Electron Configuration & Structure

Mark Scheme

Level	International A Level
Subject	Chemistry
Exam Board	Edexcel
Topic	The Core Principles of Chemistry
Sub Topic	Electron Configuration & Structure
Booklet	Mark Scheme

Time Allowed: **44 minutes**

Score: **/36**

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	D		1
	Incorrect Answers: A – There is no dative covalent bond B - There is no dative covalent bond C- There is no dative covalent bond		

Question Number	Correct Answer	Reject	Mark
2	D		1
	Incorrect Answers: A – Electron configuration lacks energy level 3 electrons B - Electron configuration has an extra 18 electrons C- E ctron configuration lacks energy level 3 electrons		

Question Number	Correct Answer	Reject	Mark
3	B		**1**

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

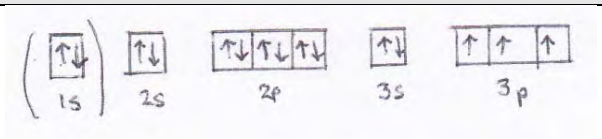
Question Number	Correct Answer	Mark
5	B	**1**

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

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

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

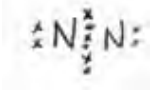
Question Number	Correct Answer	Reject	Mark
9	D		1

Question Number	Acceptable Answers	Reject	Mark
10(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
10(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**

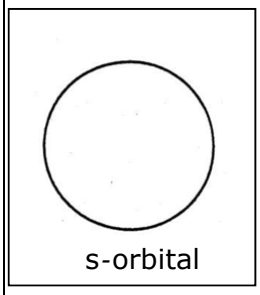
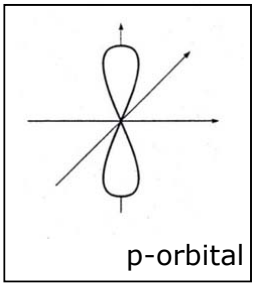
Question Number	Acceptable Answers	Reject	Mark
10(a)(iii)	$P^{2+}(g) \rightarrow P^{3+}(g) + e^{(-)}$ ALLOW $P^{2+}(g) - e^{(-)} \rightarrow P^{3+}(g)$ ALLOW +2/+3 for 2+/3+ or additional electrons provided the equation balances Correct symbols **(1)** Both (g) **(1)** Mark independently IGNORE state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

Question Number	Acceptable Answers	Reject	Mark
10(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**

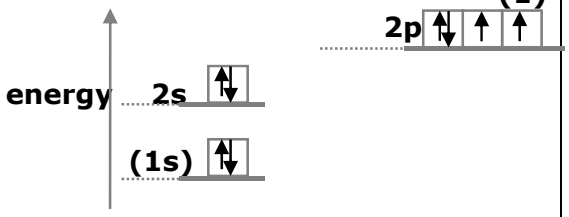
Question Number	Acceptable Answers	Reject	Mark
10(b)(ii)	 OR  ALLOW all dots, all crosses or any other symbol for the electrons **First Mark** Three pairs of electrons between the nitrogen atoms ALLOW Two or three of the 3 pairs of electrons circled to show sharing as part of triple bond **(1)** **Second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

Question Number	Acceptable Answers	Reject	Mark
10(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 = $0.2 \times 6.02 \times 10^{23}$ = 1.204×10^{23} / 1.20×10^{23} / 1.2×10^{23} **(1)** TE on number of moles IGNORE SF except 1SF		**2**

(Total for Question 10 = 13 marks)

Question Number	Acceptable Answers	Reject	Mark
11(a)	 s-orbital  p-orbital **(s-orbital)** Circle drawn ALLOW Concentric circles drawn **(1)** **(p-orbital)** Figure of '8' / 'dumb-bell' drawn NOTE: p-orbital can be drawn along any axis (axis does not have to be shown) **(1)** ALLOW If one, two or three p-orbitals of correct shapes are shown If **overlapping** orbitals are shown of correct shape in both cases, award **(1)** mark		**2**

Question Number	Acceptable Answers	Reject	Mark
11(b)	**(region)** **(no. of electrons)** (a d-orbital) **2** **(1)** (a p sub-shell) **6** **(1)** (the third shell) **18** **(1)**		**3**

Question Number	Acceptable Answers	Reject	Mark
11(c)	**First mark: BOTH** 2s and 2p labelled ALLOW $2s^2$ and $2p^4$ **(1)** **Second mark: ALL** eight e^- shown correctly **(1)**  ALLOW Half-arrows or full arrows for each electron Paired arrows in any one of the 2p orbitals NOTE Single arrows must be orientated in same direction Paired arrows must have opposite spins	$2p^6$	**2**

Question Number	Acceptable Answers	Reject	Mark
11(d)(i)	**First mark:** Makes mention of energy/enthalpy/(heat) energy/heat (change/required) AND to remove an electron **(1)** **Second mark:** one mole/1 mol **(1)** **Third mark:** Makes mention of **gaseous atom(s)** **(1)** **ALTERNATIVE ANSWER** Energy change per mole / kJ mol^{-1} for **(1)** $X(\mathbf{g}) \rightarrow X^{+}(\mathbf{g}) + e^{(-)}$ **(2)** One mark for species One mark for correct state symbols Mark independently IGNORE any references to standard conditions	"Energy **given out**…" for first mark **Just** 'gaseous element'/ 'gaseous substance'	**3**

Question Number	Acceptable Answers	Reject	Mark
11(d)(ii)	$O^{2+}(g) - e^- \rightarrow O^{3+}(g)$ OR $O^{2+}(g) \rightarrow O^{3+}(g) + e^-$ All species and balancing correct **(1)** State symbols correct **(1)** 2nd mark is dependent on 1st mark ALLOW 'e' for 'e^-' IGNORE (g) the e^-	Reverse equation scores **(0)** overall	**2**

Question Number	Acceptable Answers	Reject	Mark
11(d)(iii)	**First mark:** **Big** 'jump' / **large** increase **(1)** **Second mark:** between **6th** and **7th** (IE) OR after the **6th** OR to the **7th** OR from 13327 to 71337 OR of 58010 **IGNORE** Additional jump identified between **4th** and **5th** (IE) if justified in terms of a change of **sub-shell** OR Additional jump identified between **4th** and **5th** (IE) if justified in terms of NOT being a change of shell **(1)**	Any other ionization jumps mentioned	**2**

(Total for Question 11 = 14 marks)