

Mark Scheme (Results) January 2007

GCE

GCE Chemistry (6241/01)

General Guidance on Marking

Examiners should look for qualities to reward rather than faults to penalise. This does NOT mean giving credit for incorrect or inadequate answers, but it does mean allowing candidates to be rewarded for answers showing correct application of principles and knowledge, and for critical and imaginative thinking. Examiners should therefore read carefully and consider every response: even if it is not what is expected it may be worthy of credit.

Using the mark scheme

The mark scheme gives you:

- an idea of the types of response expected
- how individual marks are to be awarded
- the total mark for each question
- examples of responses that should NOT receive credit.

Candidates must make their meaning clear to the examiner to gain the mark. Make sure that the answer makes sense. Do not give credit for correct words/phrases which are put together in a meaningless manner. Answers must be in the correct context.

/ means that the responses are alternatives and either answer should receive full credit.

() means that a phrase/word is not essential for the award of the mark, but helps the examiner to get the sense of the expected answer.

[] words inside square brackets are instructions or guidance for examiners.

Phrases/words in **bold** indicate that the meaning of the phrase or the actual word is essential to the answer.

CQ (consequential) means that a wrong answer given in an earlier part of a question is used correctly in answer to a later part of the same question.

There is space at the bottom of each page of this mark scheme for examiners to write their notes.

Note:

If a candidate has crossed out an answer and written new text, the crossed out work should be ignored. If the candidate has crossed out work, but written no new text, the crossed out work for that question or part question should be marked, as far as it is possible to do so.

	EXPECTED ANSWER	ACCEPT	REJECT	MARK
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1	(a)		Neutrons	Electrons	Words or numbers		3 marks																						
		$^{24}_{12}\text{Mg}$		12																									
		$^{26}_{12}\text{Mg}$	14																										
		$^{24}_{12}\text{Mg}^{2+}$		10																									
		1 mark each number																											
	(b)	<p>(i) Mg</p> <table style="margin-left: 40px;"> <tr> <td>1s</td> <td>2s</td> <td>2p</td> <td>3s</td> <td>3p</td> </tr> <tr> <td><input type="text"/></td> <td><input type="text"/></td> <td><input type="text"/>↑↓ <input type="text"/>↑↓ <input type="text"/>↑↓</td> <td><input type="text"/>↑↓</td> <td><input type="text"/> <input type="text"/> <input type="text"/></td> </tr> </table> <p>(ii) Cl</p> <table style="margin-left: 40px;"> <tr> <td>1s</td> <td>2s</td> <td>2p</td> <td>3s</td> <td>3p</td> </tr> <tr> <td><input type="text"/></td> <td><input type="text"/></td> <td><input type="text"/>↑↓ <input type="text"/>↑↓ <input type="text"/>↑↓</td> <td><input type="text"/>↑↓</td> <td><input type="text"/>↑↓ <input type="text"/>↑↓ <input type="text"/>↑</td> </tr> </table> <p>Arrows can be</p> <p style="margin-left: 40px;">↑ for ↑</p> <p style="margin-left: 40px;">↓ for ↓</p>					1s	2s	2p	3s	3p	<input type="text"/>	<input type="text"/>	<input type="text"/> ↑↓ <input type="text"/> ↑↓ <input type="text"/> ↑↓	<input type="text"/> ↑↓	<input type="text"/> <input type="text"/> <input type="text"/>	1s	2s	2p	3s	3p	<input type="text"/>	<input type="text"/>	<input type="text"/> ↑↓ <input type="text"/> ↑↓ <input type="text"/> ↑↓	<input type="text"/> ↑↓	<input type="text"/> ↑↓ <input type="text"/> ↑↓ <input type="text"/> ↑	Both arrows up or both down	Numbers	2 marks
1s	2s	2p	3s	3p																									
<input type="text"/>	<input type="text"/>	<input type="text"/> ↑↓ <input type="text"/> ↑↓ <input type="text"/> ↑↓	<input type="text"/> ↑↓	<input type="text"/> <input type="text"/> <input type="text"/>																									
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NOTES:

