



GCE

Chemistry B

H433/02: Scientific literacy in chemistry

A Level

Mark Scheme for June 2025

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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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Mark Scheme
MARKING INSTRUCTIONS

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**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 40% 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 or the RM Assessor messaging system, or by email.
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 a 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 'SEEN' (or award ticks) to confirm that the work has been seen.

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7. There is a NR (No Response) option. Award NR (No Response)

- if there is nothing written at all in the answer space
- OR if there is a comment which does not in any way relate to the question (e.g. 'can't do', 'don't know')
- OR if there is a mark (e.g. a dash, a question mark) which isn't an attempt at the question.

Note: Award 0 marks – for an attempt that earns no credit (including copying out the question).

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 e-mail.

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 **2g** and **5a(i)**.

The only annotation on a level of response question should be the indication of the level.

A level annotation should be used where all marks for a level have been achieved e.g. a candidate has 6 marks, so they would have this annotation on their script:

L3

If a candidate has achieved 5 marks then they have reached Level 3 but with one mark omitted. They should have the following annotations on their scripts:

L3 

The same principle should be applied to Level 2 and Level 1.

No marks (0) should have a cross: 

Place the annotations alongside the mark for the question.

On additional pages, annotate using 

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11. Annotations

Annotation	Meaning
	Correct response
	Incorrect response
	Omission mark
	Benefit of doubt given
	Contradiction
	Rounding error
	Error in number of significant figures
	Error carried forward
	Level 1
	Level 2
	Level 3
	Benefit of doubt not given
	Noted but no credit given
	Ignore

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Annotation	Meaning
	Blank page

12. Subject Specific Marking Instructions

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 allowed
ORA	Or reverse argument

13. Subject-specific Marking Instructions

INTRODUCTION

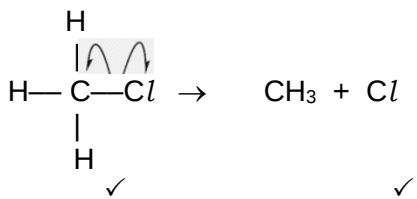
Your first task as an Examiner is to become thoroughly familiar with the material on which the examination depends. This material includes:

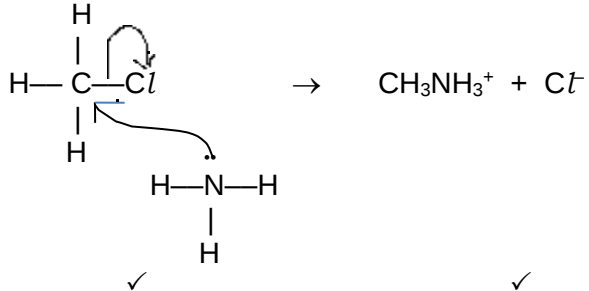
- the specification, especially the assessment objectives
- the question paper
- the mark scheme.

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**.

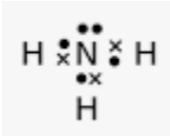
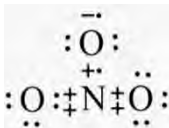
Please ask for help or guidance whenever you need it. Your first point of contact is your Team Leader.

