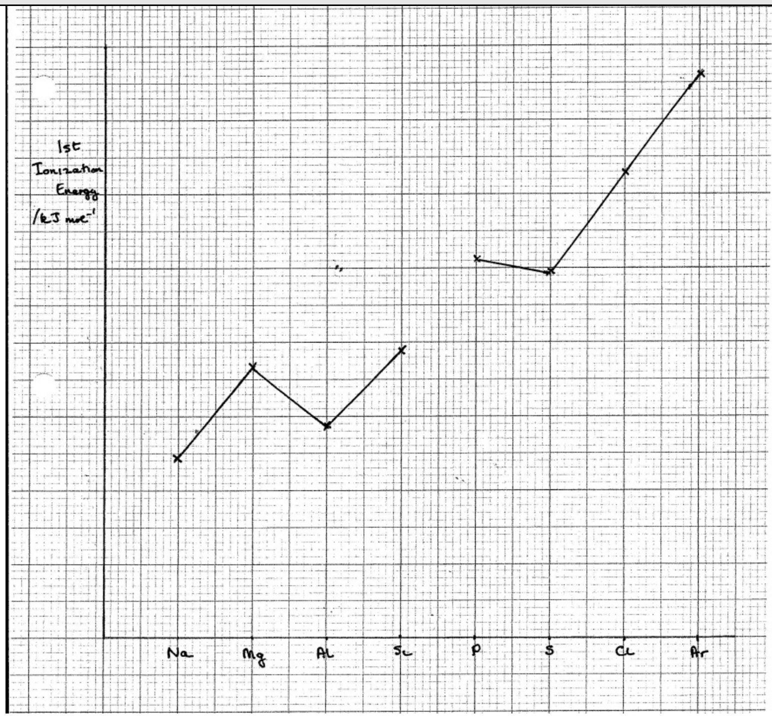
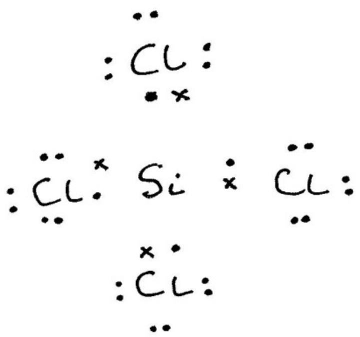
1.

Question Number	Acceptable Answers	Reject	Mark
1(a)	$Mg(g) \rightarrow Mg^+(g) + e^{(-)}$ ALLOW $Mg(g) - e^{(-)} \rightarrow Mg^+(g)$ Loss of electron to form Mg^+ (1) IGNORE (g) sign on electron State symbols ALLOW Provided the equation involves magnesium, even if electron is added to the wrong side. (1)	Formation of Mg^{2+}	**(2)**

Question Number	Acceptable Answers	Reject	Mark
1(b)	$(1s^2)\ 2s^2 2p^6\ 3s^2 3p^1$ ALLOW Capital s and/or p, subscripts $2p_x^2\ 2p_y^2\ 2p_z^2\ 3p_x^1$ $3p_y^1$ / $3p_z^1$ for $3p_x^1$		**(1)**

Question Number	Acceptable Answers	Reject	Mark
***1(c)(i)**	Mg to Al: Electron removed from Al is from a higher energy level (3p rather than 3s) ALLOW Electron removed in Al is (more) shielded (by 3s) IGNORE Outer electron is further from nucleus Full sub-shell is more stable than part filled sub-shell (1) **MP2** Al to Si: Si has one more proton than Al/ has greater nuclear charge, **and** electrons removed in both cases are 3p / same sub-shell / are equally shielded (1) **MP3** EITHER The attraction of the extra proton in Al is less than the effect of the higher energy level/ the shielding OR Electron removed from Si is closer to nucleus (than Al) ALLOW Silicon is smaller in size (1)		**(3)**

Question Number	Acceptable Answers	Reject	Mark
1(c)(ii)	 **MP1** S does not follow trend (P is above Si followed by dip in graph from P to S rising again to Cl and Ar) (1) **MP2** S has one (3)p orbital which has two electrons/ paired electrons/ is fully occupied OR S has $3p_x^2$, $3p_y^1$, $3p_z^1$ OR Electron in box diagram for S ALLOW S has **a pair of** electrons in the (3)p subshell (1) **MP3** A paired electron is easier to remove OR paired electrons repel each other ALLOW half filled sub-shell (in P) is stable (1)	Just "S has $3p^4$" d orbital P has **a** half filled orbital	**(3)**

Question Number	Acceptable Answers	Reject	Mark
1(d)	Four x round Si sharing one ● with each Cl (1) Seven ● round each Cl sharing one x with each Si (1)  ALLOW Reversed symbols		**(2)**

