

3(a)(ii)	H	1
----------	---	---

May/June 2017 9701/21 · Q3 (a)(ii)

1(a)	atomic number	nucleon number	number of electrons	number of protons	number of neutrons	symbol	2 1 1
		6		3	3		
						$^{58}_{26}\text{Fe}^{3+}$	

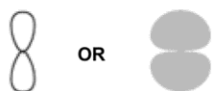
May/June 2017 9701/22 · Q1 (a)

3(b)(i)	(outer) electron removed from <u>3p</u> subshell / orbital	1
	(3p) higher in energy / more shielded / further from the nucleus	1
3(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

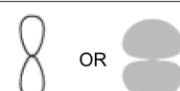
May/June 2018 9701/21 · Q3 (b)(i), (b)(ii)

2(b)(i)	$1s^2 2s^2 2p^6 3s^2 3p^6$	1
---------	----------------------------	---

March 2019 9701/22 · Q2 (b)(i)

3(a)	$\text{Ar}^+(\text{g}) \rightarrow \text{Ar}^{2+}(\text{g}) + \text{e}^{(-)}$ OR $\text{Ar}^+(\text{g}) - \text{e}^{(-)} \rightarrow \text{Ar}^{2+}(\text{g})$	1
3(b)	at $x = 8$, within range 13000–20000	1
	at $x = 9$, within range 35000–45000	1
3(c)		1
3(d)(ii)	Method 1 $M1 = 3.263 \times 10^{-3} \times 2$ Method 2 $M1 = \frac{0.23}{71.0} \times 2$ OR 6.53×10^{-3}	1
	$M2 = 6.02 \times 10^{23} \times M1$ $= 3.93 \times 10^{21}$ atoms of Cl $M2 = 6.02 \times 10^{23} \times M1$ $= 3.90 \times 10^{21}$ atoms of Cl	1

May/June 2019 9701/21 · Q3 (a), (b), (c), (d)(ii)

1(c)(i)	1s	1
1(c)(ii)		1
1(d)(ii)	M1 (in S, the electron is removed from the) 2 electrons in (3)p orbital OR a pair of electrons in (3)p (orbital / sub-shell) M2 (paired electrons) repel	2

Question	Answer	Marks
----------	--------	-------

May/June 2019 9701/23 · Q1 (c)(i), (c)(ii), (d)(ii)

1(a)(i)		1
1(a)(ii)	$\text{Si(g)} \rightarrow \text{Si}^+(\text{g}) + \text{e}^-$	1
1(a)(iii)	M1: similar shielding AND increase in proton number / atomic number / nuclear charge M2: increased nuclear attraction	2
1(a)(iv)	M1: 3 OR 13 M2: large(r) increase between third and fourth ionisation energies OR large(r) increase after third electron removed	2
1(b)(i)	M1: $\frac{(92.2 \times 28) + ({}^{29}\text{Si} \times 29) + ({}^{30}\text{Si} \times 30)}{100} = 28.09$ M2: ($x =$) 6.6 OR $28.09 = 28.078 + x$ (where x = abundance of Si-29) M3: 7.8 – M2 calculated correctly to one decimal place (or more) (=) 1.2%	3
1(b)(ii)	M1 giant (molecule) M2 strong covalent bonds (between atoms / particles) M3 no mobile charged particles / carriers	3
1(c)(i)	$\text{C}_2\text{H}_5\text{SH} + 4\frac{1}{2}\text{O}_2 \rightarrow 2\text{CO}_2 + 3\text{H}_2\text{O} + \text{SO}_2$	1

© UCLES 2019

Page 4 of 10

Question	Answer	Marks
1(c)(ii)	M1: (causes) acid rain OR reacts/dissolves with (rain)water (vapour) to form (sulfuric / sulfurous) acid M2: one point from the following list. - lowers pH / increases acidity of rivers / lakes / oceans / water supplies / seas / soil / ground water - kills/harms / damages fish - kills / harms / damages plants / damages coral / aquatic life / plants / crops / trees or deforestation - leaches (toxic) aluminium (ions / salts) from soil (into rivers / lakes) - leaches away soil nutrients / soil unfit for agriculture - damages / weathers / erodes / destroys buildings / statues	2
1(d)(i)	M1: no effect / none M2: equal mol(es) (of gas) on both sides (of equilibrium / equation) owtte	2
1(d)(ii)	M1: (forward reaction is) endothermic M2: Any temperature higher than 300 K	2