	EXPECTED ANSWER	ACCEPT	REJECT	MARK
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(c)	$\text{Mg(s)} + \text{Cl}_2(\text{g}) \rightarrow \text{MgCl}_2(\text{s})$ Formulae (1) State symbols (1) - only if formulae correct or near miss for MgCl_2 (e.g. $\text{MgCl}/\text{Mg}_2\text{Cl}$)	Multiples $\text{Mg}^{2+}(\text{Cl}^-)_2(\text{s})$	$\text{“Mg}^{2+} + 2\text{Cl}^-”$ for MgCl_2 (0 mark)	2 marks
(d)	$\frac{(56.25 \times 70) + (37.50 \times 72) + (6.25 \times 74)}{100} \quad (1)$ $= 71 \quad (1)$ Any unit max 1 <i>2nd mark consequential on fraction provided 70, 72 and 74 used</i>	Answer ≥ 2 SF	Use of Ar (0 mark) Just “71” with no working (0 mark)	2 marks
(e)	$\frac{4.73}{71}$ moles (1) $\times 30.6 = 2.04 \text{ dm}^3$ (1) Answer with no working 1 max	<i>Consequential if wrong answer to (d) used.</i> <i>71 used when (d) incorrect</i> Answer ≥ 2 SF	No or incorrect unit of volume (loses 1 mark)	2 marks

NOTES:

	EXPECTED ANSWER	ACCEPT	REJECT	MARK
(f)	<p>Type - Metallic(1)</p> <p>Attraction between Mg^{2+} (1)</p> <p>And (surrounding) sea of electrons/delocalised electrons (1)</p> <p>Stand alone</p>	Cations/positive ions /magnesium ions	atoms/nuclei/ions “force between” if used instead of “attraction”	3 marks
(g)	<p>Ionic (1)</p> $\left[\begin{array}{ccc} & oo & \\ o & Mg & o \\ & oo & \end{array} \right]^{2+} \quad 2 \left[\begin{array}{ccc} & oo & \\ o & Cl & o \\ & oo & \end{array} \right]^{-}$ <p>OR</p> $\left[\begin{array}{ccc} & oo & \\ o & Cl & o \\ & oo & \end{array} \right]^{-} \quad \left[\begin{array}{ccc} & oo & \\ o & Mg & o \\ & oo & \end{array} \right]^{2+} \quad \left[\begin{array}{ccc} & oo & \\ o & Cl & o \\ & oo & \end{array} \right]^{-}$ <p>Correct charges and number of ions (1)</p> <p>Correct electronic structures (1)</p> <p>Stand alone</p>	<p>Diagram without brackets</p> <p>Mg with no electrons shown ie $[Mg]^{2+}$</p>	<p>Any suggestion of electrons being shared</p> <p>$[Mg^{\bullet}]^{+}$</p>	3 marks
Total 17 marks				

NOTES:

	EXPECTED ANSWER	ACCEPT	REJECT	MARK
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2	(a)	<i>Penalise lack of nucleus/atom once only in (i) and (ii)</i> <i>Penalise use of element each time it occurs</i>			
		(i)	The number of protons in the nucleus of an atom (of an element) <i>OR</i> The number of protons in an atom/nucleus (of an element)		the number of protons in an element the number of protons 1 mark
		(ii)	The number of protons plus the number of neutrons in the nucleus (of an atom) <i>OR</i> number of nucleons (in the nucleus of an atom)	“and neutrons” instead of “plus the number of.....”	The number of protons plus neutrons in an element 1 mark
	(b)	(i)	<u>C and L</u> (1) (Group 0 elements) have the highest (first) ionisation energy (of each period) (1) Stand alone	implied e.g. immediately precedes large drop Group 0 elements have the highest peaks on the graph highest (effective) nuclear charge/highest number of protons in period	high first I.E. filled shell smallest atom same shielding 2 marks

NOTES:

	EXPECTED ANSWER	ACCEPT	REJECT	MARK
	(ii) F (1) Third after noble gas/C (1) Or first element in period with p electron (1)	first mini dip after big drop lowest after Group 1/D in same period (1) (In F, e ⁻ removed from) p orbital is at a higher energy level than s orbital (in E)	just “electron in p orbital” just “s orbitals shield p”	2 marks
	(iii) Increase in (effective) nuclear charge (1) Same shielding <i>OR</i> same number of electrons in inner shell/orbitals (1) Stand alone	Number of protons/atomic number	Same distance from nucleus increased size of nucleus Same number of shells Electrons in same shell	2 marks
				Total 8 marks