Question Number	Acceptable Answers	Reject	Mark
1(e)(i)	I^- / anion becomes distorted / not spherical. May be shown in a diagram (1) **MP2** Mg^{2+} has high(er) charge **and** small(er) radius/ Mg^{2+} has high charge density (1) **MP3** Bonding in magnesium iodide has some covalent character OR Orbitals of Mg^{2+} and I^- overlap/ Mg^{2+} shares some of the I^- electrons OR Mg^{2+} and I^- ions are not completely separate (1)	Iodine becomes distorted Just “electrons in outer shell are attracted” Atoms of Mg have a small (atomic) radius	**(3)**

Question Number	Acceptable Answers	Reject	Mark
1(e)(ii)	Experimental/ Born Haber cycle and theoretical/ calculated lattice energies are **different** OR Experimental/ Born Haber cycle lattice energy is more exothermic/ more negative than theoretical/ calculated lattice energy ALLOW Greater for more negative IGNORE Comments about melting temperature	Just "Compare Experimental/ Born Haber cycle and theoretical/ calculated lattice energies" Use of electron density map	**(1)**

(Total for Question = 15 marks)

Question Number	Acceptable Answers	Reject	Mark
2(a)	(Protons) **18** (Electrons) **18** (Neutrons) **22** All three numbers correct for the mark		**1**

Question Number	Acceptable Answers	Reject	Mark
2(b)	(Position in the Periodic Table) depends upon atomic number / proton number OR Ar (atom) has (one) fewer proton(s) (than K atom) OR K (atom) has (one) more proton(s) (than Ar atom) OR K has atomic number 19 (whereas) Ar has atomic number 18 OR Ar has 18 protons, K has 19 protons IGNORE ‘Elements are not arranged in order of (relative) atomic mass’ IGNORE Mention of numbers of electrons / numbers of shells (of electrons) IGNORE Arranged in vertical groups in accordance to properties / Argon is a noble gas		**1**

Question Number	Acceptable Answers	Reject	Mark
2(c)	**First mark** Property / trend / pattern ALLOW Any named property (e.g. atomic radius, ionization energy, melting temperature) **(1)** **Second mark** **Repeated** (across each period) OR **Regular** (across each period) OR **Re-occurring** (across each period) **(1)** NOTE Statement such as: "A repeating trend across a period / across each period" scores **(2)**		**2**

Question Number	Acceptable Answers	Reject	Mark
2(d)(i)	Phosphorus / P / P_4 OR Sulfur / S / S_8 OR Chlorine / Cl / Cl_2 IGNORE Argon / Ar		**1**

Question Number	Acceptable Answers	Reject	Mark
2(d)(ii)	(The covalent) **bonds** are **strong** (throughout the lattice) **(1)** (therefore) a lot of **energy** is required to break the bonds / a lot of **energy** is needed to overcome the attractions (between atoms) / 'more **energy**' is required to break the bonds /'more **energy**' is needed to overcome the attractions (between atoms) / 'greater amount of **energy**' is required to break the bonds /'greater amount of **energy**' is needed to overcome the attractions (between atoms) **(1)**	**MENTION OF ANY OF THE FOLLOWING SCORES (0) OVERALL** '(simple) molecular silicon' **(0)** 'molecules of silicon' **(0)** 'silicon has ions' / 'silicon is ionic' **(0)** 'intermolecular forces' / 'van der Waals' forces' / 'London forces' / 'forces between the molecules' **(0)** 'metallic bonding' **(0)**	**2**

Question Number	Acceptable Answers	Reject	Mark
2(d)(iii)	**ALLOW reverse arguments in each case** **Any two from four:-** ●magnesium ions / magnesium atoms are smal**ler** (than sodium ions / sodium atoms) **(1)** **NOTE:** Allow symbols (e.g. Mg or Mg^{2+}) ●magnesium **ions** are Mg^{2+} whereas sodium **ions** are Na^{+} OR Mg^{2+} / magnesium **ions** have a larg**er** charge (density) (than Na^{+} /sodium **ions**) **(1)** **[NOTE:** It follows that the statement that "Mg^{2+} ions are smaller than Na^{+} ions" would score the first two scoring points above**]** ●magnesium has more **delocalised** electrons (than sodium) **(1)** IGNORE 'free electrons' IGNORE just 'sea of electrons' ●magnesium is close-packed (but sodium is not close-packed) **(1)** **Third mark (stand-alone):** · more / a lot of (heat) energy is needed to break (metallic) bonds in Mg (than in Na) OR · attraction between the positive ions and (delocalised) electrons is strong**er** in magnesium (than in sodium) **(1)**	attraction between **nucleus** and (delocalised) electrons (no third mark) mention of **intermolecular forces / molecules** (no third mark)	**3**

	IGNORE Just ‘metallic bonding in Mg stronger than that in Na’	ionic bonding (no third mark) attraction between Mg^{2+} ions (no third mark) **NOTE:** arguments based on ionization energies scores **(0) overall** **OR** any suggestion of removal of outer shell electrons as part of the melting process scores **(0) overall**	

