Mark Scheme (Final)

Summer 2008

GCE

GCE Chemistry (6241/01)

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General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

Using the mark scheme

1 / means that the responses are alternatives and either answer should receive full credit.
2 ( ) 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.
3 [ ] words inside square brackets are instructions or guidance for examiners.
4 Phrases/words in **bold** indicate that the <u>meaning</u> of the phrase or the actual word is **essential** to the answer.
5 ecf/TE/cq (error carried forward) 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.

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (a)(i)	High energy/fast/gun electrons **hit/strike** *OR* bombarded by electrons **(1)** Removes/knocks out /causes loss of electron *OR* equation e.g. $X \rightarrow X^{+} + e^{(-)}$ OR $X + e \rightarrow X^{+} + 2e$ **(1)** *IGNORE state symbols* *If knock out is mentioned, hit/strike is not required in 1st mark*		Any suggestion that a negative ion is produced score zero overall If just "forms a cation/positive ion", not sufficient for second mark	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (a)(ii)	Mass **(1)** Charge **(1)** *Ignore the following:* *speed* *kinetic energy* *size/volume* *radius* *charge density* *density*	Weight Mass: charge ratio OR m/e OR m/z **(1)**		2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (b)	**1^{st} mark** (stand alone) The mass of an **atom** (of the isotope) **(1)** **2^{nd} mark** (stand alone) Relative to $^{1}/_{12}{}^{th}$ the mass of a ^{12}C (atom) OR Relative to ^{12}C = 12(exactly) OR On a scale where C^{12} has a mass of 12 **(1)** **If 'atom' missing from 1^{st} mark it can score if mentioned in 2^{nd} mark**	**1^{st} mark** The mass of a mole of the **isotope (1)** **2^{nd} mark** Relative to $^{1}/_{12}{}^{th}$ the mass of a **mole** of ^{12}C OR On a scale where a **mole** of C^{12} has a mass of 12 g **(1)** **Must mention the word 'mole' at least once in these definitions** **Answer must be either consistently atoms or moles in order to be awarded both marks**	Average mass/ weighted average/ Element instead of isotope	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (c)	[(49.95 x 4.345)+(51.94 x 83.79)+(52.94 x 9.501)+(53.94 x 2.364)]/100 **(1)** = 51.9958 = 52.00 *must be to 4 SF***(1)** Correct answer to 4SF with no working **(2)** Should not have units but allow g mol^{-1} Allow error carried forward only on transcription error of mass or percentage	51.99 scores (1) not (2)	52 52.0 52.00 g	2

<table>
<tr><th>Question Number</th><th>Correct Answer</th><th>Acceptable Answers</th><th>Reject</th><th>Mark</th></tr>
<tr><td>1 (d)</td><td>
<table>
<tr><td>1s</td><td>2s</td><td colspan="3">2p</td><td>3s</td><td colspan="3">3p</td><td colspan="5">3d</td><td>4s</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td>↿⇂</td><td>↿⇂</td><td>↿⇂</td><td>↿⇂</td><td>↿⇂</td><td>↑</td><td>↑</td><td>↑</td><td>↑</td><td>↿⇂</td></tr>
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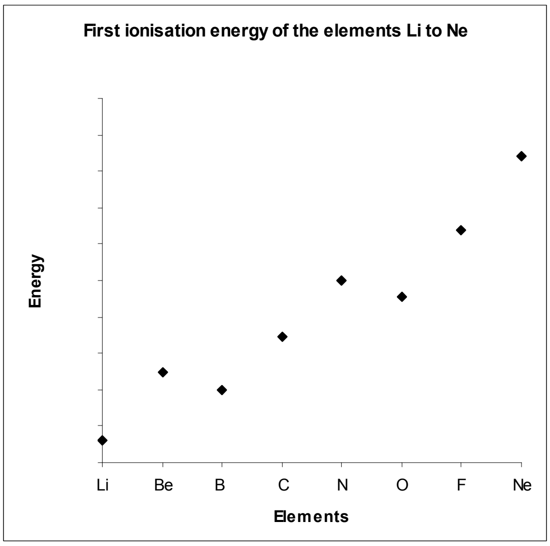
2 marks for fully correct configuration
1 mark if 26 electrons with 2 in 4s but the 3d electrons shown as pairs

Ignore the way the arrow heads point in the singly occupied 3d boxes.

