

Foundation

GCSE

Chemistry B Twenty First Century Science

J258/03: Breadth in Chemistry (Higher Tier)

General Certificate of Secondary Education

Mark Scheme for June 2023

OCR (Oxford Cambridge and RSA) is a leading UK awarding body, providing a wide range of qualifications to meet the needs of candidates of all ages and abilities. OCR qualifications include AS/A Levels, Diplomas, GCSEs, Cambridge Nationals, Cambridge Technicals, Functional Skills, Key Skills, Entry Level qualifications, NVQs and vocational qualifications in areas such as IT, business, languages, teaching/training, administration and secretarial skills.

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This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by examiners. It does not indicate the details of the discussions which took place at an examiners' meeting before marking commenced.

All examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the report on the examination.

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MARKING INSTRUCTIONS**PREPARATION FOR MARKING****RM ASSESSOR**

1. Make sure that you have accessed and completed the relevant training packages for on-screen marking: *RM Assessor Online Training*; *OCR Essential Guide to Marking*.
2. Make sure that you have read and understood the mark scheme and the question paper for this unit. These are available in RM Assessor.
3. Log-in to RM Assessor and mark the **required number** of practice responses (“scripts”) and the **required number** of standardisation responses.

MARKING

1. Mark strictly to the mark scheme.
2. Marks awarded must relate directly to the marking criteria.
3. The schedule of dates is very important. It is essential that you meet the RM Assessor 50% and 100% (traditional 50% Batch 1 and 100% Batch 2) deadlines. If you experience problems, you must contact your Team Leader (Supervisor) without delay.
4. If you are in any doubt about applying the mark scheme, consult your Team Leader by telephone, email or via the RM Assessor messaging system.
5. **Crossed Out Responses**
Where a candidate has crossed out a response and provided a clear alternative then the crossed out response is not marked. Where no alternative response has been provided, examiners may give candidates the benefit of the doubt and mark the crossed out response where legible.

Rubric Error Responses – Optional Questions

Where candidates have a choice of question across a whole paper or a whole section and have provided more answers than required, then all responses are marked and the highest mark allowable within the rubric is given. Enter a mark for each question answered into RM assessor,

which will select the highest mark from those awarded. (*The underlying assumption is that the candidate has penalised themselves by attempting more questions than necessary in the time allowed.*)

Multiple Choice Question Responses

When a multiple choice question has only a single, correct response and a candidate provides two responses (even if one of these responses is correct), then no mark should be awarded (as it is not possible to determine which was the first response selected by the candidate).

When a question requires candidates to select more than one option/multiple options, then local marking arrangements need to ensure consistency of approach.

Contradictory Responses

When a candidate provides contradictory responses, then no mark should be awarded, even if one of the answers is correct.

Short Answer Questions (requiring only a list by way of a response, usually worth only **one mark per response**)

Where candidates are required to provide a set number of short answer responses then only the set number of responses should be marked. The response space should be marked from left to right on each line and then line by line until the required number of responses have been considered. The remaining responses should not then be marked. Examiners will have to apply judgement as to whether a 'second response' on a line is a development of the 'first response', rather than a separate, discrete response. (*The underlying assumption is that the candidate is attempting to hedge their bets and therefore getting undue benefit rather than engaging with the question and giving the most relevant/correct responses.*)

Short Answer Questions (requiring a more developed response, worth **two or more marks**)

If the candidates are required to provide a description of, say, three items or factors and four items or factors are provided, then mark on similar basis – that is downwards (as it is unlikely in this situation that a candidate will provide more than one response in each section of the response space.)

Longer Answer Questions (requiring a developed response)

Where candidates have provided two (or more) responses to a medium or high tariff question which only required a single (developed) response and not crossed out the first response, then only the first response should be marked. Examiners will need to apply professional judgement as to whether the second (or a subsequent) response is a 'new start' or simply a poorly expressed continuation of the first response.

