoms should only be penalised when it is very obviously wrong. This applies mostly to the OH group for alcohols.

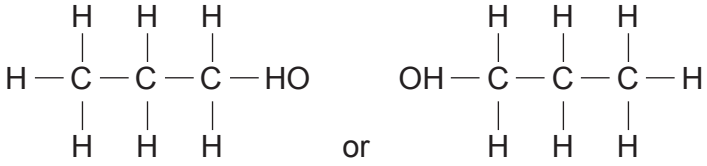
Example: Draw the structural formula of propan-1-ol. [1]

MS:



[1]

- The structures below would not be awarded the mark due to connectivity issues with the OH group.



[1]

- Note that the bond between the O and H is not required unless the question asks for all bonds to be shown.

12. Marking diagrams

- Diagrams of apparatus are expected to be two-dimensional cross-sectional diagrams of the apparatus where appropriate.
- The marks awarded for an apparatus diagram are usually based on 1 mark being awarded for each label of a recognisable piece of apparatus in an assembled diagram.
- **No labels = no marks.**
- In some diagrams a combination of pieces of apparatus is worth 1 mark such as a gauze on a tripod with a Bunsen burner/heat. All must be recognisable in a diagram of assembled apparatus and labelled correctly for the combined mark to be awarded.

					AVAILABLE MARKS
1	**(a)**	**(i)**	$NaOH(aq) + HCl(aq) \rightarrow NaCl(aq) + H_2O(l)$ correct formulae of reactants [1] correct formulae of products [1] correct state symbols [1]	[3]	
		(ii)	exothermic as highest temperature reached was recorded	[1]	
	(b)	**(i)**	poor conductor of heat/insulator/less heat lost to surroundings	[1]	
		(ii)	to ensure uniform temperature (of solution)/to mix reactants	[1]	
		(iii)	any **one** improvement from [1]: add a lid/insulate more (e.g. with cotton wool) place polystyrene cup in a beaker any **associated explanation** from [1]: prevent heat loss prevent toppling	[2]	
		(iv)	any **two** from: same concentration of acid same concentration of alkali same volume of acid same volume of alkali	[2]	
	(c)		moles of NaOH = $\frac{25 \times 1.0}{1000} = 0.025$	[1]	
	(d)	**(i)**	propanoic acid is a weak acid **and** hydrochloric acid is a strong acid	[1]	
		(ii)	propanoic acid + sodium hydroxide $\rightarrow$ sodium propanoate + water	[1]	
		(iii)	$H^+ + OH^- \rightarrow H_2O$ correct formulae of reactants [1] correct formula of product [1]	[2]	15

2 Indicative content

Graphite and titanium conduct electricity and sulfur, sodium chloride and iodine do not conduct electricity. [1]

graphite: delocalised electrons can move and carry charge [1]
titanium: delocalised electrons can move and carry charge [1]
sulfur: no charge carriers/no delocalised electrons or ions which can move (and carry charge) [1]
sodium chloride: ions cannot move (and carry charge) [1]
iodine: no charge carriers/no delocalised electrons or ions which can move (and carry charge) [1]

Band	Response	Mark
A	Candidates must use appropriate specialist terms to explain the conduction of electricity in these substances [5–6 indicative content points]. Relevant material is organised with a high degree of clarity and coherence. They must use excellent spelling, punctuation and grammar and the form and style are of a very high standard.	[5]–[6]
B	Candidates must use appropriate specialist terms to explain the conduction of electricity in these substances [3-4 indicative content points]. Relevant material is organised with some clarity and coherence. They use good spelling, punctuation and grammar and the form and style are of a satisfactory standard.	[3]–[4]
C	Candidates briefly explain the conduction of electricity in these substances [at least 2 indicative content points]. The organisation of material may lack clarity and coherence. They use limited spelling, punctuation and grammar and they have limited use of specialist terms. The form and style are of limited standard	[1]–[2]
D	A response not worthy of credit	[0]

[6]

AVAILABLE MARKS

6

			AVAILABLE MARKS
3	**(a)**	$CuCO_3 + 2HCl \rightarrow CuCl_2 + CO_2 + H_2O$ correct formulae of reactants [1] correct formulae of products [1] correct balancing [1] [3]	
	(b)	measure 25 cm^3 of hydrochloric acid using a measuring cylinder/pipette place hydrochloric acid in a suitable container [1] add copper(II) carbonate until in excess [1] filter [1] evaporate (filtrate) until reduced/half volume [1] allow to cool and crystallise [1] filter off the crystals [1] dry between two sheets of filter paper/in a desiccator/in a low temperature oven [1] (ignore any reference to heating the initial reaction) max [6]	
	(c)	nichrome wire [1] dipped in concentrated hydrochloric acid [1] place in a blue Bunsen burner flame [1] blue-green flame [1] [4]	
	(d)	white precipitate [1]	14

				AVAILABLE MARKS
4	(a)	(i)	some gas may escape before stopper in place/stopper may displace some air [1]	
		(ii)	A = conical flask [1] B = delivery tube [1] C = trough/basin [1] [3]	
	(b)		moles of calcium = $\frac{0.10}{40}$ = 0.0025 [1] moles of hydrogen = 0.0025 [1] volume of hydrogen = 0.0025 × 24000 = 60 [1] cm^3 100 cm^3 syringe as 50 cm^3 not large enough [1] [4]	
	(c)	(i)	manganese(IV) oxide/manganese dioxide [1] black [1] solid [1] (accept powder for solid) [3]	
		(ii)	colourless [1] solution/liquid [1] [2]	
		(iii)	relights a glowing splint [1]	14

5 **P** = acidified [1] potassium dichromate (solution) [1]
Q = limewater/calcium hydroxide (solution) [1]
R = bromine water [1]
S = concentrated [1] hydrochloric acid [1]
T = phenolphthalein [1] [7]

AVAILABLE MARKS
7

AVAILABLE MARKS

6 **(a)**

Substance	Colour
solid hydrated sodium carbonate	white [1]
sodium carbonate solution	colourless [1]

[2]

(b) pipette [1]

(c) burette [1]
conical flask below burette [1]
on a white tile [1]
sodium carbonate solution and methyl orange in conical flask [1]
hydrochloric acid in burette [1] max [4]

(d) moles of HCl = $\frac{24.5 \times 0.100}{1000}$ = 0.00245 [1]

moles of Na_2CO_3 = $\frac{0.00245}{2}$ = 0.001225 [1]

concentration of Na_2CO_3 solution = 0.001225 × 40 = 0.049 [1] mol/dm^3 [3]

(e) relative formula mass of $Na_2CO_3.xH_2O$ = $\frac{7.84}{0.049}$ = 160 [1]
water contribution to relative formula mass = 160 – 106 = 54 [1]

x = $\frac{54}{18}$ = 3 [1]
(working out must be shown) [3]

(f) heating to constant mass [1] 14

Total **70**