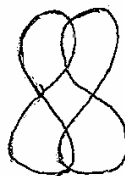

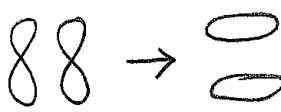
NOTES:

			EXPECTED ANSWER	ACCEPT	REJECT	MARK
3	(a)	(i)	$2\text{Na} + \text{O}_2 \rightarrow \text{Na}_2\text{O}_2$ <i>IGNORE state symbols</i>	$4\text{Na} + \text{O}_2 \rightarrow 2\text{Na}_2\text{O}$ or multiples	NaO	1 mark
		(ii)	$\text{Ba} + 2\text{H}_2\text{O} \rightarrow \text{Ba}(\text{OH})_2 + \text{H}_2$ <i>IGNORE state symbols</i>	multiples	$\text{Ba} + \text{H}_2\text{O} \rightarrow \text{BaO} + \text{H}_2$	1 mark
		(iii)	$\text{NaCl} + \text{H}_2\text{SO}_4 \rightarrow \text{NaHSO}_4 + \text{HCl}$ OR $2\text{NaCl} + \text{H}_2\text{SO}_4 \rightarrow \text{Na}_2\text{SO}_4 + 2\text{HCl}$ <i>IGNORE state symbols</i>	multiples	HNaSO ₄	1 mark
	(b)	(i)	Green/pale green/apple green	yellow-green	Any mention of blue e.g. blue green OR Any other colour	1 mark
		(ii)	Red	deep/dark red / carmine/crimson /scarlet	Lilac Any mention of lilac e.g. lilac-red OR any other colour	1 mark

NOTES:

	EXPECTED ANSWER	ACCEPT	REJECT	MARK												
	(c) Electrons (absorb heat/energy) and are promoted to higher energy levels (1) as they drop back/down (1) Emit radiation (of characteristic colour) <i>OR</i> emit light (1)	“excited/go” instead of “promoted” “orbitals/shells” instead of “energy levels”	If any reference to absorption spectra e.g. light absorbed (0) (produce) colours (0)	3 marks												
	(d) Percentage oxygen (=45.1) (1) $\div A_r$ (1) Empirical formula = KO_2 (1) e.g. Percentage of oxygen = 45.1 (1) <table style="margin-left: 40px;"> <tr> <td style="padding-right: 20px;">K</td> <td>O</td> <td></td> </tr> <tr> <td style="padding-right: 20px;"><u>54.9</u></td> <td><u>45.1</u></td> <td>(1)</td> </tr> <tr> <td style="padding-right: 20px;">39</td> <td>16</td> <td></td> </tr> <tr> <td style="padding-right: 20px;">1.41</td> <td>2.82</td> <td></td> </tr> </table> KO_2 (1)	K	O		<u>54.9</u>	<u>45.1</u>	(1)	39	16		1.41	2.82		Use of atomic numbers 2 max use of “ O_2 ” $M_r \sim 32$ but only if give formula KO_2 (for 3 marks)	Mole calculation - then inverted, no consequential marking on formula	3 marks
K	O															
<u>54.9</u>	<u>45.1</u>	(1)														
39	16															
1.41	2.82															

NOTES:

	EXPECTED ANSWER	ACCEPT	REJECT	MARK
(e)	<p>Sigma: end on overlap between s and s <i>OR</i> s and p <i>OR</i> p and p orbitals</p> <p>Pi :sideways overlap between p and p orbitals</p> <p>One or both explanations wrong but correct diagrams (or vice versa) (1)</p>	<p>or or</p>  <p>Overlap of hybrid orbitals for</p> <p>p</p> 	 	<p>1 mark</p> <p>1 mark</p>
				Total 13 marks

NOTES:

