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General Certificate of Education

Chemistry 1421

CHEM1 Foundation Chemistry

Mark Scheme

2010 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.

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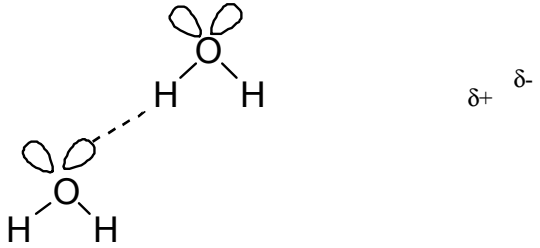
Question	Part	Sub Part	Marking Guidance	Mark	Comments
1	(a)		$2s^2 2p^6 3s^1$	1	$1s^2$ can be rewritten Allow $2s^2 2p_x^2 2p_y^2 2p_z^2 3s^1$ Allow subscripts and capitals
1	(b)	(i)	Energy/enthalpy (needed) to remove one mole of electrons from one mole of atoms/compounds/molecules/elements ***OR*** Energy to form one mole of positive ions from one mole of atoms ***OR*** Energy/enthalpy to remove one electron from one atom In the gaseous state (to form 1 mol of gaseous ions)	1 1	Energy given out loses M1 M2 is dependent on a reasonable attempt at M1 Energy needed for this change $X(g) \rightarrow X^+(g) + e^{(-)}$ = 2 marks This equation alone scores one mark
1	(b)	(ii)	$Mg^+(g) \rightarrow Mg^{2+}(g) + e^{(-)}$ $Mg^+(g) + e^{(-)} \rightarrow Mg^{2+}(g) + 2e^{(-)}$ $Mg^+(g) - e^{(-)} \rightarrow Mg^{2+}(g)$	1	Do not penalise MG Not equation with X
1	(b)	(iii)	Electron being removed from a positive ion (therefore need more energy)/ electron being removed is closer to the nucleus/Mg^+ smaller (than Mg)/Mg^+ more positive than Mg	1	Allow from a + particle/ species Not electron from a higher energy level/or higher sub-level More protons = 0
1	(b)	(iv)	Range from 5000 to 9000 kJ mol^{-1}	1	
1	(c)		Increase Bigger nuclear <u>charge</u> (from Na to Cl)/more <u>protons</u> electron (taken) from same (sub)shell/ similar or same shielding/ electron closer to the nucleus/smaller atomic radius	1 1 1	If decrease CE = 0/3 If blank mark on QWC If no shielding = 0 Smaller ionic radius = 0

1	(d)		Lower Two/pair of electrons in (3)p orbital or implied repel (each other)	1 1 1	If not lower CE = 0/3 If blank mark on Allow does not increase Not 2p M3 dependent upon a reasonable attempt at M2
1	(e)		Boron/B or oxygen/O/ O_2	1	

Question	Part	Sub Part	Marking Guidance	Mark	Comments
2	(a)	(i)	M_r = 132.1 0.0238	1 1	132 Allow 0.024 Allow 0.0237 Penalise less than 2 sig fig once in (a)
2	(a)	(ii)	0.0476	1	0.0474-0.0476 Allow (a) (i) x 2
2	(a)	(iii)	1.21	1	Allow consequential from (a) (ii) ie allow (a) (ii) x 1000 / 39.30 Ignore units even if wrong
2	(b)		$\frac{34 \times 100}{212.1}$ = 16.0(3)%	1 1	Allow mass or Mr of desired product times one hundred divided by total mass or Mr of reactants/products If 34/212.1 seen correctly award M1 Allow 16% 16 scores 2 marks
2	(c)		100(%)	1	Ignore all working
2	(d)		PV = nRT or $n = \frac{PV}{RT}$ $n = \frac{100000 \times 1.53 \times 10^{-2}}{8.31 \times 310}$ = 0.59(4)	1 1 1	If rearranged incorrectly lose M1 and M3 M2 for mark for converting P and T into correct units in any expression Allow 0.593 M3 consequential on transcription error only not on incorrect P and T

2	(e)		(Na_2SO_4) (44.1%) 44.1/142.1 0.310 =1 *x* = 10	H_2O 55.9% 55.9/18 3.11 =10	 1 1 1	 M1 is for 55.9 Alternative method gives180 for water part =2 marks X = 10 = 3 marks 10.02 = 2 marks

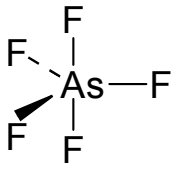
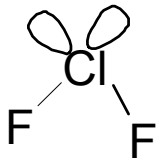
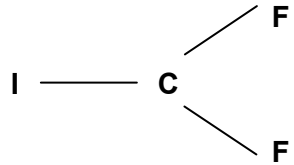
Question	Part	Sub Part	Marking Guidance	Mark	Comments
3	(a)		Hydrogen/H bonds van der Waals/vdw/ dipole-dipole/London/temporarily induced dipole/dispersion forces	1 1	Not just hydrogen Not just dipole
3	(b)			3	M1 for partial charges as indicated in diagram (correct minimum) M2 for all four lone pairs M3 for H bond from the lp to the H (δ+) on the other molecule Lone pair on hydrogen CE = 0 OHO CE = 0 If only one molecule of water shown CE = 0
3	(c)		Hydrogen bonds/IMF (in water) stronger ***OR*** IMF / VDW / dipole-dipole forces (in H_2S) are weaker ***OR*** H bonding is the strongest IMF	1	Ignore energy references Comparison must be stated or implied
3	(d)		Atoms/molecules get larger/more shells/more electrons/ more surface area therefore increased Van der Waals/IMF forces	1 1	Not heavier/greater Mr Ignore references to dipole-dipole forces

