



**GCSE**

**Chemistry A**

Unit **A172/02**: Modules C4, C5, C6 (Higher Tier)

General Certificate of Secondary Education

**Mark Scheme for June 2016**

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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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## Annotations

Used in the detailed Mark Scheme:

Annotation	Meaning
/	alternative and acceptable answers for the same marking point
(1)	separates marking points
not/reject	answers which are not worthy of credit
ignore	statements which are irrelevant - applies to neutral answers
allow/accept	answers that can be accepted
(words)	words which are not essential to gain credit
<u>words</u>	underlined words must be present in answer to score a mark
ecf	error carried forward
AW/owtte	credit alternative wording / or words to that effect
ORA	or reverse argument

Available in RM Assessor to annotate scripts:

	indicate uncertainty or ambiguity
	benefit of doubt
	contradiction
	incorrect response
	error carried forward
	draw attention to particular part of candidate's response
	no benefit of doubt
	reject
	correct response

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L1, L2, L3	draw attention to particular part of candidate's response
▲	information omitted

### Subject-specific Marking Instructions

- a. Accept any clear, unambiguous response (including mis-spellings of scientific terms if they are *phonetically* correct, but always check the guidance column for exclusions).
- b. Crossed out answers should be considered only if no other response has been made. When marking crossed out responses, accept correct answers which are clear and unambiguous.

*e.g. for a one-mark question where ticks in the third and fourth boxes are required for the mark:*

*This would be worth  
1 mark.*

*This would be worth  
0 marks.*

*This would be worth  
1 mark.*

- c. The list principle:  
If a list of responses greater than the number requested is given, work through the list from the beginning. Award one mark for each correct response, ignore any neutral response, and deduct one mark for any incorrect response, e.g. one which has an error of science. If the number of incorrect responses is equal to or greater than the number of correct responses, no marks are awarded. A neutral response is correct but irrelevant to the question.

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d. Marking method for tick-box questions:

If there is a set of boxes, some of which should be ticked and others left empty, then judge the entire set of boxes.

If there is at least one tick, ignore crosses and other markings. If there are no ticks, accept clear, unambiguous indications, e.g. shading or crosses. Credit should be given according to the instructions given in the guidance column for the question. If more boxes are ticked than there are correct answers, then deduct one mark for each additional tick. Candidates cannot score less than zero marks.

e.g. if a question requires candidates to identify cities in England:

Edinburgh	<input type="checkbox"/>
Manchester	<input type="checkbox"/>
Paris	<input type="checkbox"/>
Southampton	<input type="checkbox"/>

the second and fourth boxes should have ticks (or other clear indication of choice) and the first and third should be blank (or have indication of choice crossed out).

Edinburgh			✓			✓	✓	✓	✓	
Manchester	✓	x	✓	✓	✓				✓	
Paris				✓	✓		✓	✓	✓	
Southampton	✓	x		✓		✓	✓		✓	
<b>Score:</b>	<b>2</b>	<b>2</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>NR</b>

e. For answers marked by levels of response:

i. **Read through the whole answer from start to finish**

ii. **Decide the level that best fits** the answer – match the quality of the answer to the closest level descriptor

iii. **To determine the mark within the level**, consider the following:

Descriptor	Award mark
A good match to the level descriptor	The higher mark in the level
Just matches the level descriptor	The lower mark in the level

iv. Use the **L1**, **L2**, **L3** annotations in RM Assessor to show your decision; do not use ticks.

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Quality of Written Communication skills assessed in 6-mark extended writing questions include:

- appropriate use of correct scientific terms
- spelling, punctuation and grammar
- developing a structured, persuasive argument
- selecting and using evidence to support an argument
- considering different sides of a debate in a balanced way
- logical sequencing.

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Question		Answer	Marks	Guidance
1	a	<p><b>2 from:</b> they are (alkali) metals;</p> <p>correct physical property of metals e.g. conduct electricity/are shiny/are grey/ are soft;</p> <p>have low MP or BP or density <u>compared to other metals</u>;</p> <p>very reactive / react quickly / react violently;</p> <p>react with water / fizz in water / float on water / produce hydrogen or a gas in water / produce an alkali/hydroxide with water;</p> <p>react with oxygen/air / tarnish in air;</p> <p>react with chlorine / react with halogens / form halide salts;</p>	2	<p><b>ignore</b> references to electrons or atomic structure</p> <p><b>ignore</b> 'are solids'</p> <p><b>ignore</b> references to MP / BP / density alone</p> <p>Must mention 'water'</p>
	b	i	2	<b>Ignore</b> names
		ii	2	<p>'<u>only</u> C and Si are in the same group' (2) If group number is given, must be correct</p> <p><b>Allow</b> 'Ti is not in a group'</p> <p><b>Accept</b> 'a mixture of metals and non-metals' for (1) mark only</p>
		iii	2	