Allow half arrows ↿⇂ or | or ↿ or any combination in any box</td><td>Vertical lines in place of arrows 1 max</td><td></td><td>2</td></tr>
</table>

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (a)	 General increase, starting with carbon above boron **(1)** Dip from N to O only **(1)**	Lines joining points do not need to be drawn in. a very small drop from N to O		2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (b)	• The **nuclear** charge/proton number increases / becomes more positive **(1)** • The (inner shell) shielding is the same/same number of inner shell electrons/ no or little increase in shielding **(1)** **Either** • **Outer** electron closer to nucleus /**atomic** radius decreases /size of atom decreases **Or** • electrons being removed are in same shell **Or** • **Outer** electrons are in same shell **(1)**		Atomic Number increasing	3

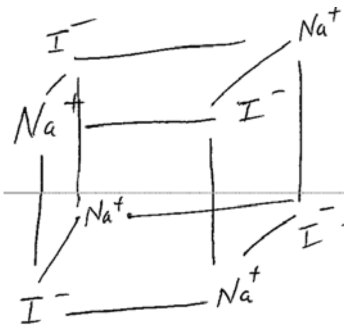
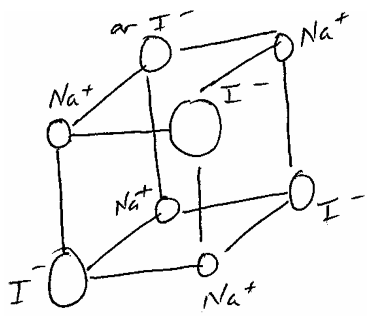
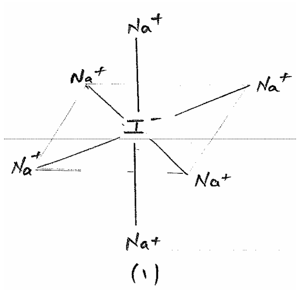
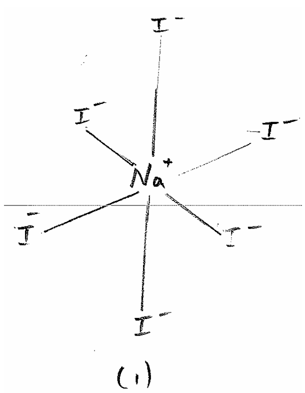
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (c)	In boron the extra electron is in a p orbital /new sub-shell **(1)** **Either** Which has extra shielding (by the s orbital electrons) **OR** Which is at a higher energy (level than the s orbital in Be) **(1)**	Reverse argument for beryllium	Shell for sub-shell Answers that refer to full shell being left do not score second mark Further from the nucleus	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (a)	$Mg^{+}(g) \rightarrow Mg^{2+}(g) + e^{(-)}$ $Mg^{+}(g) - e^{(-)} \rightarrow Mg^{2+}(g)$ Species **(1)** State symbols **(1)** Ignore (g) as state symbol for e^{-}	$X^{+}(g) \rightarrow X^{2+}(g) + e$ Or any other symbol can score SS mark only	Any other equations score zero	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (b)(i)	Dative /dative covalent/co-ordinate	"dative co**n**valent"	Just "covalent"	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (b)(ii)	Co**v**alent	Polar covalent	Any reference to hydrogen bonding	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (c)	*Please read complete answer first* **1st mark Stand alone** The Mg^{2+}/cation/Mg ion has (the same charge but) smaller size OR Mg^{2+}/cation has larger charge density **(1)**	Reverse argument based on Ba^{2+}	Mention of molecules and atoms throughout answer scores **(0)** Penalise omission of ions only once	3
	2nd Mark Mg^{2+}/cation /Mg ion is more polarising OR Carbonate anion more polarised **(1)**	Mg^{2+}/cation /Mg ion has greater polarising power	Mention of covalency between metal and carbonate/ electronegativity/ vdW or other intermolecular forces / polarising power of the carbonate ion scores zero for last 2 marks	
	3rd mark We are looking for some effect on the carbonate ion of the above Carbon to oxygen bond weakened OR Weakens (covalent) bonds **in** the carbonate OR electrons in anion pulled towards the cation OR Distorts the electron cloud (around the carbonate)		Weakens IONIC BONDS	

