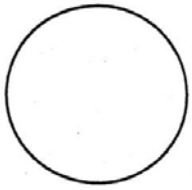
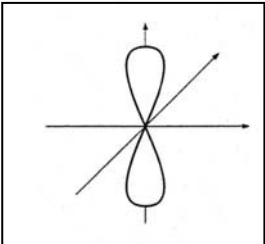
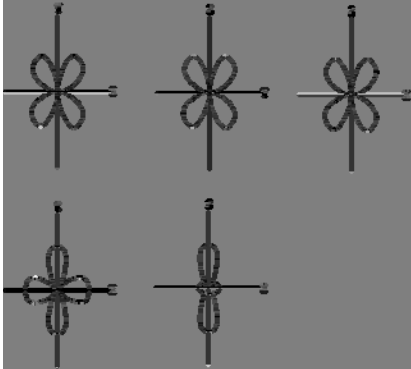


Section B

Question Number	Acceptable Answers	Reject	Mark								
1 (a)	<table border="1" style="margin-left: 20px;"> <tr> <td>1s</td> <td>2s</td> <td>2p</td> <td>3s</td> <td>3p</td> <td>4s</td> <td>3d</td> <td>4p</td> </tr> </table> <p>3d 4p (2)</p> <p>ALLOW</p> <p>4p 3d scores 1 out of 2</p> <p>4p 5s scores 1 out of 2</p> <p>ALLOW use of capital letters e.g. "3D and/or 4P"</p>	1s	2s	2p	3s	3p	4s	3d	4p	'4p 4d' or '4d 4p' gets 0	2
1s	2s	2p	3s	3p	4s	3d	4p				

Question Number	Acceptable Answers	Reject	Mark
1 (b)(i)	<p>A region / space / volume (around the nucleus / atom) where there is a high probability / chance / likelihood / of finding an electron</p> <p>ALLOW 'area' / 'sub-shell' as alternative for region</p> <p>OR</p> <p>A region where an electron is likely to be found</p>	<p>Just 'the path an electron takes orbiting around a nucleus'</p> <p>Just 'Position of electrons in an atom'</p>	1

Question Number	Acceptable Answers	Reject	Mark
1 (b) (ii)	<div style="display: flex; justify-content: space-around; align-items: center;"> <div style="text-align: center;">  <p>s-orbital</p> <p>(1)</p> </div> <div style="text-align: center;">  <p>p-orbital</p> <p>(1)</p> </div> </div>	<p>For s-orbital do not allow ellipse for first mark</p> <p>pi bond</p> <p>d-orbitals shown below</p> 	2

Question Number	Acceptable Answers	Reject	Mark
1 (c)	<p>11 / eleven</p> <p>ALLOW $2p^63p^5$</p>	$1s^22s^22p^63s^23p^5$	1

Question Number	Acceptable Answers	Reject	Mark
1 (d)	18 / eighteen	$1s^22s^22p^63s^23p^6$	1

Question Number	Acceptable Answers	Reject	Mark																																				
*1 (e)	<p>Enthalpy / energy / heat / heat energy per mole required/needed</p> <p>OR</p> <p>Enthalpy / energy / heat / heat energy change per mole (1)</p> <p>to remove one / an electron (1)</p> <p>from gaseous atom(s) (1)</p> <p>“Energy required to remove one mole of electrons from one mole of gaseous atoms” scores all three marks</p> <p>NOTE: The equation:</p> $X(g) \rightarrow X^+(g) + e^-$ <p>scores the last two marks</p> <p>NOTE: An incorrect equation given with a correct definition in words scores 2 out of 3 marks</p>	“Energy given out ... ” for first mark	3																																				
Question Number	Acceptable Answers		Mark																																				
1 (f)	<table border="1"> <tr> <td>Ionization energy / kJ mol⁻¹</td> <td>496</td> <td>456</td> <td>691</td> <td>954</td> <td>1335</td> <td>1661</td> <td>2011</td> <td>2549</td> <td>2893</td> <td>14136</td> <td>15907</td> </tr> <tr> <td>Ionization number</td> <td>1st</td> <td>2nd</td> <td>3rd</td> <td>4th</td> <td>5th</td> <td>6th</td> <td>7th</td> <td>8th</td> <td>9th</td> <td>10th</td> <td>1</td> </tr> <tr> <td></td> <td>✓</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>✓</td> <td>✓</td> <td>✓</td> <td>✓</td> </tr> </table> <p>All five correct = 2 marks</p> <p>Four/three correct = 1 mark</p> <p>Two/one/none correct = 0 marks</p>	Ionization energy / kJ mol⁻¹	496	456	691	954	1335	1661	2011	2549	2893	14136	15907	Ionization number	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	1		✓							✓	✓	✓	✓		2
Ionization energy / kJ mol⁻¹	496	456	691	954	1335	1661	2011	2549	2893	14136	15907																												
Ionization number	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	1																												
	✓							✓	✓	✓	✓																												

