GCE 2005
January Series

ASSESSMENT and QUALIFICATIONS ALLIANCE

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.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of candidates' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

Further copies of this Mark Scheme are available to download from the AQA Website: www.aqa.org.uk

Set and published by the Assessment and Qualifications Alliance.

The Assessment and Qualifications Alliance (AQA) is a company limited by guarantee registered in England and Wales 3644723 and a registered charity number 1073334. Registered address AQA, Devas Street, Manchester. M15 6EX. *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 / <u>number</u> of nucleons *(accept protons and neutrons)* 1
(Incorrect reference to electrons = contradiction)

(ii) <u>Mean /average mass of an molecule/entity/formula</u> 1
$1/12^{th}$ mass of atom of ^{12}C 1
[Not $1/12^{th}$ mass of molecule of ^{12}C] (mark independently)

OR <u>Mass of 1 mole of molecules/entities</u> (1)
$1/12^{th}$ 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 1
(idea of more abundant ^{63}Cu isotope – NOT just reference to peak heights)

(ii) Electron from electron gun / high speed electron / high energy electron 1
(accept electron gun fired at)
[NOT 'bombarded with electrons]
knock electron off (Cu atom) / idea of loss of e^- / appropriate equation 1
(Mark independently)

(iii) $^{63}Cu^{2+}$ or equivalent *[NOT 63.0 - penalise this error once only]* 1

m/z = 63/2 (= 31.5) or equivalent 1
More energy needed to remove second electron **OR** 1
$^{63}Cu^{2+}$ statistically less likely to remove second electron
(Idea that not many $^{63}Cu^{2+}$ ions formed **OR** explains why few are formed e.g. more energy needed)
If '^{63}Cu' not given, can only award M2 & M3

Notes on (c) (iii)
[If 65 used, lose M1 **and** M2]
[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 5×10^{-2} / 0.05 1

(ii) $27.3 \times 10^{-3} \times 0.600 = 1.64 \times 10^{-2}$ / 1.638×10^{-2} (mol) only 1

(iii) 1.64×10^{-2} (mol) 1
Mark conseq on (ii)

(iv) $5.00 \times 10^{-2} - 1.64 \times 10^{-2} = 3.36 \times 10^{-2}$ (mol) 1
Mark conseq on (i) & (iii)

(v) $3.36 \times 10^{-2} \times ½ = 1.68 \times 10^{-2}$ (mol) *If 2.78×10^{-2}* used 1.39×10^{-2} 1
Mark conseq on (iv)
$1.68 \times 10^{-2} \times 132(.1)$ **or** $1.39 \times 10^{-2} \times 132(.1)$
Mark for M_r 1
= 2.22 g **or** 1.83 g 1

(b) $pV = nRT$ 1

$n = \frac{0.143}{17} = 8.4(1) \times 10^{-3}$ (mol) 1

$T = \frac{pV}{nR} = \frac{(1)\ 100000 \times 2.86 \times 10^{-4}}{8.31 \times 8.41 \times 10^{-3}}$ Mark shown on left

= 408.5 – 410.5 (K) 1
Mark conseq on moles

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 $2e^-$, each Cl gains $1e^-$ 1
(Marks can be awarded from diagrams/equations)

(ii) Electrostatic attractions / attractions between oppositely charged ions 1
(molecules = CE = 0)
Are strong **or** require much energy to overcome 1
Tied to M1
'Ionic bonds are strong' score 1 mark

(b) (i) Tendency / strength / ability / power of an atom / element / nucleus to attract / withdraw electrons / e^- density / bonding pair / shared pair 1
In a covalent bond 1
(tied to M1 – unless silly slip in M1)
(If molecule/ion then = CE = 0) (NOT electron (singular) for M1)

(ii) Increasing proton number / nuclear charge 1
(NOT atomic number)
Decreasing size / same shielding / same shells 1

(c) (i) Electron cloud/distribution (around anion) 1
Is distorted or is unequally distributed 1
Marks may be awarded from diagrams
'Chloride ion is distorted' scores 1 mark
(Reference to dipoles or polarised bond = CE)

(ii) Smaller size *(Ignore m/z references)* 1
Higher charge **or** $3^+/2^+$ specified 1
('*Higher charge density' scores 1 mark if neither mark awarded above*)

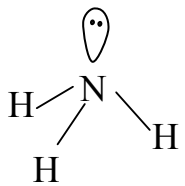
(iii) Covalent / covalent character / polar covalent / coordinate / dative 1
[NOT ionic with covalent character]

Total 13

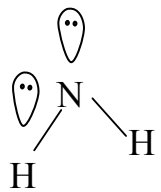
Question 4

(a) (i) $2Na + 2NH_3 \rightarrow 2NaNH_2 + H_2$ *(or multiples)* 1

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



1



1

[NOT 90 ° / 180 ° angles] *(need 2 lp & 'bent' shape)*

(iii) 107 ° 1

(iv) More lone pairs on NH_2^-, than on NH_3 1
Lone 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)

	Mg	*N*	*O*		1
16.2	16.2	18.9	64.9		
(24)	24.3	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 $Mg(NO_3)_2$ for M3 if above working shown)

Total 9

Question 5

(a) **QoL** Bonding Both covalent *(linked statement)* 1
Structure Iodine = molecular / I_2 *(stated or in diagram)* 1
[treat incorrect diagram as contradiction]
Diamond = giant molecular/macromolecular/giant covalent / giant atomic *(stated only)* 1
Reference to van der Waals' / dipole-dipole = contradiction

QoL Iodine Weak van der Waals' forces / induced dipole-induced dipole 1
Diamond Covalent bonds would need to be broken 1
Many / 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 HNO_3 / CH_3COOH) *[NOT hydrogen chloride]*
[If acid added is H_2SO_4 = CE – allow only M2]
Add Ba^{2+} salt name/correct formula $BaCl_2$ 1
(accept $Ba(NO_3)_2$ / $Ba(CH_3COO)_2$)
[If reagent added is $BaSO_4$ / Ba / $Ba(OH)_2$ = CE – allow only M1]

$MgCl_2$ No change / no ppt / no reaction 1
$MgSO_4$ White ppt / solid / suspension *[NOT chalky, milky]* 1
Both observations tied to Ba^{2+} ions being added

$MgSO_4 + BaCl_2 \rightarrow BaSO_4 + MgCl_2$ 1

Accept ionic equation

(Reagent mark (M2) can be awarded from full equation)

[Treat incorrect equation for $MgCl_2$ as contradiction of correct equation]
(Ignore carbonate equations) *(Ignore state symbols)*

(iii) Reactivity increases (down group) *[NOT solubility increases]* 1
$Ba + 2H_2O \rightarrow Ba(OH)_2 + H_2$ 1

Total 15