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (a)(i)	Diagram with Layer made of alternate identified Na^+/sodium ion **and** I^-/iodide ion **(1)** Extended to more than one layer **(1)**   Also allow  	Correct structure with + for Na^+ and – for I^- scores (2) Correct unlabelled structure or with omission of charges scores (1)	If label it NaCl max 1	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (a)(ii)	Ionic radius /Size of ion **(1)** Charge **(1)**	Size and charge scores (2) Charge density scores (1)	Any reference to size of element, atoms or molecules loses first mark Nuclear charge	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (a)(iii)	Iod**ide** (ion) larger than chlor**ide** (ion) (but has same charge) larger ionic radius **(1)** *Note* *References to iodine and/or chlorine loses 1st mark* (So increase distance between centres of charge means)forces of attraction are less/ weaker ionic bond OR Cl^- has higher charge density so stronger attraction to Na^+ **(1)**	Reverse argument	References to atoms, molecules or other forces such as vdW or covalent bonding scores zero overall	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (b)	In molten (NaI) the ions are free to move **(1)** (and carry the current) In solid (NaI) the ions are in fixed lattice / fixed position /cannot move**(1)** Both stand alone	In the solid, there are no mobile charge carriers	Electron movement scores **(0)**	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (c)	**Strong** attraction between **ions** (in liquid) OR **Strong** forces/bonds/ionic bonds (in liquid) Or Lots of energy needed to overcome the ionic attraction or Needs a lot of energy to break ionic bonds (in liquid) **(1)**		Any reference to lattice/melting	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5 (a)(i)	$Cl_2 + 2NaBr \rightarrow Br_2 + 2NaCl$ OR $Cl_2 + 2Br^- \rightarrow Br_2 + 2Cl^-$ Ignore state symbols	multiples		1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5 (a)(ii)	Disproportionation **(1)** (Bromine oxidised from 0) goes to +1 and (reduced from 0) goes to -1 **(1)** **These could be shown as annotation on the equation** Answer must be in terms of change of oxidation number. Correct references to gain and loss of electrons are non-scoring points	Redox Any reasonable spelling	A general definition of disproportionation i.e. no reference to bromine	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5 (a)(iii)	SO_2 + 4 etc **(1)** H_2SO_4 + 6 etc **(1)** If both S^{4+} and S^{6+} given award **1 (out of 2)**	4+ IV +IV Four 6+ VI +VI six	S^{4+} S^{6+}	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5 (a)(iv)	The oxidation number of S is increasing (so bromine is acting as an oxidising agent) Or oxidation number of Br is decreasing so it must be acting as an oxidising agent ecf but do not award this mark if the ON of S in H_2SO_4 is shown as less than or equal to that in SO_2 in (iii)	(The oxidation number of) S goes from +4 to +6	If say oxidation number of bromine goes from 0 to -2 score zero	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5 (b)(i)	$SO_2 + 2H_2O \rightarrow SO_4^{2-} + 4H^+ + 2e^{(-)}$ **OR** $SO_2 + 2H_2O - 2e^{(-)} \rightarrow SO_4^{2-} + 4H^+$	multiples		1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5 (b)(ii)	**Correct balanced equation** **$2\ IO_3^- + 5\ SO_2 + 4H_2O \rightarrow I_2 + 5\ SO_4^{2-} + 8H^+$ (2)** If candidate gives this equation with one omission in balancing numbers or one ionic charge, check rest of working to see if this is a transcription error in final answer. If so, award one mark Also allow 1 mark for: $2IO_3^- + 12H^+ + 5SO_2 + 10H_2O \rightarrow I_2 + 5SO_4^{2-} + 20\ H^+ + 6H_2O$ **(1)** [There is no consequential marking from (i)]	multiples		2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
6 (a)(i)	(pale) green	apple green yellow(y) green	blue green	1

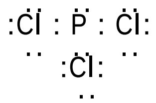
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
6 (a)(ii)	Crimson	Red Scarlet Carmine Depth of red colour e.g. Dark red Deep red Pale red Light red Bright red	Red with any other colour e.g. Brick-red Orange-red Yellow-red Magenta	1

