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ASSESSMENT and QUALIFICATIONS ALLIANCE

General Certificate of Education

Chemistry 5421

CHM1 Atomic Structure, Bonding and Periodicity

Mark Scheme

2009 examination - June series

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Question	Part	Sub Part	Marking Guidance	Mark	Comments
1	(a)	(i)	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^4$ ***OR*** $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^4$;	 1	Not [He] etc.
1	(a)	(ii)	'p' block; Highest energy / outermost e^-/e^-s in 'p' orbital/sub-level;	1 1	 Not sub-orbital/outer orbital is 4p
1	(b)	(i)	Sum of/number of/amount of protons and neutrons	1	accept nucleons in place of p & n
1	(b)	(ii)	^{68}Zn; element = Zn mass number = 68	1 1	Incorrect atomic number negates 'Zn' Not 'ZN' Not decimal mass number (68.0)
1	(c)	(i)	High energy e^- / high speed e^- / e^- from electron gun; Knock e^- off (atom);	1 1	 For M2, allow: $M + e^- \rightarrow M^+ + 2e^-$
1	(c)	(ii)	(Ions) generate/produce a <u>current</u> (on collision at the detector);	1	Not: current detected / current induced / flow of electricity / electric charge / electric impulse
1	(d)		$A_r = \frac{(76 \times 11.2) + (78 \times 23.8) + (80 \times 49.8) + (82 \times 15.2)}{100}$; = 79.4; ignore any units	1 1	Wrong approach or not dividing by 100 = CE = 0. Answer to 1 d.p. Mark conseq on transcription error.

Question	Part	Sub Part	Marking Guidance	Mark	Comments
2	(a)		$Al_2Se_3 + 6H_2O \rightarrow 2Al(OH)_3 + 3H_2Se$;	1	Allow fractions and multiples
2	(b)	(i)	H_2Se = 'bent' shape with 2 lone pairs – based on tetrahedral; NH_3 = pyramidal shape with 1 lone pair;	1 1	
2	(b)	(ii)	Bent / V-shaped /triangular/angular;	1	Not bent-linear
2	(b)	(iii)	107°; Se has 2 lone pairs but N has only 1 lone pair; Lone pairs repel more strongly than bonding pairs / etc;	1 1 1	Allow 106½° - 107½° Allow Se has more lone pairs than N if supported by diagrams
2	(c)		Clear indication that covalent bond is a shared e^- pair; Se supplies one e^- and H supplies one/the other e^-;	1 1	May be inferred from statement that $1e^-$ used from Se and 1 e^- from H Allow M2 for a correct dot-and-cross diagram (not if only dots or crosses used)

Question	Part	Sub Part	Marking Guidance	Mark	Comments
3	(a)	(i)	Moles $BaSO_4$ = 2.10 ÷ 233.4 = 9.00×10^{-3};	1	Accept 8.9×10^{-3} – 9×10^{-3}
3	(a)	(ii)	Moles $Al_2(SO_4)_3$ in 25 cm^3 = 3.00×10^{-3}; [conseq on error in (i)]	1	Accept 2.9×10^{-3} – 3×10^{-3}
			Moles $Al_2(SO_4)_3$ in sample = 3.00×10^{-2}; [conseq on error in 25 cm^3]	1	Accept 2.9×10^{-2} – 3×10^{-3}
3	(b)		M_r of $Al_2(SO_4)_3 \cdot xH_2O$ = 20.0 ÷ 3.00×10^{-2};	1	If 3.17×10^{-3} used
			= 666.9;	1	630.9
			M_r of $Al_2(SO_4)_3$ = 342(.3);	1	342(.3)
			M_r of xH_2O = 666.9 – 342.3 = 324.6; [conseq on error(s) in M_r]	1	288.7
			X = <u>18</u> / $Al_2(SO_4)_3.18H_2O$; [conseq on errors above [must be <u>integer</u>]	1	<u>16</u>
3	(c)		Mass O = 0.389;	1	
			Ba **C** **O** <u>0.835</u> <u>1.46</u> <u>0.389</u> 137.3 12 16	1	At number(s) used M2 & M3 = CE = 0
			0.00608 0.0122 0.0243 BaC_2O_4 1.0 2.00 4.00	1	Conseq on error in mass of O, Not $Ba(CO_2)_2$ / BrC_2O_4etc.
3	(d)	(i) **QoL**	(Actual) number of <u>atoms of each element</u> in a molecule/compound;	1	
3	(d)	(ii)	The M_r / <u>relative</u> molecular/formula mass;	1	Not molecular mass