	EXPECTED ANSWER		ACCEPT	REJECT	MARK	
4	(a)	(i)	Minimum of one shaded blob and one clear blob labelled (1) Labels are: Na ⁺ or sodium ion <u>and</u> Cl ⁻ or chloride ion		Na and Cl (ie no charge) sodium chlorine	1 mark
		(ii)	Strong (force of) attraction between (oppositely charged) ions (1) a lot of energy needed to separate ions (1)	Held together by strong ionic forces/bonds “attraction” may be implied by “breaking bonds” a lot of energy implies “strong” break ionic bonds break lattice	Any reference to atoms or molecules Or covalent bonds Or intermolecular forces Or metallic bonds (scores zero) All the bonds need to be broken	2 marks
	(b)		Covalent between carbon atoms in plane (1) Van der Waals’ between planes of carbon atoms (1) Names not linked to bonds (max 1)	Induced dipole/ dispersion/ London forces/temporary dipoles	Giant covalent delocalised e ⁻	2 marks

NOTES:

	EXPECTED ANSWER	ACCEPT	REJECT	MARK
	(c) Covalent Label not needed		Giant covalent BUT do not penalise twice	1 mark
	(d) Covalent bonds in diamond are shorter than the distance between layers in graphite (1) The atoms in diamond are packed closer together (1)	Layers in graphite are far apart (1)		2 marks
				Total 8 marks

NOTES:

			EXPECTED ANSWER	ACCEPT	REJECT	MARK
5	(a)	HF HCl HBr HI	hydrogen bonding /H bonding (1) van der Waals' } (1) - all three needed	Induced dipole/ dispersion/ London/temporary dipole forces any combination	just "hydrogen" dipole-dipole	2 marks
	(b)	(The boiling temperature of HF is higher) because the hydrogen bonding between HF molecules is stronger than the intermolecular forces in HCl (1) The rise from HCl to HI is because the strength of the van der Waals' forces (etc) increases (1) with increase in number of electrons (1)		H bonding strongest/strong	Any mention of ions, ionic bonds or covalent bonds (scores 0) Bigger mass/size for 3 rd mark	3 marks
						Total 5 marks

NOTES:

	EXPECTED ANSWER	ACCEPT	REJECT	MARK
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6	(a)	(i)	$2\text{ClO}^- + 4\text{H}^+ + 2\text{e}^{(-)} \rightarrow \text{Cl}_2 + 2\text{H}_2\text{O}$ (1)	Any multiples		1 mark
		(ii)	$2\text{Cl}^- \rightarrow \text{Cl}_2 + 2\text{e}^{(-)}$ (1)	Any multiples		1 mark
	(b)		$\text{ClO}^- + 2\text{H}^+ + \text{Cl}^- \rightarrow \text{Cl}_2 + \text{H}_2\text{O}$ (1) - <i>stand alone</i> not consequential on wrong equation in (a)	Any multiples		1 mark
	(c)	(i)	$\text{Cl}_2 + 2\text{Br}^- \rightarrow 2\text{Cl}^- + \text{Br}_2$ (1) Ignore states	Any multiples		1 mark
		(ii)	Oxidising agent Ignore "displaces" Mark independently of (c)(i)	To oxidise bromide (ions)	just "oxidation"	1 mark

NOTES:

	EXPECTED ANSWER	ACCEPT	REJECT	MARK	
(d)	<p>Moles of $\text{BCl}_3 = \frac{12.3}{117.5} \text{ mol (1) } = 0.1046/0.105$</p> <p>amount of water = 3 x moles BCl_3 (1) = 0.3154/0.315</p> <p>Mass of $\text{H}_2\text{O} = \text{moles H}_2\text{O} \times 18 = 5.65/5.67(\text{g})$ (1)</p> <p>Answer = 5.4 (g) or 5 (g) - from rounding to 1 s.f. max 2</p> <p>Correct answer with some working scores 3 marks</p> <p>Mass H_2O only (1 max)</p>	<p>Any alternative method e.g</p> <p>1 mol BCl_3 reacts with 3 mol H_2O (1)</p> <p>117.5 g BCl_3 reacts with 54 g H_2O (1)</p> <p>12.3 g BCl_3 reacts with <u>54×12.3</u> g H_2O 117.5</p> <p>= 5.65 g (1)</p> <p>Answer ≥ 2 SF</p>			3 marks
(e)	<p>Hydrogen ions/H^+/H_3O^+/oxonium ions formed (from HCl and H_3BO_3)(1)</p>	<p>presence of/contains H^+ ions</p> <p>Hydroxonium ions</p>	<p>HCl/H_3BO_3 is an acid</p> <p>H^+ ions from water</p> <p>just "H^+ ions"</p>		1 mark
					Total 9 marks

NOTES: