Periodicity & Trends

Mark Scheme 1

Level	International A Level
Subject	Chemistry
Exam Board	Edexcel
Topic	The Core Principles of Chemistry
Sub Topic	Periodicity & Trends
Booklet	Mark Scheme 1

Time Allowed: **76 minutes**

Score: **/63**

Percentage: **/100**

Grade Boundaries:

A*	A	B	C	D	E	U
>85%	'77.5%	70%	62.5%	57.5%	45%	<45%

Question Number	Correct Answer	Reject	Mark
1	C		1
	Incorrect Answers: A – Melting temperatures increase across the period with a peak at group IV not Group I B - Melting temperatures increase across the period with a peak at group IV not Group III D- Melting temperatures increase across the period with a peak at group IV not Group V		

Question Number	Correct Answer	Reject	Mark
2	C		**1**

Question Number	Correct Answer	Reject	Mark
3(a)	A		**1**

Question Number	Correct Answer	Reject	Mark
3(b)	D		**1**

Question Number	Correct Answer	Mark
4	C	**1**

Question Number	Correct Answer	Mark
5	B	**1**

Question Number	Correct Answer	Mark
6	A	**1**

Question Number	Correct Answer	Mark
7	B	**1**

Question Number	Correct Answer	Mark
8	C	**1**

Question Number	Correct Answer	Mark
9	A	**1**

Question Number	Correct Answer	Reject	Mark
10(a)	B		1

Question Number	Correct Answer	Reject	Mark
10(b)	A		1

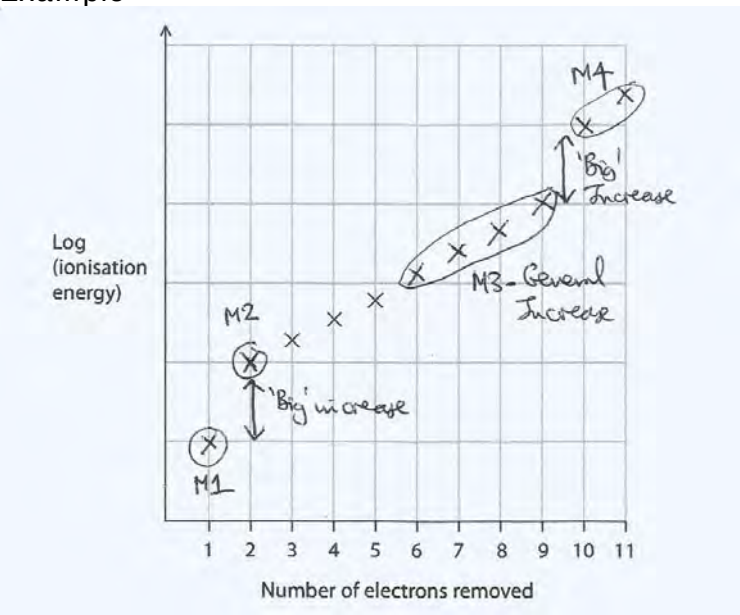
Question Number	Correct Answer	Reject	Mark
10 (c)	C		1

Question Number	Correct Answer	Reject	Mark
11	A		1

Question Number	Acceptable Answers	Reject	Mark
12(a)	The energy required ALLOW energy / enthalpy change/endothermic (1) to remove one electron from each atom in one mole of atoms ALLOW to remove one mole of electrons from one mole of atoms **Or** to produce one mole of singly charged positive ions from one mole of atoms (1) (all species) in the gaseous state (1) IGNORE equation even if correct	Energy given out / energy produced/ exothermic	3

Question Number	Acceptable Answers	Reject	Mark
12(b)	$Li^{+}(g) \rightarrow Li^{2+}(g) + e^{(-)}$ OR $Li^{+}(g) - e^{(-)} \rightarrow Li^{2+}(g)$ IGNORE missing (g) if gaseous is in part (a) DO NOT penalise missing gaseous state symbol if omission of gaseous is already penalised in part (a)		1

Question Number	Acceptable Answers	Reject	Mark
12(c)	Helium only has two electrons/ Helium does not have a third electron to lose IGNORE Helium only has two valence electrons/ only has two electrons in its outer shell		1

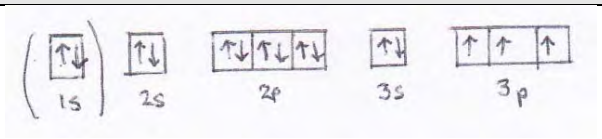
Question Number	Acceptable Answers	Reject	Mark
12(d)	**Marking point 1** One cross for electron 1 significantly below those already present (1) **Marking point 2** One cross for electron 2 slightly below the three crosses already present (1) **Marking point 3** Crosses for electrons 6 to 9 on an approximately straight line upwards continuing from electrons 3 to 5 (1) **Marking point 4** Cross for electron 10 significantly above the cross for electron 9 **and** cross for electron 11 slightly above the cross for electron 10 (1) Mark Independently IGNORE Lines drawn between crosses Example  	‘big’ increase anywhere between crosses 6 to 9 ‘big’ increase from cross 10 to cross 11	4

Question Number	Acceptable Answers	Reject	Mark
12(e)	Any three from Increased shielding (by inner electron shells) / greater repulsion between inner shell electrons (1) More shells (1) Greater distance from nucleus (to outermost electron) / increased (atomic) radius (1) These outweigh the increased nuclear attraction from the greater number of protons (1)	Reference to molecule, max 2 Ionic radius	3

Question Number	Acceptable Answers	Reject	Mark
12(f)	(For sulfur) the outermost electron is paired in the p orbital (1) Repulsion between (paired) electrons (reduces ionisation energy) (1) If no correct reference to sulfur then allow one mark for phosphorus (atom) having more stable p^3/half-filled p sub-shell	4p	2

Question Number	Acceptable Answers	Reject	Mark
12(g)	(Ionisation energy value) Any value in the range of (+)520-700 (kJ mol^{-1}) [Actual value (+)578] ALLOW Any range within the values given above (1) The outermost electron for aluminium is in a **p** orbital / subshell (1) Which has higher energy (than the **s** orbital) ALLOW is further away from the nucleus (and requires less energy to remove) than the 3s electrons (of aluminium) **Or** Shielded by the 3s electrons (1) ACCEPT Reverse arguments	 2p Higher energy **level / shell**	3

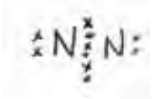
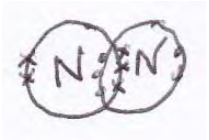
(Total for Question 12 = 17 marks)

Question Number	Acceptable Answers	Reject	Mark
13(a)(i)	 Arrows correct ALLOW half-headed arrows/ 3p electrons all pointing downwards **(1)** Labels correct OR $2p_x$, $2p_y$, $2p_z$ and $3p_x$, $3p_y$, $3p_z$ **(1)** IGNORE numbers as superscripts		**2**

Question Number	Acceptable Answers	Reject	Mark
13(a)(ii)	Mark independently **First mark** (idea of paired electrons in S) In sulfur: spin-pairing has occurred (in the 3p orbital / sub-shell)/ there are paired electrons (in a 3p orbital / sub-shell) OR there are two electrons in the same (3p) orbital **/** there is a full (3p) orbital **(1)** **Note** – Just stating $3p^4$ does not get this mark **Second mark** (idea of repulsion) (Resultant increase in) repulsion (allows electron to be removed more easily) **(1)** **Note** – if no correct reference to sulfur ALLOW Phosphorus has a half-filled sub-shell which is (more) stable **(1)** IGNORE any reference to nuclear attraction / atomic radius / shielding	Sub-shell / shell	**2**

Question Number	Acceptable Answers	Reject	Mark
13(a)(iii)	$P^{2+}(g) \rightarrow P^{3+}(g) + e^{(-)}$ ALLOW $P^{2+}(g) - e^{(-)} \rightarrow P^{3+}(g)$ ALLOW +2/+3 for 2+/3+ or additional electrons provided the equation balances Correct symbols **(1)** Both (g) **(1)** Mark independently IGNORE state symbol on the electron / IE in equation	Incorrect symbol for first mark only	**2**

Question Number	Acceptable Answers	Reject	Mark
13(b)(i)	Mark independently **First mark** (number of shells) N has fewer (electron) shells than P ALLOW The outer electron is in a shell closer to the nucleus in N OR In N the atomic radius/size is less **(1)** **Second mark** (shielding) (Outermost electron in N) has less shielding **(1)** **Third mark** (attraction) (Even though N has a lower nuclear charge/ fewer protons) (there is a) greater (force of) attraction between the nucleus and the (outer) electron/ greater effective nuclear charge OR outer electron is held more strongly by the nucleus **(1)** IGNORE N has a greater charge density ALLOW Reverse argument for phosphorus / trend down the group	Mention of molecules Just 'lower atomic number' / 'N is smaller than P' Ionic radius N has a higher nuclear charge than P	**3**

Question Number	Acceptable Answers	Reject	Mark
13(b)(ii)	 OR  ALLOW all dots, all crosses or any other symbol for the electrons **First Mark** Three pairs of electrons between the nitrogen atoms ALLOW Two or three of the 3 pairs of electrons circled to show sharing as part of triple bond **(1)** **Second Mark** Lone pair on each nitrogen atom ALLOW 2 unpaired electrons **(1)**		**2**

Question Number	Acceptable Answers	Reject	Mark
13(c)	Correct answer with or without working scores both marks Number of moles = $\frac{24.8}{31.0 \times 4}$ **(1)** $= 0.2(00)$ (mol) Number of molecules of P_4 $= 0.2 \times 6.02 \times 10^{23}$ $= 1.204 \times 10^{23}$ / 1.20×10^{23} / 1.2×10^{23} **(1)** TE on number of moles IGNORE SF except 1SF		**2**