6. Always check the pages (and additional objects if present) at the end of the response in case any answers have been continued there. If the

candidate has continued an answer there then add a tick to confirm that the work has been seen.

7. Award No Response (NR) if:

- there is nothing written in the answer space.

Award Zero '0' if:

- anything is written in the answer space and is not worthy of credit (this includes text and symbols).

Team Leaders must confirm the correct use of the NR button with their markers before live marking commences and should check this when reviewing scripts.

8. The RM Assessor **comments box** is used by your Team Leader to explain the marking of the practice responses. Please refer to these comments when checking your practice responses. **Do not use the comments box for any other reason.**

If you have any questions or comments for your Team Leader, use the phone, the RM Assessor messaging system, or email.

9. Assistant Examiners will send a brief report on the performance of candidates to their Team Leader (Supervisor) via email by the end of the marking period. The report should contain notes on particular strengths displayed as well as common errors or weaknesses. Constructive criticism of the question paper/mark scheme is also appreciated.

10. For answers marked by levels of response:

Read through the whole answer from start to finish, using the Level descriptors to help you decide whether it is a strong or weak answer. The indicative scientific content in the Guidance column indicates the expected parameters for candidates' answers, but be prepared to recognise and credit unexpected approaches where they show relevance. Using a 'best-fit' approach based on the skills and science content evidenced within the answer, first decide which set of level descriptors, Level 1, Level 2 or Level 3, best describes the overall quality of the answer.

Once the level is located, award the higher or lower mark:

The higher mark should be awarded where the level descriptor has been evidenced and all aspects of the communication statement (in italics) have been met.

The lower mark should be awarded where the level descriptor has been evidenced but aspects of the communication statement (in italics) are missing.

In summary:

The skills and science content determines the level.

The communication statement determines the mark within a level.

Level of response questions on this paper are **X** and **X**

11. Annotations available in RM Assessor

Annotation	Meaning
✓	Correct response
✗	Incorrect response
▲	Omission mark
BOD	Benefit of doubt given
CON	Contradiction
RE	Rounding error
SF	Error in number of significant figures
ECF	Error carried forward
L1	Level 1
L2	Level 2
L3	Level 3
NBOD	Benefit of doubt not given
SEEN	Noted but no credit given
I	Ignore

12. Abbreviations, annotations and conventions used in the detailed Mark Scheme (to include abbreviations and subject-specific conventions).

Annotation	Meaning
/	alternative and acceptable answers for the same marking point
✓	Separates marking points
DO NOT ALLOW	Answers which are not worthy of credit
IGNORE	Statements which are irrelevant
ALLOW	Answers that can be accepted
()	Words which are not essential to gain credit
—	Underlined words must be present in answer to score a mark
ECF	Error carried forward
AW	Alternative wording
ORA	Or reverse argument

13. Subject-specific Marking Instructions

INTRODUCTION

Your first task as an Examiner is to become thoroughly familiar with the material on which the examination depends. This material includes:

- the specification, especially the assessment objectives
- the question paper
- the mark scheme.

You should ensure that you have copies of these materials.

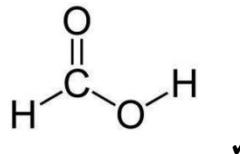
You should ensure also that you are familiar with the administrative procedures related to the marking process. These are set out in the OCR booklet **Instructions for Examiners**. If you are examining for the first time, please read carefully **Appendix 5 Introduction to Script Marking: Notes for New Examiners**.

Please ask for help or guidance whenever you need it. Your first point of contact is your Team Leader.