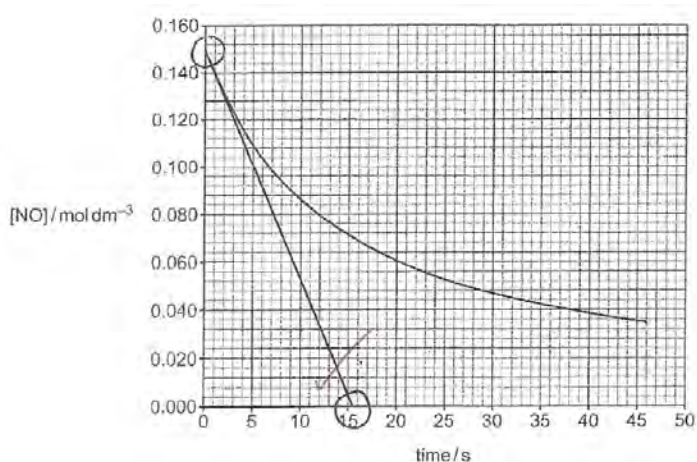
Question			Answer	Mark	Guidance
1	(a)	(i)	Chloromethane ✓	1	
1	(a)	(ii)		2	Arrows must be 'half arrows' and start (extended if necessary) on bond and finish on C and Cl atoms. One can be under the bond. ALLOW CH₃ displayed. IGNORE dots on radicals
1	(a)	(iii)	Ultraviolet/UV ✓	1	
1	(a)	(iv)	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = $3.46 \times 10^{-7}(\text{m})$ award 5 marks 1. $\lambda = c h N_A / \Delta E$ ✓ 2. Converts 346kJ to 346000J ✓ 3. $= 3 \times 10^8 \times 6.63 \times 10^{-34} \times 6.02 \times 10^{23} / 346(000)$ ✓ 4. $= 3.46 \times 10^{-7} (\text{m})$ ✓ 5. 3sf ✓	5	Marking point 3 subsumes marking points 1 and 2 $3.46 \times 10^{-4}(\text{m})$ scores 4 marks(or 3 if wrong sf) $5.75 \times 10^{-31}(\text{m})$ scores 4 marks (or 3 if wrong sf) $5.75 \times 10^{-28} (\text{m})$ scores 3 marks (or 2 if wrong sf) No other ecf If no other marks scored for MP1-4 ALLOW any <i>calculated</i> answer to 3sf for MP5.
1	(a)	(v)	$\text{Cl} + \text{O}_3 \rightarrow \text{ClO} + \text{O}_2$ and $\text{ClO} + \text{O} \rightarrow \text{Cl} + \text{O}_2$ ✓ $\text{O} + \text{O}_3 \rightarrow 2\text{O}_2$ ✓	2	ALLOW $\text{Cl} + \text{O}_3 \rightarrow \text{ClO} + \text{O}_2$ and $\text{ClO} + \text{O}_3 \rightarrow \text{Cl} + 2\text{O}_2$ ✓ $2\text{O}_3 \rightarrow 3\text{O}_2$ ✓

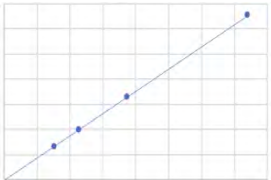
Question			Answer	Mark	Guidance
1	(a)	(vi)	Ozone removes/absorbs UV radiation ✓ UV causes sunburn/ skin cancer/ DNA damage/ damages eyes/damages crops ✓	2	ALLOW if ozone not present higher levels of uv will pass through to troposphere
1	(b)	(i)	An electron pair donor ✓	1	
1	(b)	(ii)		2	Curly arrow must start on lone pair on N and end on C atom CH ₃ NH ₃ ⁺ can be displayed (ignore position of positive charge). IGNORE further reaction to form other products
1	(b)	(iii)	Methylamine ✓	1	ALLOW aminomethane
1	(c)	(i)	C ₄ H ₉ I / the iodo compound(AW) ✓ C-I bond is weakest/ has lowest bond enthalpy ✓	2	
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Question			Answer	Mark	Guidance
2	(a)		7 ✓	1	
2	(b)		Sodium/potassium hydroxide/NaOH/KOH ✓	1	DO NOT ALLOW OH ⁻ / hydroxide ions
2	(c)		Green/ dark green ✓ $\text{Fe}^{2+}(\text{aq}) + 2\text{OH}^{-}(\text{aq}) \rightarrow \text{Fe}(\text{OH})_2(\text{s})$ Equation ✓ state symbols for a pptn reaction ✓	3	DO NOT ALLOW other colours eg grey/green, blue/green etc
2	(d)	(i)	Nitrate(III) (ion) ✓	1	DO NOT ALLOW nitrite
2	(d)	(ii)	NO ₂ ✓ $3\text{NO}_2^{-} + 2\text{H}^{+} \rightarrow 2\text{NO} + \text{NO}_3^{-} + \text{H}_2\text{O}$ ✓ for NO ₂ ⁻ + H ⁺ → NO (in any quantities and with other substances) ✓ for completely correct	3	ALLOW nitrogen(IV) oxide
2	(e)	(i)	Suitable container for heating solids/named solids ✓ Suitable container for drying gas ✓ Named drying agent ✓ Gas Syringe ✓	4	ALLOW poorly drawn apparatus ALLOW any suitable reaction vessel eg rb flask/boiling tube etc ALLOW as drying agent: Calcium chloride/ sodium sulfate/ conc sulfuric acid (gas bubbled through) ALLOW upturned measuring cylinder (even if over water) as method of measuring volume of gas produced