(Total for Question 13 = 13 marks)

Question Number	Acceptable Answers	Reject	Mark
14(a)	$F(g) \rightarrow F^{+}(g) + e^{(-)}$ OR $F(g) - e^{(-)} \rightarrow F^{+}(g)$ Species **(1)** State symbols IGNORE Any state symbols on electrons **(1)** 2nd mark is dependent on the first **NOTE:** $F(g) + e^{(-)} \rightarrow F^{+}(g) + 2e^{(-)}$ Use of 'Fl' **max (1)**	Electron affinity equation (0) overall Equations with $F_2(g)$ score **(0)** overall	**2**

Question Number	Acceptable Answers	Reject	Mark
14*(b)	**1 mark:** Number of protons increases / increasing nuclear charge / increasing effective nuclear charge **IGNORE** Just 'the atomic number increases' **(1)** **2nd mark:** Same shielding / same number of (occupied) shells / electron removed from the same shell / atomic radius decreases **(1)** **3rd mark:** Greater (electrostatic) attraction between nucleus / protons and (outermost) electron **(1)**	'Shielding increases' **(0)** for 2nd mark	**3**

Question Number	Acceptable Answers	Reject	Mark
14(c)*(i)	For aluminium **1st mark:** (Electron lost from) (3)**p**-subshell / (3)**p**-orbital ALLOW Correct electron configuration for Al: $1s^2 2s^2 2p^6 3s^2 3p^1$ or $[Ne]3s^2 3p^1$ or drawn as electrons-in-boxes **(1)** **NOTE** First mark must refer to aluminium **2nd mark:** at higher energy / further from the nucleus / (more) shielded (by 3s) OR Magnesium electron is at lower energy / closer to the nucleus / less shielded **(1)** **IGNORE** References to stability of $3s^2$ or full s-orbitals / full s sub-shell in Mg	Mention of **2**p, no 1st mark	**2**

Question Number	Acceptable Answers	Reject	Mark
14(c)*(ii)	For sulfur **1st mark:** (Electron lost from a) pair of electrons / an orbital with electrons (spin-) paired / a full (p) orbital **ALLOW** Mention of (3)p^4 OR Correct electron configuration for S:$1s^2 2s^2 2p^6 3s^2 3p^4$ or [Ne]$3s^2 3p^4$ or drawn as electrons-in-boxes **(1)** **2nd mark:** (increase in) **repulsion** (allows e^- to be removed more easily) **(1)** If no correct reference to Sulfur, then allow one mark for P (atom) has half-filled p sub-shell / p^3 (arrangement) is stable.		**2**

Question Number	Acceptable Answers	Reject	Mark
14(d)(i)	(Al) (Si) (P) (S) high high low low Four correct **(2)** Three correct **(1)**		**2**

Question Number	Acceptable Answers	Reject	Mark
14(d)(ii)	(Na) (Al) (Si) (P) (S) giant (giant) giant giant molecular molecular ALLOW 'giant molecular' for Si ALLOW 'simple molecular' for P and/or S Five correct **(2)** Four correct **(1)**		**2**

Question Number	Acceptable Answers	Reject	Mark
14(d)(iii)	(Na) (Al) (Si) (P) (S) high (high) high **X** low low All four must be correct **IGNORE** Any word written over **X** in the Si box		**1**

Question Number	Acceptable Answers	Reject	Mark
14(e)(i)	($\frac{2.76}{23.0}$) = 0.12(0) (mol)		**1**

Question Number	Acceptable Answers	Reject	Mark
14(e)(ii)	Moles H_2 = ½ x mol Na **(1)** Volume H_2 = 0.06(0) x 24 = 1.44 (dm^3) **(1)** ALLOW ECF from moles of Na in (e)(i) ALLOW Both marks if answer given 1440 **cm^3** Correct answer, no working scores **(2)** **NOTE:** **The following answers score (1) mark with or without working** 2.88 (dm^3) / 2880 **cm^3** 5.76 (dm^3) / 5760 **cm^3** However, check as 2.88 could score 2 as a TE of 0.24 mol from (e)(i) IGNORE SF except 1 SF		**2**

Question Number	Acceptable Answers	Reject	Mark
14(e)(iii)	**1st mark:** Moles NaOH = moles of Na **(1)** Can be implied by use of value from (e)(i) **2nd mark:** ($\frac{0.12}{0.500}$) = 0.24(0) (mol dm^{-3}) **(1)** ALLOW TE from moles of Na in (e)(i) Correct answer, no working scores **(2)** IGNORE SF except 1 SF NOTE: TE from first mark to second mark only if answer from (e)(i) has been used in some way e.g. answer to (e)(i) × 2 would not score mark 1, but could then be used to score mark 2 as a TE	No 2nd mark if give wrong units, e.g "mol/dm^{-3}" "dm^3/mol"	**2**

(Total for Question 14 = 19 marks)