

1. Atomic Structure

1.4 Ionisation energy

Paper 1

Question Paper

Q1.

(c)(i)	M1 general increase	1
	M2 increase in IE between IE4 and IE5 is noticeably the largest increase between IE's shown	1
(c)(ii)	$\text{Si}^+(g) \rightarrow \text{Si}^{2+}(g) + e^-$	1

Q2.

(c)(i)	$\text{P}^{2+}(g) \rightarrow \text{P}^{3+}(g) + e^-$	1
(c)(ii)	general increase	1
	increase in IE between IE5 and IE6 is noticeably the largest increase between IEs shown	1

Q3.

(c)	$\text{Te}(g) \rightarrow \text{Te}^+(g) + e^-$	1
(d)(i)	<p>any two factors responsible for increase in IE in first 6 IE from:</p> <ul style="list-style-type: none"> • (increased) nuclear attraction / attraction for nucleus • (decreased) shielding (by sub-shells) (IE 4 to 5) • spin-pair repulsion (IE 1 to 2) 	2
(d)(ii)	<p>successive ionisation energies of tellurium</p> <p>M1 general increase M2 jumps from 4 to 5 and (largest) 6 to 7</p>	2

Q4.

(a)(i)	total # 3p e ⁻	3	4	5	1
	total # unpaired e ⁻	3	2	1	1
(a)(ii)	P(g) → P ⁺ (g) + e ⁻				1
(a)(iii)	1000 (kJmol ⁻¹)				1
	(S) less / least / lowest nuclear attraction (to outer electrons) (than P OR Cl) OR nuclear attraction for Cl is stronger (compared to S (and or P))				1
	S less nuclear charge than Cl OR Cl has a greater nuclear charge than S				1
	(S has a greater nuclear charge (of outer electrons) than P BUT) S has two electrons in a (3)p orbital AND resulting in spin-pair repulsion				1

Q5.

(b)(i)	total e ⁻ in s subshell	6	6	6	1
	total e ⁻ in p subshell	8	9	10	1
(b)(ii)	Si(g) → Si ⁺ (g) + e ⁻				1
(b)(iii)	1060 (is circled)				1
	P / it has greater attraction of nucleus for outer electrons compared to Si ORA				1
	P / it has greater nuclear charge than Si ORA				1
	S has two electrons in a (3)p orbital AND resulting in spin-pair repulsion				1

Q6.

(b)(iii)	M1 big increase in IE between first and second M2 second (and third) electron(s) is removed from inner shell OR second (and third) electron(s) is removed from a shell closer to the nucleus OR second (and third) electron(s) has a stronger nuclear attraction ora	2
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Q7.

(a)(ii)	All 3 points correct scores two marks Any 2 points scores one mark <ul style="list-style-type: none"> <i>nuclear charge increases OR increasing proton number</i> e.g. 17 / Cl has a greater nuclear charge <i>describe the similarity in shielding between the two elements</i> e.g. they have almost the same shielding <i>describe the overall effect in terms of greater nuclear attraction for (outer) electrons</i> e.g. (outer) electrons are attracted more (strongly) to the nucleus 	2
(a)(iii)	M1 describes the difference between 1st IE of elements 15 and 16 (P and S) in terms of either: spin-pair repulsion (in element 16 / S) OR electron pair repulsion (in element 16 / S) M2 describes the location of the electron pair in the (3)p orbital which repel each other	2

Q8.

(a)	$\text{Mg(g)} \rightarrow \text{Mg}^{\text{+}}(\text{g}) + \text{e}^{\text{-}}$	1
(b)	M1: distance between nucleus and outer e⁻ increases OR outer electron removed from higher energy shell	3
	M2: increased shielding	
	M3: decreased nuclear attraction	
(c)	M1: greater nuclear attraction	2
	M2: (2nd / 2s) electron being removed from smaller (ion)	


Q9.

(a)(i)	M1 (one) fewer (inner) shell of electrons / less shielding (effect) <i>ORA</i>	1
	M2 smaller distance of the outer electrons (from the nucleus) / stronger nuclear attraction to the (outer) electrons <i>ORA</i>	1

Q10.

(a)	$\text{Ar}^{\text{+}}(\text{g}) \rightarrow \text{Ar}^{2\text{+}}(\text{g}) + \text{e}^{\text{-}}$ OR $\text{Ar}^{\text{+}}(\text{g}) - \text{e}^{\text{-}} \rightarrow \text{Ar}^{2\text{+}}(\text{g})$	1
(b)	at x = 8, within range 13000–20000	1
	at x = 9, within range 35000–45000	1

Q11.

(a)(i)		1
(a)(ii)	$\text{Si(g)} \rightarrow \text{Si}^+(\text{g}) + \text{e}^-$	1
(a)(iii)	M1: similar shielding AND increase in proton number / atomic number / nuclear charge M2: increased nuclear attraction	2
(a)(iv)	M1: 3 OR 13 M2: large(r) <i>increase</i> between third and fourth ionisation energies OR large(r) <i>increase</i> after third electron removed	2

Q12.

(b)(i)	(outer) electron removed from <u>3p</u> subshell / orbital	1
	(3p) higher in energy / more shielded / further from the nucleus	1
(b)(ii)	(outer) electron for S is paired in a <u>p orbital</u> / S has a full <u>p orbital</u>	1
	causing (spin / electron) pair repulsion (which reduces attraction)	1