(Total for Question = 10 marks)

Question Number	Acceptable Answers	Reject	Mark
3(a)(i)	B **acceleration** **(1)** C **deflection** **(1)** Allow B ions are accelerated/ accelerating C ions are (being) deflected	B just electric field C just magnetic field	2

Question Number	Acceptable Answers	Reject	Mark
3(a)(ii)	(A_r for K) = (39 x 0.9322) + (40 x 0.0012) + (41 x 0.0666) or a correct fraction using percentages **(1)** = 39.1344 = 39.13 **(1)** Correct answer without working scores 2 Max 1 if not to 2 decimal places Second mark dependent on first IGNORE Units of any kind (e.g. 'g', 'g mol^{-1}', 'amu', etc.)		2

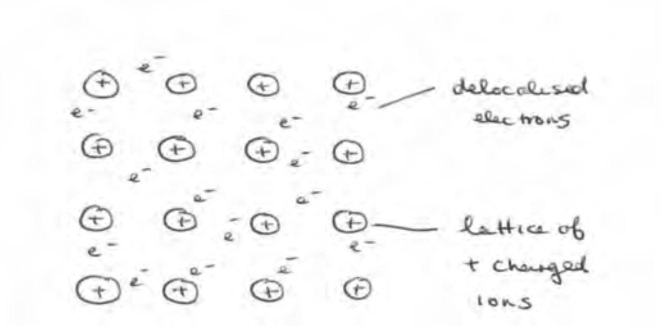
Question Number	Acceptable Answers	Reject	Mark
3(a)(iii)	see table below		1

Isotope	Electrons	Protons	Neutrons
^{39}K	19	19	20
^{41}K	19	19	22

Question Number	Acceptable Answers	Reject	Mark
3(a) (iv)	($1s^2$) $2s^2 2p^6$ $3s^2 3p^6$ $4s^1$ Fully correct Ignore additional $1s^2$		1

Question Number	Acceptable Answers	Reject	Mark
3(a)(v)	(Position in the Periodic Table) depends upon atomic number / proton number OR Ar (atom) has (one) fewer proton(s) (than K atom) OR K (atom) has (one) more proton(s) (than Ar atom) OR K has atomic number 19 (whereas) Ar has atomic number 18 OR Ar has 18 protons, K has 19 protons IGNORE 'Elements are not arranged in order of (relative) atomic mass' IGNORE Mention of numbers of electrons / numbers of shells (of electrons) IGNORE Arranged in vertical groups in accordance to properties / argon is a noble gas		1

Question Number	Acceptable Answers	Reject	Mark
3(a) (vi)	One fewer shell of electrons **(1)** Electrons in the ion are held more tightly OR Same number of protons attracting fewer electrons OR Less repulsion between (remaining) electrons **(1)** IGNORE References to effective nuclear charge / charge density		2

Question Number	Acceptable Answers	Reject	Mark
3(b)	Regular lattice of singly-positively charged (potassium) ions **(1)** Delocalised electrons / sea of electrons / mobile electrons **(1)** e.g.  Accept other regular arrangements Unlabelled diagram max (1)		2

Question Number	Acceptable Answers	Reject	Mark
3(c)(i)	**First mark:-** Makes mention of energy/enthalpy/(heat) energy/heat (change) 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 for **(1)** $X(g) \rightarrow X^{+}(g) + e^{(-)}$ **(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
3(c)(ii)	Potassium is E **(1)** Alkali metals always have the lowest first ionization energy in their period OR It follows a noble gas/ an element with very high first ionization energy OR Ionization energy falls (significantly) at the start of a (new) period / Ionization energy falls (significantly) after **D** **(1)**		2

Total for Q19 = 16 marks

<table>
<tr><th>Question Number</th><th>Acceptable Answers</th><th>Reject</th><th>Mark</th></tr>
<tr><td>4(a)</td><td>
<table>
<tr><td>Isotope</td><td>$^{131}I_{53}$</td><td>$^{127}I_{53}$</td></tr>
<tr><td>Number of protons</td><td>53</td><td>53</td></tr>
<tr><td>Number of neutrons</td><td>78</td><td>74</td></tr>
</table>
</td><td></td><td>2</td></tr>
</table>

Question Number	Acceptable Answers	Reject	Mark
4(b)	Xenon / Xe / $_{54}Xe$ / Xe_{54} / $^{131}_{54}Xe$	Anything else including: $^{130}Xe_{54}$ Xe^{-} Iodine / I with or without numbers Hydrogen / H with or without numbers Te	**1**