2	(e)	(ii)	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 70.0 - 70.3 (cm³) award 4 marks 1. Amount (NH ₄) ₂ SO ₄ = 0.2/132.1 = 1.5148 x 10 ⁻³ (mol) ✓ 2. V = nRT/P ✓ 3. = 2 x 1.5148 x 10 ⁻³ x 8.314 x 293/105 x 10 ³ (m ³) (= 7.029 x 10 ⁻⁵ m ³) ✓ 4. = 70 OR 70.3 cm ³ ✓	4	ALLOW 2 or 3sf DO NOT ALLOW use of V = 24000cm ³ MP3 subsumes MP2 ALLOW 35.0 – 35.2 for 3 marks
2	(f)		Amt O (= 63/16) = 3.937 and Amt N = 37/14 = 2.64 ✓ (Ratio O:N = 1.49 = 2:3) Formula = N ₂ O ₃ ✓	2	

2	(g)	Please refer to the marking instructions on page 5 of this mark scheme for guidance on how to mark this question. Level 3 (5–6 marks) Produces dot and cross diagrams showing ALL outer shell electrons for BOTH species and identifies the correct shape and bond angle with an explanation linked to the relevant background theory, <i>There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.</i> Level 2 (3–4 marks) Produces dot and cross diagrams for BOTH species, and identifies the correct shape and bond angle OR Produces one correct dot and cross diagram showing ALL outer shell electrons and identifies the correct shape or bond angle with some relevant background theory. <i>There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.</i> Level 1 (1–2 marks) Produces dot and cross diagrams for either one or both species and attempts to identify either the correct shape or bond angle for either one or both species OR Produces a written description that attempts to identify the shape and/or the bond angles in one or both species using relevant chemical knowledge. <i>There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.</i> 0 marks No response or no response worthy of credit.	6	Scientific points include AO1 Background Theory • areas of electron density/groups of electrons • repel to get as far apart as possible/minimise repulsion • lone pairs take up more room (AW)/lone pairs reduce bond angle by 2.5° • LP :BP repulsion greater than BP : BP repulsion AO3 Specific molecules • dot and cross for NH_3 (see below) • 4 groups of electrons/areas of electron density • NH_3 contains 3 bonding pairs and 1 lone pair of electrons • pyramidal • $107 \pm 1^\circ$ • dot and cross for NO_3^- (see below) • 3 groups of electrons/areas of electron density • NO_3^- does not contain any lone pairs • trigonal • $120 \pm 2^\circ$  
			25	

Question			Answer	Mark	Guidance
3	(a)		So (chlorine) concentration remains (virtually) constant (AW)✓	1	ALLOW $[\text{Cl}_2]$ does not change (very much)
3	(b)		 ✓ drawing of tangent on the graph at $t = 0$ ✓ 0.01 ± 0.002 ($\text{mol dm}^{-3} \text{ s}^{-1}$)	2	MP 2 dependent upon MP 1 ALLOW values between 0.012 and 0.008
3	(c)	(i)	Rate is not first order ✓	1	
3	(c)	(ii)	2.26×10^{-3} ✓	1	