Question	Part	Sub Part	Marking Guidance	Mark	Comments
4	(a)	(i)	Energy/enthalpy required to remove one electron / energy/enthalpy change when one electron is removed; From a gaseous atom; Enthalpy required/change for $M(g) \rightarrow M^+(g) + e^-$ earns both marks	1 1	If molar def^n give, must be molar throughout Allow state symbol in equation for M2
4	(a)	(ii)	Increase in number of protons/nuclear charge; Decrease in size / e^- closer to nucleus same/similar shielding / same shells;	1 1	Accept 'increased attraction between nucleus and outer electrons' as alternative to either M1 or M2 but tied to M1/M2 or near miss
4	(a)	(iii)	Electron removed from 3p orbital/sub-shell in Al rather than 3s in Mg; Al loses e^- which is of higher energy /is further away from nucleus /is shielded by 3s electrons;	1 1	Not just e^- arrangements
4	(b)	(i)	$MgCl_2(aq)$ White ppt/solid formed; $BaCl_2(aq)$ No change/no ppt/clear solution;	1 1	 Not nothing/dissolves
4	(b)	(ii)	$Mg^{2+}(aq) + 2OH^-(aq) \rightarrow Mg(OH)_2(s)$;	1	Penalise 2 equations Allow Ba^{2+} equation conseq on reversed observations in (b)(i)
4	(c)	(i)	(A covalent bond in which) the electron density is unequally shared;	1	Allow e^- cloud is unequally shared Not e^- cloud distorted
4	(c)	(ii) **QoL**	Greater difference in electronegativity in HCl / Cl more electronegative than I; So electron density more strongly drawn towards the Cl (than towards the I);	1 1	Not HCl/Cl^- is more electronegative Tied to M2 or 'near miss' Not more attracted to Cl but allow e^- cloud more distorted towards Cl

Question	Part	Sub Part	Marking Guidance	Mark	Comments
5	(a)	M1	Macromolecular/giant atomic/giant covalent structure;	1	Allow separate 'giant' and 'covalent' if appropriate Reference to IMF loses M1 Ions/metallic bonds = CE = 0 for M1-M3 Reference to C-C bonds negates M1
		M2	Covalent bonds must be broken/overcome;	1	Tied to M2 or near miss Not loosened
		M3	Much energy to break bonds/bonds strong/many bonds to break;	1	
		M4	S and Cl both (simple) molecular / S_8 & Cl_2 / separate refs to molecules;	1	
		M5	Van der Waals' forces present in both (or implied);	1	Not vdW between atoms
		M6	vdW forces increase with number of e^-/size/M_r etc;	1	
		M7	e^-/size/M_r is smaller for Cl molecules;	1	'molecules' may be implied
5	(b)		Correct bonding in both structures – accept correct descriptions	1	Incorrect bonding loses M1 and either M2 or M3, depending on the bonding error.
			In Na, atoms/ions/layers/particles slide/move when struck (but still metallic bonding);	1	
			Idea that, in NaCl, ions of same charge repel each other;	1	

Question	Part	Sub Part	Marking Guidance	Mark	Comments
6			pV = nRT;	1	If V = p/nRT lose M3 and M4
			Moles methanol = n = $\frac{1.04}{32}$ (= 0.0325 mol);	1	
			V = nRT/p = $\frac{0.0325 \times 8.31 \times 350;}{101000}$ Conseq on error in moles	1	If $\frac{1}{101}$ used, & V = .936 dm^3 allow M3 & M4
			= 9.36×10^{-4} m^3; ignore missing units but penalise incorrect units	1	If $\frac{1}{101}$ used, & V = .936 m^3/cm^3/no units, penalise M3 allow M4 conseq
			= 936 cm^3; mark is for correct conversion from their M4 units to cm^3	1	If no units in M4, assume them to be m^3 when awarding M5