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Question			Answer	Marks	Guidance
	c	i	Idea that reversing elements due to properties; idea of leaving gaps for undiscovered elements;	2	Accept AW e.g. 'to fit trends in groups'
		ii	The proton number	1	
			Total	11	



Question	Answer	Marks	Guidance
2	<p><b>[Level 3]</b> Identifies all elements present and absent, with a reason for each and discusses spectrum/ flame test linked to unknown elements. Quality of written communication does not impede communication of the science at this level. (5 – 6 marks)</p> <p><b>[Level 2]</b> Identifies whether all four named elements are present/absent in mineral and states some reasons.  OR Correctly identifies whether 2 elements are present/absent with reasons and discusses spectrum/flame test linked to unknown element(s).  OR Identifies whether all four named elements are present/absent in mineral and discusses spectrum/flame test linked to unknown element(s).  Quality of written communication partly impedes communication of the science at this level. (3 – 4 marks)</p> <p><b>[Level 1]</b> Correctly identifies whether 2 elements are present/absent with reasons  OR identifies whether all four named elements are present or absent with no reasons.  OR discusses spectrum/flame test linked to unknown element(s). Quality of written communication impedes communication of the science at this level.</p>	6	<p><b>This question is targeted at grades up to A/A*</b></p> <p><b>Indicative scientific points may include:</b></p> <p><b>Elements</b></p> <ul style="list-style-type: none"> <li>• mineral contains sodium</li> <li>• mineral contains rubidium</li> <li>• mineral contains other unidentified element(s)</li> <li>• mineral does not contain lithium</li> <li>• mineral does not contain potassium</li> </ul> <p><b>Reasons</b></p> <ul style="list-style-type: none"> <li>• Lines/wavelength/frequency/line spectra match for sodium</li> <li>• Lines/wavelength/frequency/line spectra match for rubidium (<b>Ignore</b> 'spectrum matches' alone)</li> <li>• No lines/AW match for lithium</li> <li>• No lines/AW match for potassium</li> <li>• sodium colour only shown in flame test</li> </ul> <p><b>Unknown elements</b></p> <ul style="list-style-type: none"> <li>• Flame test: other elements 'masked' by strong colour / can't see other colours</li> <li>• Spectrum: Some extra lines indicate unknown element</li> <li>• need spectra of other unknown elements to identify</li> </ul> <p><b>Use the L1, L2, L3 annotations in RM Assessor; do not use ticks.</b></p>

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Question	Answer	Marks	Guidance
	(1 – 2 marks)		
	<b>[Level 0]</b> Insufficient or irrelevant science. Answer not worthy of credit. (0 marks)		

Question	Answer	Marks	Guidance
3 (a)	gas liquid solid (1)  green orange / red-brown (1)	2	<b>Accept</b> green-yellow / yellow as colour of chlorine. <b>Accept</b> red or orange-brown, brown, orange. <b>Reject</b> other colours. <b>Ignore</b> 'dark' 'light' 'pale' etc
(b)	Box 2;  Box 3;	2	
(c)	two <u>atoms</u> / pair of <u>atoms</u> ;  in each molecule / (covalently) bonded together;	2	<b>Accept</b> 'which share a pair of electrons' / 'joined together' <b>Do not allow</b> ionic bond <b>Do not allow</b> molecules/ions joined together <b>Ignore</b> double/triple <b>Ignore</b> any examples / diagrams / formulae
	<b>Total</b>	<b>6</b>	