The breakdown of Assessment Objectives for GCSE (9-1) in Chemistry B:

Assessment Objective	
AO1	Demonstrate knowledge and understanding of scientific ideas and scientific techniques and procedures.
AO1.1	Demonstrate knowledge and understanding of scientific ideas.
AO1.2	Demonstrate knowledge and understanding of scientific techniques and procedures.
AO2	Apply knowledge and understanding of scientific ideas and scientific enquiry, techniques and procedures.
AO2.1	Apply knowledge and understanding of scientific ideas.
AO2.2	Apply knowledge and understanding of scientific enquiry, techniques and procedures.
AO3	Analyse information and ideas to interpret and evaluate, make judgements and draw conclusions and develop and improve experimental procedures.
AO3.1	Analyse information and ideas to interpret and evaluate.
AO3.1a	Analyse information and ideas to interpret.
AO3.1b	Analyse information and ideas to evaluate.
AO3.2	Analyse information and ideas to make judgements and draw conclusions.
AO3.2a	Analyse information and ideas to make judgements.
AO3.2b	Analyse information and ideas to draw conclusions.
AO3.3	Analyse information and ideas to develop and improve experimental procedures.
AO3.3a	Analyse information and ideas to develop experimental procedures.
AO3.3b	Analyse information and ideas to improve experimental procedures.

	Question	Answer	Marks	AO element	Guidance															
1	(a)	low boiling/melting point / does not conduct electricity / poor heat conductor / low density / colourless / odourless ✓	1	1.1	IGNORE non-metal / full outer shell ALLOW gas (at room temperature) / insulator															
	(b)	Argon has a full outer shell / has 8 electrons in the outer shell / has a stable electronic structure/arrangement ✓ Chlorine gains one electron (to give a full (outer) shell) ✓	2	2.1	IGNORE argon does not gain/lose electrons IGNORE chlorine has 7 electrons in the outer shell alone / chlorine does not have a full outer shell / is missing an electron DO NOT ALLOW chlorine loses or gains electrons ALLOW chlorine needs to gain electrons															
	(c)	(i) <table border="1"> <tr> <th></th> <th>True</th> <th>False</th> </tr> <tr> <td>X is a metal.</td> <td>✓</td> <td></td> </tr> <tr> <td>X is in the first period of the Periodic Table.</td> <td></td> <td>✓</td> </tr> <tr> <td>X forms X⁻ ions.</td> <td></td> <td>✓</td> </tr> <tr> <td>X loses one electron when it reacts.</td> <td>✓</td> <td></td> </tr> </table> ✓ ✓		True	False	X is a metal.	✓		X is in the first period of the Periodic Table.		✓	X forms X ⁻ ions.		✓	X loses one electron when it reacts.	✓		2	3.2a	All 4 correct = 2 marks Any 2 correct = 1 mark
	True	False																		
X is a metal.	✓																			
X is in the first period of the Periodic Table.		✓																		
X forms X ⁻ ions.		✓																		
X loses one electron when it reacts.	✓																			
	(ii)	Sodium / potassium ✓	1	3.2b	ALLOW rubidium / caesium /francium IGNORE hydrogen/ Group II IGNORE fluorine															
	(d)	22 ✓	1	1.2	ALLOW 21.9															

	Question		Answer	Marks	AO element	Guidance
2	(a)	(i)		1	1.2	DO NOT ALLOW -OH
		(ii)	Methanoic acid ✓	1	1.1	
	(b)		1 - 6.9 ✓	1	1.1	ALLOW 0
	(c)	(i)	Carbon dioxide ✓	1	1.2	ALLOW CO ₂ DO NOT ALLOW CO ²
		(ii)	Ca(HCOO) ₂ ✓	1	2.1	ALLOW correct formula in any attempt at an equation ALLOW CaH ₂ C ₂ O ₄ / Ca(HCO ₂) ₂ / Ca ²⁺ (HCOO) ₂
	(d)		Filtration/filter ✓ to remove calcium carbonate from the mixture ✓	2	3.3b	ALLOW filtration given in explanation but DO NOT ALLOW 'filter to remove crystals' (=0) IGNORE to remove solids/insoluble solids/excess substances Mark point 2 for identifying calcium carbonate as the impurity to be removed
	(e)	(i)	Evaporation/evaporate (AW) ✓	1	1.2	IGNORE filtration / boiling / heating / crystallisation / put in an oven

		(ii)	<p>First check the answer on answer line If yield = 30(%) award 3 marks</p> <p>20g of calcium carbonate gives 26g of calcium formate / actual yield for 10g is 3.9 g ✓</p> <p>% = $7.8/26 \times 100$ or $3.9/13 \times 100$ ✓</p> <p>= 30(%) ✓</p>	3	2.2	<p>ALLOW (2) for 60 ALLOW (2) for 0.3 ALLOW (1) for 0.6</p>
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Question		Answer	Marks	AO element	Guidance
3	(a)	<p>CO₂ concentration has increased (over the last 20 years) ✓</p> <p>use of coal has (increased then) stayed (approximately) the same/constant/has not changed/has not increased/has decreased ✓</p> <p>(in the last 20 years) use of oil/gas/ use of other fossil fuels has increased (more than coal) ✓</p>	3	3.1b	<p>IGNORE statements about any changes / increase in CO₂ before 2000 / increased 'carbon emissions'</p> <p>ALLOW we use more oil/gas/other fossil fuels than coal / use less coal than other fossil fuels</p> <p>ALLOW values quoted from the graph to make comparisons</p>
	(b)	<p>First check answer on answer line If answer = 1×10^{11} award 3 marks</p> <p>$1350 \text{ kWh} = 1350 \times 10^3 / 1350 \text{ 000 (Wh)} \checkmark$</p> <p>$\text{No. Solar panels} = 135000 \times 10^{12} / 1350 \times 10^3 \checkmark$</p> <p>$= 1 \times 10^{11} \checkmark$</p>	3	1.2 2.2 x 2	<p>ALLOW (2) for 1×10^{14} (no unit conversion) / 1×10^{17} (unit conversion inverted)</p> <p>ECF for any calculated value with working given in standard form</p> <p>ALLOW MAX 2 for errors in standard form e.g. 0.1×10^{12}</p>

(c)	<p>2020 value is 415 (± 5) ✓ and EITHER works out percentage increase: $(415 (\pm 5) - 278) \times 100/278$ ✓ $\sim 49.1\%$ ✓ OR works out total percentage increase $415 (\pm 5) / 278 \times 100$ ✓ $= 149\%$ ✓ OR works out predicted 2020 value from 278 (278×1.5) or $(278/2 + 278)$ ✓ $= 417$ OR works out pre-industrial value from 2020 value $415 (\pm 5) \times 2/3$ ✓ $= 276(.7)$ ✓ OR works out 50% increase and compares $(278/2) = 139$ ✓ $(415 (\pm 5) - 278) = 137$ ✓ </p>	3	3.1a 2.2 x 2	<p>Working must be shown IGNORE answers that divide 2020 value by 2 ALLOW values 410-420 for 2020 CO₂ concentration ALLOW values 47.5 – 51.1 ALLOW values 147.5 – 151.1 ALLOW values 273.3 - 280.0 ALLOW values 132-142 </p>
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	(d)	(i)	<p>Any three from:</p> <p>UV radiation/radiation from the Sun passes through the atmosphere/reaches the Earth ✓</p> <p>Earth emits IR ✓</p> <p>radiation emitted by the Earth/IR is absorbed by greenhouse gas/CO₂ ✓</p> <p>radiation is (re)radiated/emitted (from the Earth) in all directions ✓</p>	3	1.1	<p>IGNORE references to the ozone layer</p> <p>ALLOW light for radiation for M1 only</p> <p>IGNORE heat</p> <p>ALLOW wrong verb in place of 'emits' e.g. reflects/refracts etc for M2 and M3</p> <p>IGNORE 'reflected' in place of 'absorbed'</p> <p>ALLOW trapped</p> <p>ALLOW ECF for incorrect radiation named in M2</p> <p>IGNORE temperature increase/warming/global warming</p>
		(ii)	<p>Any three from:</p> <p>increase in (global) temperature ✓</p> <p>extreme weather patterns / hurricanes/tornadoes ✓</p> <p>increased/decreased rainfall/monsoons / increased flooding (due to rain) / droughts / rise in sea level / melting ice caps ✓</p> <p>increase risk of (forest) fires ✓</p> <p>crop failure / famine / extinction ✓</p> <p>change to ocean currents (e.g. Gulf Stream slows) ✓</p>	3	1.1	<p>IGNORE climate change</p> <p>ALLOW global warming/ 'becomes hotter'</p> <p>e.g. very hot summers/very cold winters / more storms</p> <p>ALLOW wetter/drier/desertification</p>

Question			Answer	Marks	AO element	Guidance
4	(a)	(i)	Any one from: Only number of neutrons differs in isotopes ✓ Number of protons is equal to number of electrons (in an isotope/atom) ✓	1	1.2	IGNORE if they were different it would be a different element / changing the electrons changes the group/changes the element IGNORE electrons (and protons) do not change/stay the same in isotopes (rewords the question) IGNORE 'because the atomic/proton number is the same' alone / 'because they are all the same element'
		(ii)	electron arrangement 2.6 ✓ <div style="border: 1px solid black; padding: 5px;"> Nucleus containing: 8 (protons) 10 (neutrons) ✓ </div>	2	2.2	
	(b)		First check answer on answer line If answer = 50 (m) award 3 marks unit conversion cm:m $0.5/100 = 5 \times 10^{-3}$ or 0.005m ✓ scales up to model: $x 1 \times 10^4$ ✓ answer: = 50 (m) ✓	3	1.2 2.2 x 2	ALLOW M1 for $\div 100$ anywhere in answer ALLOW (2) for 5000m (no unit conversion) ALLOW ECF for M2 and M3 on incorrect unit conversion

Question		Answer	Marks	AO element	Guidance
5	(a)	(i) labelled evaporating basin/dish / beaker ✓ Bunsen burner / other heat source (under open vessel containing mineral water) ✓	2	3.3a	IGNORE basin/bowl alone IGNORE conical flask / test-tube / boiling tube DO NOT ALLOW distillation
		(ii) $\text{Ca}(\text{OH})_2$ ✓ (s) ✓	2	1.2	DO NOT ALLOW M1 if equation is unbalanced by additional numbers DO NOT ALLOW M1 if additional products are given DO NOT ALLOW $\text{Ca}^{2+}(\text{OH}^-)_2$ / CaO_2H_2 ALLOW (s) symbol on any compound of calcium, even if formula is incorrect
	(b)	Sodium (is also present) ✓	1	1.2	
	(c)	(i) spectroscopy ✓	1	1.2	IGNORE spectrum
		(ii) Calcium (ions) present in the mineral water ✓ Mineral water contains element(s)/minerals/metal (ions) other than calcium / unknown element(s)/minerals/metal (ions) ✓	2	3.2b	ALLOW it contains calcium chloride / it contains 'the solution' / it contains the same minerals as the solution IGNORE it is a mixture/is not pure/contains other substances IGNORE chlorine/chloride/ other anions/other ions IGNORE it has additional lines ALLOW it contains sodium (ions)/magnesium ALLOW it contains other minerals/elements

Question		Answer	Marks	AO element	Guidance
6	(a)	So that the ions are free to move / so that it conducts electricity ✓	1	1.2	DO NOT ALLOW so that electrons can move ALLOW it does not conduct when solid IGNORE so that it can be electrolysed
	(b) (i)	Loss of electrons ✓	1	1.2	IGNORE gains oxygen
	(ii)	Oxide ion ✓	1	1.2	DO NOT ALLOW 'oxygen' or ' O^{2-} ' or oxygen ion ALLOW anion
	(iii)	Carbon (anode) reacts with oxygen ✓	1	1.2	ALLOW carbon and oxygen form/make/produce carbon dioxide DO NOT ALLOW carbon cathode reacts with oxygen
	(c)	$Al^{3+} + 3e^- \rightarrow Al$ ✓✓	2	1.2	Al^{3+} = 1 mark (even if on RHS) electrons in fully correct equation= 1 mark ALLOW M2 for $Al^+ + e \rightarrow Al$ / $Al^{2+} + 2e \rightarrow Al$
	(d) (i)	$(2 \times 27) + (3 \times 16) / 54 + 48 = 102$ ✓	1	1.1	DO NOT ALLOW adding of masses on RHS of equation e.g. $(2 \times 27) + (1.5 \times 32)$
	(ii)	<p>First check the answer on answer line If Answer = 0.53 (g) award 4 marks</p> <p>$1/102$ mol Al_2O_3 (= 0.0098) ✓</p> <p>2×0.0098 mol of Al (=0.0196) OR mass Al is 2×27 (=54) ✓</p> <p>$0.0098 \times 27 \times 2$ g / $(2 \times 27)/102$ Al (= 0.5292) ✓</p> <p>0.53 (g) to 2 sf ✓</p>	4 1.2	<p>2.2 x 3</p> <p>ALLOW (3) for 0.52 (incorrect rounding loses M4) ALLOW M4 for incorrect answer, with working to 2 sf</p>	

Question		Answer	Marks	AO element	Guidance
	(e)	hydrogen gas forms (at the cathode) ✓ (because) aluminium is more reactive than hydrogen / aluminium is above hydrogen in the reactivity series ORA ✓	2	2.1	For M2 must have comparison of reactivity of hydrogen and aluminium
	(f)	Aluminium ('it') is more reactive than carbon / aluminium is above carbon in the reactivity series ✓	1	2.1	IGNORE aluminium is a very reactive metal / too reactive / reactive Must have comparison of reactivity of carbon and aluminium

Question			Answer	Marks	AO element	Guidance
7	(a)	(i)	Top label: Metal ion / positive ion / cation ✓ Lower label: electron(s) ✓	2	1.1	DO NOT ALLOW positive atoms
		(ii)	Particle X/metal ions/positive ions do not move/only vibrate (AW) ✓ Particle Y electrons move (through the structure) ✓	2	1.1	ALLOW ECF on incorrect name for X e.g. atoms/protons IGNORE 'carry charge'
	(b)		Atoms/ions (of Al and Mg) are different sizes ✓ The (aluminium) lattice is distorted/not regular AW ✓ (In the alloy) layers/atoms cannot move over each other (easily) / in pure aluminium layers/atoms can move over each other (easily) ✓	3	1.1	ALLOW MAX 2 if answer refers to covalent/ionic bonds or intermolecular forces

	(c)	(i)	(Copper/zinc act as a) barrier / prevents contact ✓ to oxygen AND water ✓	2	1.1	IGNORE coating (in the question) IGNORE sacrificial protection arguments/reactivity IGNORE air ALLOW M2 for 'oxygen in the water'
		(ii)	A rusts because copper is below iron in the reactivity series / unreactive / does not react (with the oxygen/water) ✓ B does not rust because zinc is above iron in the reactivity series / more reactive than iron / provides sacrificial protection / reacts instead of iron / ✓	2	2.1	For (2) marks rust/does not rust must be stated for either A or B IGNORE zinc rusts IGNORE copper is less reactive than zinc ALLOW M2 only Max (1) for 'both copper and zinc are more reactive than iron/act as sacrificial metals/react instead of iron (correct for zinc but incorrect for copper)'