Total for Question = 12 marks

Question Number	Acceptable Answers	Reject	Mark
2 (a)	<p>F mark:- Makes mention of energy/enthalpy/(heat) energy/heat (change) AND to remove an electron AND one mole/1 mol</p> <p>Second mark: Makes mention of gaseous atom(s)</p> <p>ALTERNATIVE ANSWER</p> <p>Energy change per mole for (1)</p> <p>$X(g) \rightarrow X^+(g) + e^{(-)}$ (1)</p> <p>Mark the two points independently</p> <p>IGNORE any references to standard conditions</p>	<p>"Energy given out..." for first mark</p> <p>Just 'gaseous element'/ 'gaseous substance'</p>	2

Question Number	Acceptable Answers	Reject	Mark
*2(b)	<p>Any two from three:- (Atomic) radius increases/there are more shells/(outermost) electron further from the nucleus (1)</p> <p>there is 'more shielding' or 'more screening' (down group) (1)</p> <p>the nuclear attraction decreases OR attraction between nucleus and (outermost) electron decreases OR the increased shielding/increased distance outweighs the increased nuclear charge (1)</p> <p>IGNORE any references to 'more protons' and/just 'increasing nuclear charge' IGNORE references to "effective nuclear charge"</p>	<p>Ionic radius increases</p>	2

Question Number	Acceptable Answers	Reject	Mark
2(c) (i)	<p>Any ONE from: (Electrons are being removed from an) increasingly positive ion/ charge on the ion (successively) increases/ increasing proton : electron ratio/ same number of protons (attracting) fewer electrons / ions get smaller/ the electron repulsion decreases/ the shielding decreases/ electrons (being removed are) closer to the nucleus/ effective nuclear charge increases</p>		1

Question Number	Acceptable Answers	Reject	Mark
*2(c)(ii)	<p>First mark: <u>Two</u> jumps</p> <p>Two (large) jumps (between 1st and 2nd and 9th and 10th IEs) (1)</p> <p>NOTE: A sketch graph with two (large) jumps can score this first mark</p> <p>Note if the jumps are specified, they must be between 1st and 2nd and 9th and 10th IEs</p> <p>Second mark: Electronic configuration of Na</p> <p>2, 8, 1 mentioned in words, annotated on a sketch graph or drawn out in a diagram (e.g. electrons shown in orbits/shells around the centre of the atom) but NOT just inferred (1)</p> <p>ALLOW "1, 8, 2" OR 1s²2s²2p⁶3s¹</p> <p>Mark the two points independently</p>	<p>1st mark if the graph is sketched 'back to front'</p>	<p>2</p>

Question Number	Acceptable Answers	Reject	Mark
2(d)(i)	<p>Credit any of the following representations (but need BOTH Mg AND Al to be correct)</p> <p>Mg $1s^22s^22p^63s^2$ and Al $1s^22s^22p^63s^23p^1$</p> <p>Mg $1s_22s_22p_63s_2$ and Al $1s_22s_22p_63s_23p_1$</p> <p>Mg $1S^22S^22P^63S^2$ and Al $1S^22S^22P^63S^23P^1$</p> <p>Mg $1S_22S_22P_63S_2$ and Al $1S_22S_22P_63S_23P_1$</p>		1

Question Number	Acceptable Answers	Reject	Mark
*2(d)(ii)	<p>NOTE: ALLOW an argument focusing on either the Al or the Mg atom</p> <p>EITHER In Al, (3p) electron (lost is) at higher energy/more shielded (by 3s electrons)/further from the nucleus IGNORE any reference to an unpaired electron in Al OR In Mg, (3s) electron (lost is) at lower energy/less shielded/nearer to the nucleus/from a full subshell/from a full orbital/from (stable) $(3s)^2$</p> <p>Any reference to an Al atom being larger in size than an Mg atom scores zero overall.</p>	<p>Al has one more shell than Mg</p> <p>Just (lost from) a new sub-shell</p> <p>Electron lost in Mg from a "full shell"</p>	1

