

GCE 2005

January Series



Mark Scheme

Chemistry

CHM1 Atomic Structure, Bonding and Periodicity

Mark schemes are prepared by the Principal Examiner and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation meeting attended by all examiners and is the scheme which was used by them in this examination. The standardisation meeting ensures that the mark scheme covers the candidates' responses to questions and that every examiner understands and applies it in the same correct way. As preparation for the standardisation meeting each examiner analyses a number of candidates' scripts: alternative answers not already covered by the mark scheme are discussed at the meeting and legislated for. If, after this meeting, examiners encounter unusual answers which have not been discussed at the meeting they are required to refer these to the Principal Examiner.

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Dr Michael Cresswell Director General

Guidance on the award of the mark for Quality of Written Communication

Quality of Written Communication assessment requires candidates to:

- select and use a form and style of writing appropriate to purpose and complex subject matter;
- organise relevant information clearly and coherently, using specialist vocabulary when appropriate; and
- ensure text is legible, and spelling, grammar and punctuation are accurate, so that meaning is clear.

For a candidate to be awarded 1 mark for quality of written communication on the question identified as assessing QWC in a unit test, the minimum acceptable standard of performance should be:

- the longer parts (worth 4 marks or more) should be structured in a reasonably logical way, appropriate and relevant to the question asked;
- ideas and concepts should be explained sufficiently clearly to be readily understood. Continuous prose should be used and sentences should be generally be complete and constructed grammatically. However, minor errors of punctuation or style should not disqualify;
- appropriate AS/A level terminology should be used. Candidates should not use such phrases as ‘fighting disease’, ‘messages passing along nerves’, ‘enzymes being killed’ etc, but a single lapse would not necessarily disqualify. Technical terms should be spelled correctly, especially where confusion might occur, e.g. mitosis/meiosis, glycogen/glucagon.

The Quality of Written Communication mark is intended as a recognition of competence in written English. Award of the mark should be based on overall impression of performance on the question identified on the paper as assessing QWC. Perfection is not required, and typical slips resulting from exam pressure such as ‘of’ for ‘off’ should not be penalised. Good performance in one area may outweigh poorer performance in another. Care should be taken not to disqualify candidates whose lack of knowledge relating to certain parts of a question hampers their ability to write a clear and coherent answer; in such cases positive achievement on other questions might still be creditworthy. No allowance should be made in the award of this mark for candidates who appear to suffer from dyslexia or for whom English is a second language. Other procedures will be used by the Board for such candidates.

Examiners should record 1 or 0 at the end of the paper in the Quality of Written Communication lozenge. This mark should then be transferred to the designated box on the cover of the script.

CHM1 Atomic Structure, Bonding and Periodicity**SECTION A****Question 1**

- (a) (i) $p + n$ / number of nucleons (accept protons and neutrons) 1
 (Incorrect reference to electrons = contradiction)
- (ii) Mean / average mass of an molecule/entity/formula 1
 $1/12^{\text{th}}$ mass of atom of ^{12}C 1
 [Not $1/12^{\text{th}}$ mass of molecule of ^{12}C] (mark independently)
- OR** Mass of 1 mole of molecules/entities (1)
 $1/12^{\text{th}}$ mass of 1 mole of ^{12}C (1)
- OR** Average mass of a molecule/entity (1)
 Relative to the mass of a ^{12}C atom taken as 12 / 12.000 (1)
- (Mean/average = stated or explained)
 (mass = stated or explained)
 (Penalise 'weight' once only)
 (Ignore 'average' mass of ^{12}C)
 (Do not allow 'mass of average molecule')
- (b) (i) $2s^2 2p^6 3s^2 3p^6 4s^1 3d^{10}$ (accept $3d^9 4s^2$) 1
 (accept subscripts or caps)
 [Penalise missing shell numbers]
- (ii) d / D [NOT 3d/ 'transition element'] 1
- (iii) 36 [NOT 36.0] 1

