



General Certificate of Education

Chemistry 5421

**CHM1 Atomic Structure, Bonding and
Periodicity**

Mark Scheme

2009 examination - January series

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

Copyright © 2009 AQA and its licensors. All rights reserved.

COPYRIGHT

AQA retains the copyright on all its publications. However, registered centres for AQA are permitted to copy material from this booklet for their own internal use, with the following important exception: AQA cannot give permission to centres to photocopy any material that is acknowledged to a third party even for internal use within the centre.

Set and published by the Assessment and Qualifications Alliance.

Question	Part	Sub Part	Marking Guidance	Mark	Comments
1	(a)		Part A = electron gun / ionisation chamber;	1	
1	(b)	(i)	Path deviates at the start of the magnet and deflects less than ^{87}Sr ;	1	Allow deviation to start between dashes 3 and 7 curve is smooth and path goes through slits – see samples
1	(b)	(ii)	m/z of $^{88}\text{Sr} > ^{87}\text{Sr}$ (allow mass/mass n^2 /atomic mass $^{88}\text{Sr} > ^{87}\text{Sr}$);	1	Not 'heavier'/atomic number for M1
		Ind	Magnetic field has less effect on higher m/z /heavier ions;	1	Needs link with magnetic field– not just 'defects more/less'
1	(c)		Increase magnetic field strength/decrease in electric field;	1	If decrease magnetic field = CE = 0
			So that ions hit the detector (Tied to M1 or near miss);	1	
1	(d)		$\frac{(84 \times 0.56) + (86 \times 9.86) + (87 \times 7.02) + (88 \times 82.56)}{100}$ = 87.7	1	
				1	Ignore 'g'
1	(e)		's' block;	1	'd' block etc. = CE = 0
			Highest energy/outmost electron in (5)s sublevel (allow missing principal QN but penalise incorrect one (tied to M1 but NOT conseq);	1	Allow sub-shell/orbital Not sub-orbital/level/shell

Question	Part	Sub Part	Marking Guidance	Mark	Comments
2	(a)		$2\text{C}_2\text{H}_2 + 5\text{O}_2 \rightarrow 4\text{CO}_2 + 2\text{H}_2\text{O};$	1	Allow multiples/fractions
2	(b)		$pV = nRT$ $n = \frac{pV}{RT} = \frac{1.01 \times 10^5 \times 3.88 \times 10^{-4}}{8.31 \times 284}$ $= 0.0166/0.0165/0.017 \text{ mol (allow missing units/mol/moles)}$	1 1 1 1	If error in rearrangement, lose M3/M4 Not 0.0170
2	(c)		Moles $\text{CaC}_2 = 0.0166 \text{ mol};$ Mass of $\text{CaC}_2 = 0.0166 \times 64.1 = 1.06 \text{ g};$ % purity = $\frac{1.06}{1.33} \times 100;$ = 79.7 to 80.0 %; (if answer > 100% allow M3 but do not allow M4)	1 1 1 1	(0.017 \Rightarrow 81.9) (0.0155 \Rightarrow 74.7) Inverted expression = CE = 0 for M3/M4 If % <u>impurity</u> calculated lose M4 unless 80% etc. appears in calculation
2	(d)		$\text{H} \cdot \overset{\times \times}{\text{C}} \overset{\times \times}{\text{C}} \cdot \text{H}$ $\text{HC}\equiv\text{CH}$	1	Any unambiguous structure – must show triple bond.
2	(e)	(i)	Simplest/lowest (whole number) ratio of atoms of each element in a compound/molecule;	1	
2	(e)	(ii)	Empirical formula = CH;	1	
2	(f)		$\frac{22.24}{12} \quad \frac{3.71}{1} \quad \frac{74.05}{79.9}$ (allow 80) = 1.85 = 3.71 = 0.927 ratio C:H:Br = 2:4:1 \therefore $\text{C}_2\text{H}_4\text{Br};$ (emp mass = 108 \therefore mol formula = $215.8/107.9 \times \text{C}_2\text{H}_4\text{Br} =$) $\text{C}_4\text{H}_8\text{Br}_2;$	1 1 1	CE if inverted or At N ^o used