Question		Answer	Marks	Guidance
4	a	<p><b>[Level 3]</b> Makes two statements about properties <b>and</b> two about structure, including one link between structure and a property. Quality of written communication does not impede communication of the science at this level. (5 – 6 marks)</p> <p><b>[Level 2]</b> Makes two statements about properties and/or structure <b>OR</b> Gives one link between structure and a property. Quality of written communication partly impedes communication of the science at this level. (3 – 4 marks)</p> <p><b>[Level 1]</b> Makes a correct statement about a property <b>or</b> structure for solid <b>or</b> solution. Quality of written communication impedes communication of the science at this level. (1 – 2 marks)</p> <p><b>[Level 0]</b> Insufficient or irrelevant science. Answer not worthy of credit. (0 marks)</p>	6	<p>This question is targeted at grades up to A</p> <p><b>Indicative scientific points may include:</b></p> <p><b>Properties</b></p> <ul style="list-style-type: none"> <li>• Solid has high MP and/or BP / solution MP below room temperature/low/lower</li> <li>• Solid does not change shape / is a fixed shape / solution can change shape/be poured</li> <li>• Solid does not conduct electricity / solution conducts electricity</li> </ul> <p><b>Structure</b></p> <ul style="list-style-type: none"> <li>• <b>Both</b> have ions/ionic bonding</li> <li>• Solid: arrangement of ions regular / Solution: not regular structure / solution has random arrangement of ions</li> <li>• Solid: is crystalline / forms a 3-D structure / forms a lattice</li> </ul> <p><b>Structure linked</b> to properties....</p> <ul style="list-style-type: none"> <li>• (solid) strong bonds/attraction (linked to MP/BP)</li> <li>• (solid) ions can't move (linked to no conduction or shape) / (solution) ions in solution can move (linked to changes shape / conducts) <b>Allow</b> 'free ions'</li> <li>• (solution) forces/attraction between ions broken in solution (linked to changes shape / conducts)</li> </ul> <p><b>At Level 1</b> only allow 1 mark for 'behaves like a liquid'</p> <p><b>Consider QWC to be impeded</b> if incorrect terms are used e.g. molecules/atoms (for ions) or covalent (rather than ionic) or intermolecular forces</p> <p><b>Do not allow</b> electrons move during conduction</p> <p><b>Use the L1, L2, L3 annotations in RM Assessor; do not use ticks.</b></p>

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Question			Answer	Marks	Guidance
4	b	i	decreases by 3 ( $^{\circ}\text{C}$ ) ;  for every 5.0 (g) added;  <b>Allow (1) mark for....</b> as mass increases, freezing point decreases / more salt added the lower the temperature ;	2	<b>Allow</b> 'melting point' as AW for 'freezing point'  <b>Ignore</b> 'gets colder' <u>Mass and freezing point</u> show a negative correlation/are inversely proportional (1)
		ii	50 g (2)  If answer incorrect: Idea of incremental steps of 3 / Working showing $30/3 = 10$ (1)	2	50 without correct units = (1)
	c	i	25.0 g follows the pattern / links 25.0g to pattern described in b i ;  35.0 g does not / 35.0 g should be lower / 35.0 g is higher than expected / 35.0 g similar to value for 10g salt added;  35.0 g should be <u>-21<math>^{\circ}\text{C}</math></u> / 35.0 g should be lower than <u>-15<math>^{\circ}\text{C}</math></u> ;	3	<b>Allow</b> '-5 reading' or just '35.0' as alternative for '35.0 g' <b>Allow</b> 35.0 g/-5 $^{\circ}\text{C}$ is an outlier  '35.0 g should be -21 $^{\circ}\text{C}$ ' gets MP2 and MP3 (2) '35.0 g should be lower than -15 $^{\circ}\text{C}$ ' gets MP2 and MP3 (2)
		ii	measure/take/record the freezing point (for another experiment);  Add a range of salt masses to water / 35g, 45g, 50g;  Use 100cm <sup>3</sup> water/same amount every time;	3	Need at least two different salt masses or 'range' idea <b>Ignore</b> 'add more' or 'add 50' alone
<b>Total</b>				<b>16</b>	

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Question		Answer	Marks	Guidance
5	a	It is below 373°C / below melting point of lead bromide;	1	<b>Accept</b> 'it IS 373 °C' or 'before 373 °C' <b>Ignore</b> boiling point
	b	(negative/cathode) because lead is a metal / because it is a positive ion / it is a cation / needs to gain electrons;	1	<b>Do not accept</b> 'positive electrode' <b>Accept</b> idea that Pb is a positive ion, even if charge is incorrect e.g. 'because it is Pb <sup>2+</sup> ' or 'because it is Pb <sup>+</sup> ' <b>Ignore</b> numbers of electrons
	c	Pb <sup>2+</sup> + 2e <sup>-</sup> → Pb  Pb <sup>2+</sup> (1)  Equation fully correct (2)	2	<b>Accept</b> Pb <sup>2+</sup> → Pb - 2e <sup>-</sup>  <b>Accept</b> Pb <sup>+2</sup>
<b>Total</b>			<b>4</b>	