3	(e)		Dative (covalent)/ coordinate	1	If not dative/coordinate CE = 0/2 If covalent or blank read on
			(Lone) pair/both electrons/two electrons on O(H_2) donated (to H^+) OR pair/both electrons come from O(H_2)	1	Explanation of a coordinate bond specific to oxygen or water required Not just H+ attracted to lone pair since that is nearer to a H bond
3	(f)		ionic	1	if not ionic CE = 0
			oppositely charged <u>ions</u> /+ and – <u>ions or particles</u>	1	atoms or molecules loses M2 and M3
			ions attract <u>strongly</u> OR strong/many (ionic) bonds must be broken	1	S^- loses M2 Reference to IMF loses M2 and M3

Question	Part	Sub Part	Marking Guidance	Mark	Comments
4	(a)	(i)	single (C-C) bonds <u>only</u>/ no double (C=C) bonds C and H (atoms) <u>only/purely/solely/entirely</u>	1 1	Allow all carbon atoms bonded to four other atoms Single C-H bonds only =0 C=H CE Not consists or comprises Not completely filled with hydrogen CH molecules = CE Element containing C and H = CE
4	(a)	(ii)	C_nH_{2n+2}	1	*Formula only* C_xH_{2x+2}
4	(b)	(i)	$C_5H_{12} + 8O_2 \rightarrow 5CO_2 + 6H_2O$	1	Accept multiples Ignore state symbols
4	(b)	(ii)	gases produced are greenhouse gases/contribute to Global warming/effect of global warming/climate change	1	Allow CO_2 or water is greenhouse gas/causes global warming Acid rain/ozone CE = 0
4	(c)		carbon	1	Allow C Allow soot
4	(d)	(i)	$C_9H_{20} \rightarrow C_5H_{12} + C_4H_8$ ***OR*** $C_9H_{20} \rightarrow C_5H_{12} + 2C_2H_4$	1	Accept multiples
4	(d)	(ii)	Plastics, polymers	1	Accept any polyalkene / haloalkanes / alcohols
4	(d)	(iii)	so the <u>bonds</u> break ***OR*** because the <u>bonds</u> are strong	1	IMF mentioned = 0
4	(e)	(i)	1,4-dibromo-1-chloropentane / 1-chloro-1,4-dibromopentane	1	Ignore punctuation
4	(e)	(ii)	Chain/position/positional	1	Not structural or branched alone

Question	Part	Sub Part	Marking Guidance	Mark	Comments
5	(a)		Average/mean mass of (1) atom(s) (of an element) 1/12 mass of one atom of ^{12}C ***OR*** (Average) mass of one mole of atoms 1/12 mass of one mole of ^{12}C ***OR*** (Weighted) average mass of all the isotopes 1/12 mass of one atom of ^{12}C ***OR*** Average mass of an atom/isotope compared to C-12 on a scale in which an atom of C-12 has a mass of 12	1 1 This expression = 2 marks	If moles and atoms mixes Max = 1
5	(b)		d block [Ar] $3d^2 4s^2$ 27	1 1 1	Allow 3d/D Other numbers lose M1 Ignore transition metals Can be written in full Allow subscripts $3d^2$ and $4s^2$ can be in either order

5	(c)		$\frac{(90x9) + (91x2) + (92x3) + (94x3)}{17}$ (= 1550) (or ∑ their abundances)	1 1	If one graph reading error lose M1 and allow consequential M2 and M3. If 2 GR errors penalise M1 and M2 but allow consequential M3 If not 17 or ∑ their abundances lose M2 and M3
			=91.2	1	91.2 = 3 marks provided working shown.
			Zr/ Zirconium	1	M4 -allow nearest consequential element from M3 accept Zr in any circumstance
5	(d)		High energy electrons/bombarded or hit with electrons	1	accept electron gun
			knocks out electron(s) (to form ions)	1	
			Z^+ = 90 deflected most	1	If not 90 lose M3 and M4 If charge is wrong on 90 isotope lose M3 only Accept any symbol in place of Z
			since lowest mass/lowest m/z	1	Allow lightest
5	(e)		(ions hit detector and) cause current/(ions) accept electrons/cause electron flow	1	QWC
			bigger current = more of that isotope/current proportional to abundance	1	Implication that current depends on the number of ions

Question	Part	Sub Part	Marking Guidance	Mark	Comments
6				1	**Mark M1 – M5 independently** M1 for 5 bond pairs around As Do not penalise A for As or Fl for F
			trigonal / triangular bipyramid(al)	1	Allow trigonal dipyramid
				1	M3 for 2 bond pairs to F and 2 lone pairs Lone pairs can be shown as lobes with or without electrons or as xx or x x
			Bent / V shape / non-linear / triangular / angular	1	Bent-linear = contradiction Do not allow trigonal
			104° - 106°	1	
			(For candidates who thought this was ClF_2^+ which contained iodine allow 		
			Trigonal / triangular <u>planar</u>		Not just triangular
			120°		