(c) (i)	More ^{63}Cu atoms than ^{65}Cu atoms (<i>idea of more abundant ^{63}Cu isotope – NOT just reference to peak heights</i>)	1
(ii)	Electron from electron gun / high speed electron / high energy electron (<i>accept electron gun fired at</i>) [<i>NOT 'bombarded with electrons'</i>] knock electron off (Cu atom) / idea of loss of e^- / appropriate equation (<i>Mark independently</i>)	1 1
(iii)	$^{63}\text{Cu}^{2+}$ or equivalent [<i>NOT 63.0 - penalise this error once only</i>]	1
	$m/z = 63/2 (= 31.5)$ or equivalent	1
	More energy needed to remove second electron OR	1
	$^{63}\text{Cu}^{2+}$ statistically less likely to remove second electron (<i>Idea that not many $^{63}\text{Cu}^{2+}$ ions formed OR explains why few are formed e.g. more energy needed</i>) <i>If ^{63}Cu not given, can only award M2 & M3</i>	
Notes on	[If 65 used, lose M1 and M2]	
(c) (iii)	[If mass number missing from identity but appears in explanation, penalise M1 but allow M2 if earned]	

Total 12

Question 2

(a) (i)	$100 \times 10^{-3} \times 0.500 = 5.00 \times 10^{-2}$ (mol) accept $5 \times 10^{-2} / 0.05$	1
(ii)	$27.3 \times 10^{-3} \times 0.600 = 1.64 \times 10^{-2} / 1.638 \times 10^{-2}$ (mol) <u>only</u>	1
(iii)	1.64×10^{-2} (mol) <i>Mark conseq on (ii)</i>	1
(iv)	$5.00 \times 10^{-2} - 1.64 \times 10^{-2} = 3.36 \times 10^{-2}$ (mol) <i>Mark conseq on (i) & (iii)</i>	1
(v)	$3.36 \times 10^{-2} \times \frac{1}{2} = 1.68 \times 10^{-2}$ (mol) <i>If 2.78×10^{-2} used 1.39×10^{-2}</i>	1
	$1.68 \times 10^{-2} \times 132(.1)$ or $1.39 \times 10^{-2} \times 132(.1)$ <i>Mark for M_r</i>	1
	$= 2.22$ g or 1.83 g	1

(b)	$pV = nRT$		1
	$n = \frac{0.143}{17}$	$= 8.4(1) \times 10^{-3} \text{ (mol)}$	1
	$T = \frac{pV}{nR}$	$= \frac{(1) \times 100000 \times 2.86 \times 10^{-4}}{8.31 \times 8.41 \times 10^{-3}}$	Mark shown on left
	$= 408.5 - 410.5 \text{ (K)}$		1
	<i>Mark conseq on moles</i>		

Note *Sig. fig. penalty - apply once if single sf given, unless calc works exactly*

Total 11

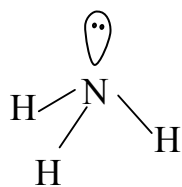
Question 3

(a)	(i)	Electron transfers from Mg to Cl / Mg loses e^- and Cl gains e^-	1
		Mg loses $2e^-$, <u>each</u> Cl gains $1e^-$ <i>(Marks can be awarded from diagrams/equations)</i>	1
	(ii)	Electrostatic attractions / attractions between <u>oppositely charged ions</u> <i>(molecules = CE = 0)</i> Are strong or require much energy to overcome <i>Tied to M1</i> <i>'Ionic bonds are strong' score 1 mark</i>	1 1
(b)	(i)	Tendency / strength / ability / power of an <u>atom</u> / <u>element</u> / <u>nucleus</u> to attract / withdraw electrons / e^- density / bonding pair / shared pair In a <u>covalent</u> bond <i>(tied to M1 – unless silly slip in M1)</i> <i>(If molecule/ion then = CE = 0)</i> <i>(NOT electron (singular) for M1)</i>	1 1
	(ii)	Increasing proton number / nuclear charge <i>(NOT atomic number)</i> Decreasing size / same shielding / same shells	1 1
(c)	(i)	Electron cloud/distribution (around anion) Is distorted or is unequally distributed <i>Marks may be awarded from diagrams</i> <i>'Chloride ion is distorted' scores 1 mark</i> <i>(Reference to dipoles or polarised bond = CE)</i>	1 1
	(ii)	Smaller size <i>(Ignore m/z references)</i> Higher charge or $3^+/2^+$ specified <i>('Higher charge density' scores 1 mark if <u>neither</u> mark awarded above)</i>	1 1
	(iii)	Covalent / covalent character / polar covalent / coordinate / dative <i>[NOT ionic with covalent character]</i>	1