Question	Part	Sub Part	Marking Guidance	Mark	Comments
3	(a)	(i)	Difference = particles mobile/free to move/solid particles in fixed positions;	1	
3	(a)	(ii)	Difference = particles close together/gas particles far apart;	1	Not closer etc.
3	(b)		Enthalpy change / energy is used/put in/endothermic to overcome; the forces holding the particles together;	1	Allow for specific system CE = 0 for bond break
3	(c)	(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;	1	Not 'affinity' (tied to M1 – unless silly slip in M1)
3	(c)	(ii)	O more electronegative than S / electronegativity difference OH > SH; Electronegativity <u>difference</u> in SH too small to cause H bonding / en diff in O–H is much greater than in S–H i.e. idea of a minimum electronegativity difference threshold;	1	
3	(c)	(iii)	IMF in H ₂ S = dipole-dipole / van der Waals', which are <u>much</u> weaker than hydrogen bonding;	1	Allow H bonding = strong + vdW = weak
3	(c)	(iv)	N; OR F;	1	
3	(d)		Partial charges shown on H and O used in H bond = min requirement; 2 lp on each oxygen; H-bond indicated between lp on O and H on second molecule;	1 1 1	Apply 'con' if any charges incorrect HO ₂ = CE = 0. If H-bond between 2 H atoms, allow M2 only. Penalise H+O 1 mark.

Question	Part	Sub Part	Marking Guidance	Mark	Comments
4	(a)		Dative / coordinate; Electron pair donated from C/CH ₂ / to H ⁽⁺⁾ ;	1 1	
4	(b)		:CH ₂ shown as 'bent' (trigonal planar with lp and 2 C-H bonds); CH ₃ ⁺ shown as trigonal planar;	1 1	Don't penalise missing charge
4	(c)		:CH ₂ = bent or V-shaped / angular / triangular planar /planar triangular / distorted/irregular trigonal planar; CH ₃ ⁺ = trigonal planar;	1 1	
4	(d)		120° only;	1	

Question	Part	Sub Part	Marking Guidance	Mark	Comments
5	(a)	(i)	Reference to lattice / crystal / regular arrangement / cubic / f.c.c. / diagram;	1	If macromolecular, CE = 0
		Mark Ind	Iodine (molecule) <u>covalently</u> bonded (Not between <u>molecules</u>);	1	If ionic/H-bond/metallic, allow M1 only
			IMF = van der Waals' (allow vdW and normal alternatives – e.g. induced dipole-dipole/dispersion/London etc);	1	
5	(a)	(ii)	Van der Waals' forces / IMFs increase F_2 to I_2 / down group/as you go across;	1	Bond break = CE = 0
			Due to increase in number of e^- / size / M_r / SA / atomic radius/more shells;	1	Not just 'increased mass'
5	(b)		Melting point increases;	1	If mention of IMF/H-bond/ionic/macro etc. allow M1, M5 and M6 only – apply 'con'.
			Metallic bonding described as <u>attraction</u> between +ve lattice / +ve centres / +ve ions / atoms and 'sea' of/delocalised e^- ;	1	If no trend stated, assume Na to Al
			Charge/charge density on Al^{3+} > charge/charge density on Na^+ or inc in number of delocalised e^- / e^- s in 'sea' from Na to Al;	1	
			Stronger attraction/metallic bonding results in higher mp;	1	M4 linked to M3
			Conductivity increases;	1	
			because number of <u>delocalised</u> e^- increases from 1 to 3;	1	Tied to M5
5	(c)		<i>Conditions for magnesium</i> = Steam / high temperature / heat <u>strongly</u>	1	Ignore state symbols
			Equation $Mg + H_2O \rightarrow MgO + H_2$;	1	
			<i>Conditions for Barium</i> = Cold/cool/room temperature water;	1	
			Equation $Ba + 2H_2O \rightarrow Ba(OH)_2 + H_2$;	1	