Question	Answer	Marks	Guidance
6	<p><b>[Level 3]</b> Draws both diagrams with basic features for NaCl and KCl with correct direction of energy change <b>and</b> shows or comments on relative size of energy change for all diagrams. Quality of communication does not impede communication of the science at this level. (5 – 6 marks)</p> <p><b>[Level 2]</b> Draws both diagrams with basic features and either comments on or shows correct direction of energy change for NaCl/KCl . Quality of written communication partly impedes communication of the science at this level. (3 – 4 marks)</p> <p><b>[Level 1]</b> Draws product lines in same direction for <u>both</u> diagrams or makes a correct statement about a temperature or energy change. Quality of written communication impedes communication of the science at this level. (1 – 2 marks)</p> <p><b>[Level 0]</b> Insufficient or irrelevant science. Answer not worthy of credit. (0 marks)</p>		<p><b>This question is targeted at grades up to C</b> <b>Indicative scientific points may include:</b></p> <p><b>Basic features</b></p> <ul style="list-style-type: none"> <li>Line drawn with products labelled (for L1 direction does not have to be correct)</li> <li>energy change arrow starts at level of reactants and ends with point at level of products</li> </ul> <p><b>Consider QWC impeded</b> if products not labelled <u>or</u> energy arrow not drawn with single arrow pointing at products (ie double ended arrow or single line)</p> <p><b>Diagram features all levels:</b></p> <ul style="list-style-type: none"> <li>product line drawn <u>above</u> reactants for both NaCl and KCl)</li> <li>Size of energy change KCl bigger than NaCl</li> <li>Size of energy change LiCl is biggest</li> </ul> <p><b>Allow (5)</b> if KCl change is not obviously smaller than LiCl</p> <p><b>Temperature and energy changes (written statements)</b></p> <ul style="list-style-type: none"> <li>Exothermic reactions give out energy (e.g LiCl)/ endothermic reactions take in energy (e.g. NaCl/KCl)</li> <li>Bigger temperature change means more energy in/out</li> <li>LiCl exothermic AND NaCl AND KCl endothermic</li> <li>LiCl temperature increases</li> <li>LiCl energy given out / products have less energy than reactants</li> <li>NaCl/KCl temperature decreases</li> <li>NaCl/KCl energy taken in/ products have more energy than reactants</li> <li>LiCl gives biggest temperature change</li> <li>LiCl gives biggest energy change</li> <li>Temperature change for KCl is bigger than NaCl</li> <li>Energy change for KCl is bigger than NaCl</li> </ul> <p><b>Use the L1, L2, L3 annotations in RM Assessor; do not use ticks.</b></p>
		6	

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Question		Answer	Marks	Guidance
7	a	Sodium hydroxide <input type="checkbox"/> Calcium bromide <input type="checkbox"/> Ammonia <input type="checkbox"/> hydrogen chloride <input checked="" type="checkbox"/> ethanoic acid <input checked="" type="checkbox"/> calcium hydroxide <input type="checkbox"/> citric acid <input checked="" type="checkbox"/>	1	Need all three (1)
	b	all (solutions of) alkalis have pH greater than 7 / all alkalis produce hydroxide ions (in solution); (dry) ammonia is covalent;	2	<b>Ignore</b> 'yes' or 'no', look at explanations  <b>Accept</b> 'ammonia is not ionic'
	c	<div style="display: flex; flex-direction: column; align-items: center;"> <div style="display: flex; align-items: center; margin-bottom: 10px;"> <input style="width: 80px; height: 20px; border: 1px solid black;" type="text"/> <div style="margin-left: 20px; text-align: center;"> <input style="width: 50px; height: 20px; border: 1px solid black;" type="text" value="solid"/> </div> </div> <div style="display: flex; align-items: center; margin-bottom: 10px;"> <div style="margin-right: 20px;">ethanoic acid</div> <div style="text-align: center;"> </div> <div style="margin-left: 20px; text-align: center;"> <input style="width: 50px; height: 20px; border: 1px solid black;" type="text" value="liquid"/> </div> </div> <div style="display: flex; align-items: center; margin-bottom: 10px;"> <input style="width: 80px; height: 20px; border: 1px solid black;" type="text"/> </div> <div style="display: flex; align-items: center;"> <div style="margin-right: 20px;">citric acid</div> <div style="margin-left: 20px; text-align: center;"> <input style="width: 50px; height: 20px; border: 1px solid black;" type="text" value="gas"/> </div> </div> </div>	2	
<b>Total</b>			<b>5</b>	

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Question			Answer				Marks	Guidance
8	a	i	(s) shows it is a solid / (s) is the state symbol / state symbol is a solid;				1	Must be linked to idea of state symbol <b>Ignore</b> 'it shows it's a solid' alone
		ii	silver nitrate + sodium chloride → silver chloride + sodium nitrate				1	
	b		chlorine				1	<b>Accept</b> Cl <sub>2</sub> <b>Do not allow</b> 'chloride' or 'Cl'
	c		Technique	needed for silver chloride	needed for sodium chloride	needed for both	3	
			filtration of reaction mixture	✓ (1)				
			heating strongly to evaporate water		✓ (1)			
			leaving in a warm oven			✓ (1)		
			<b>Total</b>				<b>6</b>	



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