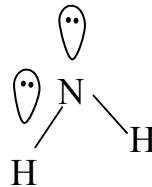
Total 13

Question 4

(ii) (Missing 'H' penalise once only) [NOT dot-and-cross diagrams]



[NOT 90° / 180° angles]



(need 2 lp & 'bent' shape)

(iii) 107° 1(iv) More lone pairs on NH_2^- , than on NH_3 1Lone pairs repel more than bonding pairs *Must be comparison* 1

(Mark separately)

[NOT repulsion between atoms or between bonds]

(b) (i) Simplest ratio of atoms of each element in a compound / substance / species / entity / molecule 1

(ii) 1

	Mg	N	O	
	<u>16.2</u>	<u>18.9</u>	<u>64.9</u>	
	(24)	14	16	

(0.675) 0.667 1.37 4.06 1

1 2 6 MgN_2O_6 (Mark M1 first. If any wrong A_r used = CE = 0)(Accept $\text{Mg}(\text{NO}_3)_2$ for M3 if above working shown)

Total 9

Question 5(a) **QoL** Bonding Both covalent (linked statement) 1Structure Iodine = molecular / I_2 (stated or in diagram) 1

[treat incorrect diagram as contradiction]

Diamond = giant molecular/macromolecular/giant 1

covalent / giant atomic (stated only)

Reference to van der Waals' / dipole-dipole = contradiction

QoL Iodine Weak van der Waals' forces / induced dipole-induced dipole 1Diamond Covalent bonds would need to be broken 1Many / strong covalent bonds **OR** much energy needed 1

Tied to M5 or near miss

[If ionic/metallic structure suggested then CE for that substance]

[If hydrogen bonding suggested, for I_2 lose M2 & M4; for diamond lose

M3, M5 & M6]

- (b) (i) Hydroxide solubility increases (*need trend*) 1
 Sulphate solubility decreases (*need trend*) 1
(If both Mg/Ba salts correctly compared – but no trend – allow 1 max)
- (ii) Add acid name/correct formula HCl 1
(accept HNO₃ / CH₃COOH) [NOT hydrogen chloride]
[If acid added is H₂SO₄ = CE – allow only M2]
 Add Ba²⁺ salt name/correct formula BaCl₂ 1
(accept Ba(NO₃)₂ / Ba(CH₃COO)₂)
[If reagent added is BaSO₄ / Ba / Ba(OH)₂ = CE – allow only M1]
- MgCl₂ No change / no ppt / no reaction 1
 MgSO₄ White ppt / solid / suspension *[NOT chalky, milky]* 1
Both observations tied to Ba²⁺ ions being added
- MgSO₄ + BaCl₂ → BaSO₄ + MgCl₂ 1
- Accept ionic equation
- (Reagent mark (M2) can be awarded from full equation)
- [Treat incorrect equation for MgCl₂ as contradiction of correct equation]
(Ignore carbonate equations) (Ignore state symbols)
- (iii) Reactivity increases (down group) *[NOT solubility increases]* 1
 Ba + 2H₂O → Ba(OH)₂ + H₂ 1

Total 15