© UCLES 2019

Page 5 of 10

Question	Answer	Marks
----------	--------	-------

Oct/Nov 2019 9701/22 · Q1 (a)(i), (a)(ii), (a)(iii), (a)(iv), (b)(i), (b)(ii), (c)(i), (c)(ii), (d)(i), (d)(ii)

1(a)(i)	(different) number of neutrons.	1
1(b)(i)	M1 attractions between atoms within a gallium trichloride molecule covalent (bonds) M2 attractions between gallium trichloride molecules temporary induced dipoles	2
1(b)(ii)	coordinate / dative (covalent)	1
1(c)(i)	$4\text{Ga} + 3\text{O}_2 \rightarrow 2\text{Ga}_2\text{O}_3$ M1 correct formula of Ga_2O_3 M2 correctly balanced equation based on $\text{Ga} + \text{O}_2$ and formula of gallium oxide in M1	2

May/June 2020 9701/21 · Q1 (a)(i), (b)(i), (b)(ii), (c)(i)

1(c)	isotope	nucleon number	total number of electrons in lowest energy level	type of orbital contains the electron in the highest energy level	3
	⁷¹ Ga	M1 71	M2 2	M3 p (-orbital)	

May/June 2020 9701/22 · Q1 (c)

2(c)(iii)	$(1s^2) 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^1$ OR $(1s^2) 2s^2 2p^6 3s^2 3p^6 4s^1 3d^{10}$	1
-----------	--	---

© UCLES 2020

Page 7 of 11

Question	Answer	Marks
----------	--------	-------

May/June 2020 9701/23 · Q2 (c)(iii)

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

© UCLES 2020

Page 5 of 11

Question	Answer	Marks
----------	--------	-------

Oct/Nov 2020 9701/21 · Q1 (a), (b), (c)

3(a)(iii)	Li^+ is $1s^2$ H^- is $1s^2$	1
-----------	--	---

Oct/Nov 2020 9701/21 · Q3 (a)(iii)

1(b)(i)	type of orbital	s	p	d	3
	number of orbitals	4	9	5	
1(b)(iii)	5				1
1(b)(iv)	Award one mark for each correct bullet point – max 3 marks - nuclear charge increases - extra electron(s) in inner shell / $n=3$ / d-subshell / d- orbital - increased shielding (of 4s electrons by electrons in $n=3$ / 3rd shell / 3d) (overall) similar nuclear attraction (for outer electron)				3

Oct/Nov 2020 9701/22 · Q1 (b)(i), (b)(iii), (b)(iv)

2(b)(i)	$\text{Cl(g)} - \text{e}^- \rightarrow \text{Cl}^{\text{+}}(\text{g})$	1
---------	--	---

© UCLES 2021

Page 6 of 9

Question	Answer	Marks
2(b)(ii)	M1: increasing proton number but similar shielding M2: greater attraction of nucleus (for outer / valence electrons)	2
2(g)(iii)	$(1s^2) 2s^2 2p^6 3s^2 3p^5$	1

March 2021 9701/22 · Q2 (b)(i), (b)(ii), (g)(iii)

2(c)(i)	Mixing / overlap / combination of one / an s and one / a p orbital	1
2(c)(ii)	Sketch a diagram to show HOW two sp hybrid orbitals can form a SIGMA bond M1  M2 	2

Oct/Nov 2021 9701/21 · Q2 (c)(i), (c)(ii)

2(a)(i)	MMMCCCC	1
2(a)(ii)	All 3 points correct scores two marks Any 2 points scores one mark - nuclear charge increases OR increasing proton number e.g. 17 / Cl has a greater nuclear charge - describe the similarity in shielding between the two elements e.g. they have almost the same shielding - describe the overall effect in terms of greater nuclear attraction for (outer) electrons e.g. (outer) electrons are attracted more (strongly) to the nucleus	2
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
2(a)(v)	M1 (anions have) same number of electrons (but increasing proton number) M2 increasing proton number / nuclear charge AND increasing attraction of nucleus for (outer) electrons OR (outer) electrons attracted more (strongly) to the nucleus AND because of increasing proton number / nuclear charge	2
2(b)		2

© UCLES 2021

Page 8 of 11

Question	Answer	Marks
2(c)	M1 density of ${}_{13}\text{Al}$: value within range 2.5–5.0 (g cm^{-3}) M2 cationic radius of ${}_{31}\text{Ga}$: value within range 0.055–0.075 (nm) M3 boiling point of ${}_{49}\text{In}$: value within range 1500–2300 (K)	3
2(d)(i)	InCl_3	1
2(d)(ii)	$\text{In}_2\text{O}_3 + 2\text{NaOH} + 3\text{H}_2\text{O} \rightarrow 2\text{NaIn}(\text{OH})_4$	1
2(d)(iii)	M1 correct connectivity of In_2Br_6 M2 showing the two correct dative covalent bonds	2

© UCLES 2021

Page 9 of 11

Question	Answer	Marks
----------	--------	-------

Oct/Nov 2021 9701/22 · Q2 (a)(i), (a)(ii), (a)(iii), (a)(v), (b), (c), (d)(i), (d)(ii), (d)(iii)

1(a)	$O(g) \rightarrow O^+(g) + e^-$	1
1(b)(i)	increase across period AND increased nuclear attraction for (valence / outer) electrons [1] increase in (positive) nuclear charge / number of protons (in the nucleus) [1] similar shielding (of outer electrons) [1]	3
1(b)(ii)	spin-pair repulsion (of electrons) in (2)p <u>orbital</u> [1] outweighs increased nuclear charge [1]	2
1(c)	$1s^2 2s^2 2p^6 3s^2 3p^1$ [1] greatest jump between 3rd and 4th ionisations [1] indicates three electrons in outer shell [1]	3

Question	Answer	Marks
----------	--------	-------

March 2022 9701/22 · Q1 (a), (b)(i), (b)(ii), (c)

1(a)	Identify and draw the shape of highest energy orbital of Ca 4s AND 	1
1(c)	white precipitate / solid (of radium sulfate)	1
1(d)(i)	number of protons: 12 number of neutrons: 13	1
1(d)(ii)	$1s^2 2s^2 2p^6 3s^2$	1
1(e)(ii)	M1 correct expression relating A_r to the mass / % abundance of the three isotopes $24.31 = x \times 0.7899 + 24.99 \times 0.1000 + 25.98 \times 0.1101$ M2 correct answer to 4 sig figs atomic mass of X = 23.99	2
1(e)(iii)	M1 (magnesium isotopes have) identical chemical properties AND same electron(ic) arrangement / configuration M2 different physical properties AND different number of neutrons	2

May/June 2022 9701/21 · Q1 (a), (c), (d)(i), (d)(ii), (e)(ii), (e)(iii)

1(a)	- energy required - when one electron is removed - from each atom in one mole of - gaseous atoms two or three points for one mark, four points for two marks	2										
1(b)	Group VI / 16 AND large increase (in IE) after 6th	1										
1(c)	M1 reference to spin pair repulsion in (3)p orbital (in S) OR due to repulsion of two electrons in a (3)p orbital (in S) M2 outweighs increased nuclear charge (in S)	2										
1(d)	M1 <i>similarity in electronic structure / shielding of Al^{2+} and Na</i> both remove electron from (3)s ¹ / single electron in (3)s (sub-level / orbital) OR Al^{2+} and Na have same electronic configuration OR shielding (of outer electron) is the same M2 <i>greater nuclear charge / number of protons</i> Al^{2+} has greater nuclear charge OR 13p compared to 11p	2										
1(e)	<table><tr><td></td><td>atomic no.</td><td>nucleon no.</td><td>no.of neutrons</td><td>electronic arrangement</td></tr><tr><td>copper –65</td><td>29</td><td>65</td><td>65 – 29 = 36</td><td>1s² 2s² 2p⁶ 3s² 3p⁶ 3d¹⁰ 4s¹</td></tr></table> M1 29 AND 65 M2 nucleon no – atomic no ALLOW ecf from M1 M3 electronic arrangement		atomic no.	nucleon no.	no.of neutrons	electronic arrangement	copper –65	29	65	65 – 29 = 36	1s ² 2s ² 2p ⁶ 3s ² 3p ⁶ 3d ¹⁰ 4s ¹	3
	atomic no.	nucleon no.	no.of neutrons	electronic arrangement								
copper –65	29	65	65 – 29 = 36	1s ² 2s ² 2p ⁶ 3s ² 3p ⁶ 3d ¹⁰ 4s ¹								

© UCLES 2022

Page 6 of 12

Question	Answer	Marks
1(f)(i)	$M_r = 63.5$ $(1.05 / 63.5) \times 6.022 \times 10^{23} = 9.958 \times 10^{21}$ OR 9.96×10^{21}	1
1(f)(ii)	M1 <i>comment explaining high melting point of Cu</i> many strong metallic bonds OR many strong (electrostatic) attractions between cations and delocalised electrons OR strong bonds in giant metallic structure. M2 <i>comment explaining electrical conductivity of Cu</i> delocalised electrons are free are to move through the structure (owtte)	2

Question	Answer	Marks
----------	--------	-------

May/June 2022 9701/23 · Q1 (a), (b), (c), (d), (e), (f)(i), (f)(ii)

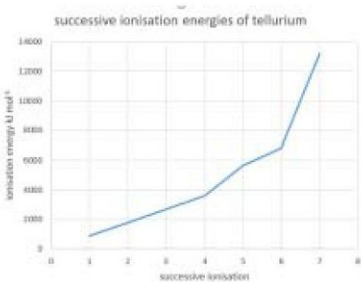
1(a)(i)	columns 1 & 3 identical	1												
	<table><tr><td><i>isotope</i></td><td><i>No of p's</i></td><td><i>No of n's</i></td><td><i>No of e's</i></td></tr><tr><td>⁶⁹Ga</td><td>31</td><td>38</td><td>31</td></tr><tr><td>⁷¹Ga</td><td>31</td><td>40</td><td>31</td></tr></table>	<i>isotope</i>	<i>No of p's</i>	<i>No of n's</i>	<i>No of e's</i>	⁶⁹ Ga	31	38	31	⁷¹ Ga	31	40	31	
<i>isotope</i>	<i>No of p's</i>	<i>No of n's</i>	<i>No of e's</i>											
⁶⁹ Ga	31	38	31											
⁷¹ Ga	31	40	31											
	• √ √	1												
1(b)(i)	they have the same electron arrangement / electronic configuration	1												
1(b)(ii)	1s ² 2s ² 2p ⁶ 3s ² 3p ⁶ 4s ¹	1												
1(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												

© UCLES 2022

Page 5 of 11

Question	Answer	Marks
----------	--------	-------

Oct/Nov 2022 9701/23 · Q1 (a)(i), (b)(i), (b)(ii), (b)(iii)

1(a)	<table><tr><td></td><td>nucleon number</td><td>number of neutrons</td><td>number of electrons</td></tr><tr><td>Tellurium-130</td><td>130</td><td>78</td><td>52</td></tr></table>		nucleon number	number of neutrons	number of electrons	Tellurium-130	130	78	52	3
	nucleon number	number of neutrons	number of electrons							
Tellurium-130	130	78	52							
1(b)	1 s	1								
1(c)	$\text{Te(g)} \rightarrow \text{Te}^{\text{+}}(\text{g}) + \text{e}^{-}$	1								
1(d)(ii)	successive ionisation energies of tellurium  M1 general increase M2 jumps from 4 to 5 and (largest) 6 to 7	2								

May/June 2023 9701/21 · Q1 (a), (b), (c), (d)(ii), (f)(ii)

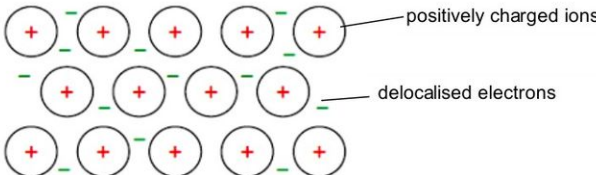
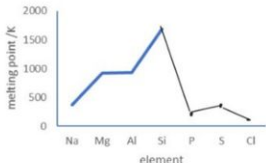
1(d)(iii)	$1s^2 2s^2 2p^6 3s^2 3p^6 3d^9 (4s^0)$	1
-----------	--	---

© UCLES 2023

Page 6 of 12

Question	Answer	Marks
----------	--------	-------

May/June 2023 9701/23 · Q1 (d)(iii)

1(a)	<table border="1"> <tr> <td>Mg²⁺</td> <td>24</td> <td>12</td> <td>10</td> </tr> <tr> <td>Al³⁺</td> <td>27</td> <td>13</td> <td>10</td> </tr> </table> 4 correct = 2 marks 2 or 3 correct = 1 mark 0 or 1 correct = 0 marks	Mg ²⁺	24	12	10	Al ³⁺	27	13	10	2
Mg ²⁺	24	12	10							
Al ³⁺	27	13	10							
1(b)	M1 it / Al³⁺ is smaller (compared to Mg²⁺) M2 greater nuclear attraction for remaining electrons M3 same shielding effect AND greater nuclear charge	3								
1(c)	 labelled diagram shows: - regular arrangement of minimum of 2 × 2 circles containing + for positive ions AND surrounded by (sea of) delocalised electrons	1								
1(d)(ii)	 M1 all 3 melting points lower than Mg M2 show melting point Cl < P < S	2								
1(e)(ii)	acid–base OR neutralisation	1								
1(f)(i)	reacts with both acids and bases OR shows both acidic and basic behaviour	1								
1(f)(ii)	Al(OH) ₃ + NaOH → NaAl(OH) ₄	1								

Question	Answer	Marks
----------	--------	-------

May/June 2024 9701/22 · Q1 (a), (b), (c), (d)(ii), (e)(ii), (f)(i), (f)(ii)

3(c)	full electronic configuration of Fe ³⁺ 1s ² 2s ² 2p ⁶ 3s ² 3p ⁶ 3d ⁵	1
------	---	---

May/June 2024 9701/22 · Q3 (c)

1(a)(i)	1s ² 2s ² 2p ⁶ 3s ² 3p ⁶				1
1(a)(ii)					1
1(a)(iii)	3 (three)				1
1(b)	isotope	number of protons	number of neutrons	total number of electron shells	3
	¹⁰³ ₄₅ Rh	● 45	58	● 5	
	¹⁹¹ ₇₇ Ir	● 77	● 114	6	
	¹⁹³ ₇₇ Ir	● 77	● 116	6	
1(d)(iii)	a single product is made				1

Oct/Nov 2024 9701/21 · Q1 (a)(i), (a)(ii), (a)(iii), (b), (c)(i), (d)(iii)

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

Question	Answer	Marks
----------	--------	-------

Oct/Nov 2024 9701/21 · Q3 (c)(i), (c)(ii)

1(a)(i)	lowest energy state owtte examples • (with) lowest energy • (with) no external energy • (with) no added energy • (where) electrons are not promoted to a higher energy level • most energetically stable	1												
1(a)(ii)	[Ar] <table><tr><td>↑</td><td>↑</td><td>↑</td><td></td><td></td></tr></table> <table><tr><td>↑↓</td></tr></table> <i>The 3 × d electrons may go in any of the d orbitals</i>	↑	↑	↑			↑↓	1						
↑	↑	↑												
↑↓														
1(a)(iii)	12	1												
1(b)(i)	<table><tr><td>isotope</td><td>RIM</td><td># protons</td><td># neutrons</td></tr><tr><td>⁹³₄₁Nb</td><td>92.91</td><td>• 41</td><td>• 52</td></tr><tr><td>¹⁸¹₇₃Ta</td><td>180.95</td><td>• 73</td><td>• 108</td></tr></table>	isotope	RIM	# protons	# neutrons	⁹³ ₄₁ Nb	92.91	• 41	• 52	¹⁸¹ ₇₃ Ta	180.95	• 73	• 108	2
isotope	RIM	# protons	# neutrons											
⁹³ ₄₁ Nb	92.91	• 41	• 52											
¹⁸¹ ₇₃ Ta	180.95	• 73	• 108											

Question	Answer	Marks
1(b)(ii)	M1 mass of an (atom of an) isotope	1
	M2 relative/compared to (the mass of) the unified atomic mass unit OR on a scale in which a carbon-12 atom / isotope has a mass of exactly 12 units OR divided by / compared to $\frac{1}{12}$ of the mass of a carbon-12 atom / isotope Alternative route using mass of 1 mol throughout M1 mass of one mol of an (atom of an) isotope M2 relative/compared to $\frac{1}{12}$ of the mass of 1 mol of C-12 atom / isotope OR when the mass of one mol C-12 atom / isotope is exactly 12(.000) g	1

Oct/Nov 2024 9701/22 · Q1 (a)(i), (a)(ii), (a)(iii), (b)(i), (b)(ii)

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

© Cambridge University Press & Assessment 2024

Page 8 of 11

Question	Answer	Marks
----------	--------	-------

Oct/Nov 2024 9701/22 · Q3 (c)(i), (c)(ii)

1(b)	isotope	number of protons	number of neutrons	total number of electron shells	3
	$^{103}_{45}\text{Rh}$	• 45	58	• 5	
	$^{191}_{77}\text{Ir}$	• 77	• 114	6	
	$^{193}_{77}\text{Ir}$	• 77	• 116	6	

Oct/Nov 2024 9701/23 · Q1 (b)

3(c)(ii)	$\text{Si}^+(g) \rightarrow \text{Si}^{2+}(g) + e^{-}$	1
----------	--	---

© Cambridge University Press & Assessment 2024

Page 8 of 11

Question	Answer	Marks
----------	--------	-------

Oct/Nov 2024 9701/23 · Q3 (c)(ii)

2(b)(ii)	ionisation energies increase because less shielding / successive ionic radii are smaller / greater attraction (of electron) to nucleus (large difference between 2nd and 3rd IE) because 3rd e^{-} coming from an inner shell / lower energy level			2
2(c)(ii)	isotope	number of protons	number of neutrons	2
	magnesium-24	12	12	
	magnesium-25	12	13	
	magnesium-26	12	14	

March 2025 9701/22 · Q2 (b)(ii), (c)(ii)

2(a)	atoms (of an element) with same number of protons and different number of neutrons	1
------	--	---

© Cambridge University Press & Assessment 2025

Page 7 of 12

Question	Answer		Marks
2(b)(ii)	particle	number of particles in one atom of ^{56}Fe	2
	protons	26	
	nucleons	56	
2(c)	5		1
2(d)	$\text{Fe(g)} \rightarrow \text{Fe}^{\text{+}}\text{(g)} + \text{e}^{\text{-}}$		1
2(e)	M1 same electronic configuration OR same shielding M2 same number of protons OR same nuclear charge M3 so same nuclear attraction to outer shell electron M4 no change / will not be affected		4

© Cambridge University Press & Assessment 2025

Page 8 of 12

Question	Answer	Marks
----------	--------	-------

May/June 2025 9701/21 · Q2 (a), (b)(ii), (c), (d), (e)

1(a)(ii)	2 (pairs)	1
1(a)(iii)		1
1(b)(ii)	M1 pair of electrons in a 3p orbital (in S) repel each other M2 outweighs the effect of increase in nuclear charge	2
1(b)(iii)	M1 $\text{Na}^+ < \text{Ne} < \text{F}^-$ M2 (all have) same number of electrons / isoelectronic M3 larger species has smaller nuclear charge / fewer protons M4 (so) smaller nuclear attraction (to outer electrons)	4

Question	Answer	Marks
----------	--------	-------

May/June 2025 9701/23 · Q1 (a)(ii), (a)(iii), (b)(ii), (b)(iii)

1(c)(i)	$\text{Ar}^{2+}(\text{g}) \rightarrow \text{Ar}^{3+}(\text{g}) + \text{e}^{(-)}$ M1 a correct equation which represents an ionisation process e.g. $\text{X}^{n+} \rightarrow \text{X}^{(n+1)+} + \text{e}^{(-)}$ M2 correct equation to show third ionisation energy of Ar including (g) state symbols	2
1(c)(ii)	M1 nuclear charge M2 distance of outer electron(s) from nucleus OR ionic radius OR shielding (by inner shells and / or sub-shells)	2
1(c)(iv)		1

May/June 2025 9701/24 · Q1 (c)(i), (c)(ii), (c)(iv)

1(a)(i)	24 protons 28 neutrons 24 electrons	1
1(a)(ii)	(⁵⁴ Cr has two) more neutrons (than ⁵² Cr)	1
1(b)(i)	1s ² 2s ² 2p ⁶ 3s ² 3p ⁶ (3d ⁵ 4s ¹)	1
1(b)(ii)	6	1
1(d)(iii)	M1 (mixture becomes more) orange M2 forward reaction is endothermic M3 (mixture becomes more) orange M4 equilibrium moves (forwards/right) to compensate for extra acid / H ⁺	4
1(e)	M1 hydrolysis M2 CrF ₄ + 2H ₂ O → CrO ₂ + 4HF	2

Question	Answer	Marks
----------	--------	-------

Oct/Nov 2025 9701/21 · Q1 (a)(i), (a)(ii), (b)(i), (b)(ii), (d)(iii), (e)

1(a)(i)	25 protons 30 neutrons 25 electrons	1
1(a)(ii)	(atoms of an element) with the same number of protons and different number of neutrons	1
1(b)(i)	1s ² 2s ² 2p ⁶ 3s ² 3p ⁶ (3d ⁵ 4s ²)	1
1(b)(ii)	5	1

Oct/Nov 2025 9701/22 · Q1 (a)(i), (a)(ii), (b)(i), (b)(ii)

1(b)(ii)	6	1
1(e)	M1 hydrolysis M2 CrF ₄ + 2H ₂ O → CrO ₂ + 4HF	2

Question	Answer	Marks
----------	--------	-------

Oct/Nov 2025 9701/23 · Q1 (b)(ii), (e)