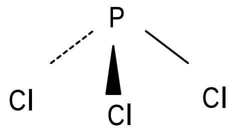
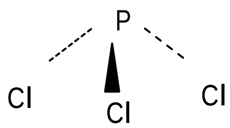
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
6 (b)	Ba O $\frac{81.1}{137}$ $\frac{18.9}{16}$ **(1)** = 0.592 = 1.18 1 2 Correct working leading to answer BaO_2 **(1)** Working must be shown and final formula given for 2 marks BaO_2 without working 1 mark	Dividing by 32 scores **(0) unless** their table is headed by O_2, then answer BaO_2 scores **(1)** but if this is the case BaO scores **(0)**	Any answer dividing by atomic number **(0)** This leads to Ba_2O	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
6 (c)(i)	$Ba + 2H_2O \rightarrow Ba(OH)_2 + H_2$ Ignore state symbols even if they are wrong	Multiples	Equations based on BaO	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
6 (c)(ii)	• Gets warm • Effervescence/fizzing/ bubbles/mist • Ba sinks/moves up and down /Does not float *Give one mark for observation from each bullet point to max of 2* 3 answers given, one wrong scores (1) 3 answers given, two wrong scores zero Ignore mention of Steam/steamy fumes Ba gets smaller Ba disappears Goes cloudy / precipitate Gas/hydrogen evolved is not an observation	Heat produced Bubbles of hydrogen	Reference to flame Melts Dashes about on surface are wrong answers	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
6 (c)(iii)	*Red litmus* (goes) blue/ "(→) blue" **and** *blue litmus* unchanged/stays blue/no effect/nothing			1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
7 (a)(i)	 8 electrons around each Cl **(1)** three shared pairs and one lone pair around P **(1)** *If symbols omitted max 1*	All dots or all crosses		2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
7 (a)(ii)	 	Must be an attempt to draw as a pyramid. Wedge, dashes, both. If draw 3 lines must not look planar Ignore name unless they say planar Ignore indicated bond angles unless it is written as 120^{o}	Planar triangular even if no lone pair shown in part (i)	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
7 (a)(iii)	**Mark consequentially on part (a)(ii)** **1st mark** PCl_3 has 4 pairs of electrons/3 bond and 1 lone pair **(1)** **2nd mark** The electron pairs repel to a position of maximum separation /minimum repulsion OR lp-bp repulsion > bp-bp **(1)** **3rd mark** CH_4 has 4 bonding pairs of electrons so angle **less** in PCl_3 or more in CH_4 OR CH_4 has no lone pairs so angle **less** in PCl_3 or more in CH_4 **(1)** **If in part (ii) they give a structure which <u>is planar triangular</u> they can score full marks for a correct description of why it is planar triangular i.e.** PCl_3 has 3 pairs of electrons **(1)** The electron pairs repel to a position of maximum separation /minimum repulsion **(1)** So the angles are 120 ^{o} for PCl_3 and CH_4 has 4 bonding pairs of electrons, so 109(.5) ^{o} for CH_4 **(1)**	Phosphorus in PCl_3 has a lone pair but carbon in CH_4 has no lone pairs scores first mark	Repulsion of atoms or bonds	3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
7 (b)(i)	Ignore sig figs unless they round to 1 sig.fig during calculation Incorrect /absent units in final answer penalise only once in part (i)/(ii) 7.19 g of PCl_5 = $\frac{7.19}{208.5}$ mol **(1)** (= 0.03448) (1 mol of PCl_5 from 1 mol of P) Mass of P = 0.03448 x 31 = 1.07 g **(1)** Penalise use of Atomic Number only once Answer with no working scores 2	2 x 31 g of P produce 2 x 208.5 g of PCl_5 **(1)** 7.19 g of PCl_5 from $\frac{2 \times 31 \times 7.19}{2 \times 208.5}$ =1.07g **(1)** Allow 0.034 but NOT 0.035		2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
7 (b)(ii)	Mark consequentially on part (i) Moles of chlorine needed = 0.03448 x 2.5 **(1)** Volume = 24 x 0.03448 x 2.5 = 2.07 dm^3 **(1) -** Value **and** unit necessary Value consequential on their calculated/stated moles of chorine x 24 Answer with no working scores 2	2 x 208.5 g of PCl_5 produced from 5 x 24 dm^3 of Cl_2 **(1)** 7.19 g PCl_5 produced from $\frac{5 \times 24 \times 7.19}{2 \times 208.5}$ = 2.07 dm^3 **(1)**	Just 24 x 2.5 = 60 dm^3 scores zero	2