Question			Answer	Mark	Guidance
3	(c)	(iii)	 plotted area to occupy 1/2 grid and scale shown with <u>correct st form.</u> ✓ axes labelled including units: x $[\text{NO}]^2/(\text{mol dm}^{-3})^2$ y Rate/ $\text{mol dm}^{-3}\text{s}^{-1}$ ✓ points plotted correctly ✓ LBF going thro' origin ✓	4	PLACE ANNOTATIONS on RHS of grid ECF from c(ii) Check plotting of any points not on LOBF LOBF should go through all 4 points and the origin if drawn correctly
3	(c)	(iv)	Rate is proportional_to $[\text{NO}]^2$ ✓	1	ALLOW '∞' ALLOW as $[\text{NO}]$ doubles, rate quadruples(AW)
3	(d)	(i)	Rate = $k[\text{NO}]^2[\text{Cl}_2]$ ✓	1	ALLOW Concentrations in either order
3	(d)	(ii)	$\text{dm}^6 \text{mol}^{-2} \text{s}^{-1}$ ✓	1	ALLOW $\text{mol}^{-2} \text{dm}^6 \text{s}^{-1}$ No ecf from (d)(i)
3	(d)	(iii)	Concentration of chlorine is not known (AW) ✓	1	
3	(d)	(iv)	Rds is slow(er) step ✓ $[\text{NOCl}_2]$ depends on $[\text{Cl}_2]$ and $[\text{NO}]$ ✓ Rate of step 2 depends on $[\text{Cl}_2]$ and $[\text{NO}]^2$ (AW)✓	3	ALLOW the overall equation for the reaction involves ALL of the species identified in the rate equation for 1 mark as an alternative to marking points 2 and 3
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Question			Answer	Mark	Guidance
4	(a)	(i)	The R/side groups of the amino acids are bonded together ✓	1	Do not allow amide/peptide bonds as these are referring to the wrong part of the diagram
4	(a)	(ii)	HOOCCH(CH ₃)NH ₂ ✓	1	ALLOW any unambiguous representation of alanine.
4	(a)	(iii)	Hydrogen bonds ✓ O ^{δ-} not O ⁻ attracted to H ^{δ+} in bonds 1,4 & 5 ✓ (AW) attraction between H ^{δ+} and O ⁻ is stronger than attraction between H ^{δ+} and O ^{δ-} ✓	3	
4	(a)	(iv)	Bond 4 does not form / O cannot (form hydrogen) bond with O (on vancomycin chain) ✓ Less intermolecular bonding (between bacterial cell wall and vancomycin) ✓	2	
4	(b)		Pharmacophore ✓	1	ALLOW phonetic spelling
4	(c)		mRNA has base triplets/codons (AW) ✓ tRNA binds to mRNA by complementary anti-codons ✓ tRNA with complementary triplet codes for amino acid (required for peptide/protein building) ✓	3	idea of aa sequencing, aa's sequencing for protein construction etc.
4	(d)		Active site ✓	1	
4	(e)	(i)	(NH ₂ /NH groups in) nylon (become) NH ₃ ⁺ /NH ₂ ⁺ in acid. ✓ positive ions form <u>ionic bonds</u> with the –SO ₃ ⁻ ✓	2	

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4	(e)	(ii)	random movement of electrons creates unequal distribution of electron density ✓ Causes (instantaneous) dipole to form (within the molecule) ✓ Induces a dipole (in another molecule) and attracts it ✓	ALLOW idea that More electrons at one end of molecule than the other/ electrons unevenly distributed in molecule DO NOT ALLOW idea of polar molecules/bonds
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Question		Answer	Mark	Guidance
5	(a)	Please refer to the marking instructions on page 5 of this mark scheme for guidance on how to mark this question. Level 3 (5–6 marks) Gives full electron configurations for BOTH elements and uses these to explain why Lithium only forms one stable oxidation state but Vanadium can form multiple oxidation states. Identifies all stable oxidation states for both elements with corresponding electron configurations provided for most stable ions (ions can be represented by shorthand notation eg V^{2+} is $[Ar] 3d^3$) <i>There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.</i> Level 2 (3–4 marks) Gives full electron configurations for both elements and identifies one stable oxidation state for both elements with corresponding electron configurations provided, (ions can be represented by shorthand notation eg V^{2+} is $[Ar] 3d^3$) OR Discusses either Lithium or Vanadium giving ground state electron configuration for the element and one ion and explains why Li/V can form one/many oxidation states <i>There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.</i> Level 1 (1–2 marks) Discusses either Lithium or Vanadium giving correct electron configuration for the element or one ion <i>There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.</i> 0 marks No response or no response worthy of credit.	6	Scientific points include <i>Minor points in italic</i> • <i>Li s-block element</i> • $Li 1s^2 2s^1$ • $Li^+ 1s^2$ • <i>only stable ion</i> • <i>V d-block element/transition element</i> • $V 1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^3$ • several stable electron configs in ions • <i>because of d subshell (AW)</i> • $V^{2+} [Ar] 3d^3$ • $V^{3+} [Ar] 3d^2$ • $V^{4+} [Ar] 3d^1$ • $V^{5+} [Ar] 3d^0$ or $V^{5+} [Ar]$

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5	(b)	(i)	$\text{VO}_2^+(\text{aq}) + 2\text{H}^+(\text{aq}) + \text{V}^{2+}(\text{aq}) \rightarrow \text{V}^{3+}(\text{aq}) + \text{VO}^{2+}(\text{aq}) + \text{H}_2\text{O}(\text{l})$ ✓ 1.26 V ✓	2	DO NOT ALLOW -1.26V
5	(b)	(ii)	Salt bridge is missing add a salt bridge/ filter paper soaked in a salt ✓ V rod should be Pt ✓	2	ALLOW graphite electrode
5	(b)	(iii)	Sn will reduce V^5 to V^3 / VO_2^+ to V^{3+} but not reduce V^{3+} to V^{2+} ✓ Ag will not reduce V^4 to V^3 ✓ Zn will reduce V^3 to V^2 ✓ Equation $\text{Sn} + 4\text{H}^+ + \text{VO}_2^+ \rightarrow \text{Sn}^{2+} + \text{V}^{3+} + 2\text{H}_2\text{O}$ ✓	4	V^5/V^4 etc in this question are referring to the oxidation state of the vanadium species ALLOW correct use of Roman Numerals to identify oxidation states
5	(c)	(i)	Advantages: <i>two from:</i> ✓✓ • (stores) all components inside cells • responds quickly to changes in power demands • unmatched/high/good energy density • low self-discharge	2	ALLOW • advantages in either order • both in 'Advantage 1/2' IGNORE wrong suggestions that are not contradictory
5	(c)	(ii)	Advantages: <i>two from:</i> ✓✓ • energy capacity can be expanded (by adding more solution to the tank)/ use a larger tank/. • Store energy generated from renewable source(s) eg solar • consistent supply when energy production drops below demand. • can run at 100% capacity for long time (AW) • hold large amounts of energy / has a very high energy capacity • variable ratio of power to energy (volume) • will not cause damage or fires • can handle more charge/discharge cycles	2	As above ALLOW 'forever' for 'long time'
5	(d)		Li-ion: Li^+ ions VFRB H^+ ions ✓ (both for 1 mark)	1	

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5	(e)	(i)	Absorption of certain frequencies/wavelengths of light ✓ Transmission of complementary colour ✓	2	ALLOW words derived from those given eg 'They absorb light' References to emission are CON to second marking point.
5	(e)	(ii)	Frequencies/wavelengths absorbed depend on ΔE between d energy levels ✓ ΔE depends on/varies with Vanadium ion/complex present ✓	2	ALLOW $\Delta E = hf$ for 'depend on' Answers can be in either order.
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