Question Number	Acceptable Answers	Reject	Mark
4(c)	Potassium iodide / KI Accept any soluble, non-toxic iodide or iodate Wrong name, correct formula (0) Correct name, wrong formula (0)	HI KI_3 Wrong formulae like CaI, MgI Wrong name like calcium idodate BaI_2 (toxic) AgI (insoluble) Potassium iodine	**1**

<table>
<tr><th>Question Number</th><th>Acceptable Answers</th><th>Reject</th><th>Mark</th></tr>
<tr><td>4(d)</td><td>Country /ALLOW state and justification
Both needed for one mark

e.g. Japan / New Zealand / California etc

Country / state at risk from Earthquake / tsunami / flooding

Further examples:

Italy with volcanoes

Afghanistan / middle eastern / African countries terrorist / (nuclear) weapon threat / war zone / political instability / abuse of nuclear power.

USA /America / Jamaica etc risk of hurricane / tornado

California San Andreas fault</td><td>...population density

...landslide

...too hot

... surrounded by other countries

Antarctica</td><td>1</td></tr>
</table>

Total for Question = 13 Marks

Question Number	Acceptable Answers	Reject	Mark
5(a)	$As(g) – e^{(–)} \rightarrow As^{+}(g)$ OR $As(g) \rightarrow As^{+}(g) + e^{(–)}$ Entities **(1)** All species gaseous **(1)** providing a reasonable attempt at an ionization energy Examples: $As(g) + e^{(–)} \rightarrow As^{+}(g)$ $As(g) – e^{(–)} \rightarrow As^{-}(g)$ $As^{2+}(g) – e^{(–)} \rightarrow As^{3+}(g)$ IGNORE state symbol of electron ALLOW upper case / large S in arsenic ALLOW $As(g) + e^{(–)} \rightarrow As^{+}(g) + 2e^{(–)}$ **(2)**	$As(g)+e^{(–)} \rightarrow As^{-}(g)$ (electron affinity)	**2**

Question Number	Acceptable Answers	Reject	Mark
5(b)	AsH_3 / H_3As **(1)** H_2Se / SeH_2 **(1)** IGNORE charges ALLOW upper case / large S in arsenic **NOTE:** If two or more answers given for one element mark that element on a plus minus basis	SE for Selenium	**2**

<table>
<tr><th>Question Number</th><th>Acceptable Answers</th><th>Reject</th><th>Mark</th></tr>
<tr><td>5(c)(i)</td><td>
<table>
<tr><td></td><td></td><td>4s</td><td colspan="3">4p</td></tr>
<tr><td>As</td><td>[Ar] 3d^{10}</td><td>↑↓</td><td>↑</td><td>↑</td><td>↑</td></tr>
<tr><td>Se</td><td>[Ar] 3d^{10}</td><td>↑↓</td><td>↑↓</td><td>↑</td><td>↑</td></tr>
</table>
One mark for each row

Arrows may be half-headed

Arrows must be in same direction if in singly occupied boxes (can be down)

ALLOW two arrows for Se in any 4p box

Selenium two arrows must show opposite spins</td><td></td><td>2</td></tr>
</table>

Question Number	Acceptable Answers	Reject	Mark
5(c)(ii)	**For parts c(ii),d and e it is important to keep in mind the two elements involved in each part** **As and Se** **First mark:** EITHER In Se, (spin) pairing has occurred (for the first time in that p sub-shell) OR electron removed from orbital containing two electrons **(1)** ALLOW sub-shell for orbital **Second mark:** EITHER (Increase in) repulsion (so electron lost more easily) OR Half-filled (sub-) shell/allow orbital (particularly) stable (in As) ALLOW orbital for sub-shell **(1)** Mark each point independently IGNORE reference to distance from nucleus and shielding		**2**

Question Number	Acceptable Answers	Reject	Mark
5(d)	**Se and Kr** **First mark:** EITHER The nuclear charge is increasing (Nuclear must be stated or clearly implied) OR number of protons / atomic number is increasing **(1)** **Second mark:** (Outermost) electron closer to nucleus / electron is removed from the same (sub)shell / electron experiences similar shielding / (atomic) radius is smaller/ smaller **atom** **(1)** ALLOW reverse arguments for selenium IGNORE Kr has full outer shell	Ionic radius Molecule (unless monatomic)	**2**

Question Number	Acceptable Answers	Reject	Mark
5(e)	**Kr and Rb** Any two from: The **electron** (in Rb) (removed) is further from the nucleus **(1)** The **electron** is in a higher / new / another / 5s (energy quantum) shell / energy level **(1)** **More** shielded **(1)** IGNORE any reference to stability of krypton or larger atomic radius of Rb / full outer shell of Kr It is possible that two answers may be offered together in one sentence e.g. Rb outer electron is in another shell further from nucleus (2)		**2**

Question Number	Acceptable Answers	Reject	Mark
5(f)	Krypton / Kr	Anything else	**1**

Total for Question = 13 Marks