Question		Answer	Marks	AO element	Guidance
8	(a)	<p>Carbon monoxide: incomplete combustion (of hydrocarbons/fuel)/burns without enough oxygen ✓</p> <p>Nitrogen monoxide: nitrogen (from air) and oxygen ✓</p> <p>--react at high temperatures (in the car engine) ✓</p>	3	1.1	<p>DO NOT ALLOW incomplete combustion of carbon</p> <p>DO NOT ALLOW nitrogen from the fuel</p> <p>DO NOT ALLOW combustion/incomplete combustion of nitrogen</p> <p>ALLOW $N_2 + O_2 \rightarrow 2NO$</p> <p>IGNORE heat/hot engine</p>
	(b)	$2CO + 2NO \rightarrow N_2 + 2CO_2$ ✓ ✓	2	2.1	<p>Correct formulae = 1 mark</p> <p>Correct equation = 1 mark</p> <p>ALLOW multiples</p>
	(c) (i)	<p>First check the answer on answer line</p> <p>If answer = 0.9 (%) award 2 marks</p> <p>shows in working 9000×10^{-4} / $9000/10^4$ / states that $1 \text{ ppm} = 1 \times 10^4 \text{ pph}$ / states that $1 \text{ ppm} = 10\ 000 \text{ pph}$ / states that $1 \text{ pph} = 1 \times 10^{-4} \text{ ppm}$ / states that $1 \text{ pph} = 1/10000 \text{ ppm}$; ✓</p> <p>$= 0.9\% \checkmark$</p> <p>OR</p> <p>$(9\ 000/1\ 000\ 000 / 9\ 000 \times 10^{-6}) \times 100 \checkmark$</p> <p>$= 0.9\% \checkmark$</p>	2	1.2	

		(ii)	<p>First check answer on answer line If answer = 92.9(%) award 3 marks</p> <p>both 2800 and 200 or 2600 alone shown in working ✓</p> <p>$2600/2800 \times 100 = 92.85714286$ ✓</p> <p>= 92.9% (1 dp) ✓</p>	3	2.2 x 2	
					1.2	<p>ALLOW ECF on incorrect readings from graph</p> <p>ALLOW M3 for incorrect answer, with working to 1 dp</p>

Question		Answer	Marks	AO element	Guidance
9	(a)	<p>First check answer on answer line If answer = 99.5(%) award 2 marks</p> <p>$1.99/2 \times 100 \checkmark$</p> <p>$= 99.5(%) \checkmark$</p>	2	2.2	<p>If no other marks awarded, allow (1) for a correct mass of SO_3 i.e. 80 / 79.6 / 160 / 159 IGNORE decimal place for RFMs</p>
	(b)	<p>More moles/molecules/particles on the left-hand side/as reactants ORA \checkmark</p> <p>Equilibrium moves to right / favours forward reaction / favours products \checkmark</p>	2	2.1	
	(c)	<p>Any two from: A lot of energy/fuel is needed (to maintain the pressure) \checkmark</p> <p>high pressures are difficult to maintain/cause safety problems/damage or wear to equipment \checkmark</p> <p>idea that yield is already high \checkmark</p>	2	2.1	<p>IGNORE cost</p> <p>ALLOW high pressures are hazardous/dangerous/cause explosions</p>

(d)	<p>As temp increases, % decreases ✓</p> <p>Between 200-400 °C, percentage converted decreases slightly idea / percentage is above 90% / Between 400-800 °C, percentage converted decreases by a large amount / drops from approximately 90% to less than 20% / Between 800-1000 °C, percentage decreases less / less than 20% converted / At 200 °C almost 100% conversion / at 1000 °C less than 10 % ✓</p>	2	3.1b	<p>IGNORE decrease in percentage causes the temperature to increase IGNORE highest percentage at low temperatures / lowest percentage at high temperatures alone (need both for M1) DO NOT ALLOW M1 for proportional / inversely proportional IGNORE correlation</p> <p>ALLOW decreases slowly/quickly for decreases slightly/by a large amount</p>
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