Question Number	Acceptable Answers	Reject	Mark
3 (a)	<p>First mark The energy (allow enthalpy / heat) required (allow change) per mole (1)</p> <p>Second mark to form (gaseous) singly charged positive ions Or to remove (1 mole of) electrons (1)</p> <p>Third mark from gaseous atoms (of the element) (1)</p> <p>$X(g) \longrightarrow X^+(g) + e^{(-)}$ scores last 2 marks</p> <p>Ignore standard conditions Per mole scores at any point</p>	<p>Energy / enthalpy produced</p> <p>Just gaseous element</p>	3

Question Number	Acceptable Answers	Reject	Mark
3 (b)	<p>Nuclear charge / effective nuclear charge / number of protons / atomic number increases (1)</p> <p>Two of</p> <p>(Outer) electrons in the same (quantum) shell / same number of electron shells (1)</p> <p>Shielding (of nucleus)(about) the same (1)</p> <p>Distance from nucleus/atomic radius less (1)</p>	<p>charge density</p> <p>orbitals, sub-shell</p>	3

Question Number	Acceptable Answers	Reject	Mark
3 (c)	<p>Route 1 Electrons (in the p sub-shell) are paired (for the first time) (in S) / two electrons occupy the same (p) orbital / full orbital / electrons-in-boxes diagram (1)</p> <p>repulsion between the (paired) electrons (reduces IE) (1)</p> <p>Route 2 P has a half-filled p sub-shell / half-filled p orbitals which is stable (1)</p> <p>(on ionization) S gains a half-filled p sub-shell / half-filled p orbitals (1)</p>		2

Question Number	Acceptable Answers	Reject	Mark
3 (d)	200 – 490 (kJ mol ⁻¹)	Negative values	1

Question Number	Correct Answer			Reject	Mark												
4 (a)	<table border="1"> <tr> <td>element</td> <td>str</td> <td>bonding</td> </tr> <tr> <td>sodium</td> <td>Giant</td> <td>metallic</td> </tr> <tr> <td>silicon</td> <td>Giant (atomic)/ macromolecular/ giant molecular</td> <td>covalent</td> </tr> <tr> <td>sulfur</td> <td>simple / small molecules OR (simple) molecular OR S₈ molecules</td> <td>covalent or van der Waals' forces/ London forces/ intermolecular forces/dispersion forces/induced- dipole forces</td> </tr> </table>			element	str	bonding	sodium	Giant	metallic	silicon	Giant (atomic)/ macromolecular/ giant molecular	covalent	sulfur	simple / small molecules OR (simple) molecular OR S ₈ molecules	covalent or van der Waals' forces/ London forces/ intermolecular forces/dispersion forces/induced- dipole forces		3
element	str	bonding															
sodium	Giant	metallic															
silicon	Giant (atomic)/ macromolecular/ giant molecular	covalent															
sulfur	simple / small molecules OR (simple) molecular OR S ₈ molecules	covalent or van der Waals' forces/ London forces/ intermolecular forces/dispersion forces/induced- dipole forces															
<i>IGNORE</i> the word "lattice" OR "crystalline"																	
6 boxes correct (3)																	
5,4 boxes correct (2)																	
3,2 boxes correct (1)																	
1,0 boxes correct (0)																	

Question Number	Correct Answer	Reject	Mark
4 (b)	<p>Si : covalent bonds / many bonds/ strong bonds (between atoms) (1)</p> <p>S : weak forces /van der Waals' forces/London forces/dispersion forces/intermolecular forces/induced-dipole forces (1) (need to be overcome)</p>	<p>any reference to intermolecular forces in Si</p> <p>suggestion that covalent bonds are broken</p>	2

Question Number	Correct Answer	Reject	Mark
4 (c) QWC	<p>Cations/ions decrease in size (from Na⁺ to Al³⁺) OR charge increases/charge density on (cat)ions increases/ "effective nuclear charge" increases (from Na⁺ to Al³⁺) (1)</p> <p>more e⁻ (per atom in 'sea' of delocalized electrons) / more delocalized electrons</p> <p>OR (force of) attraction between (cat)ions/nucleus and (delocalised) electrons increases (from Na to Al) (1)</p> <p><i>IGNORE</i> "nuclear charge increases" / "increasing no. of protons"</p>	<p>atoms decrease in size</p> <p>any mention of "molecules" / "covalent bonds" / "van der Waals' forces" / "ionic bonds" (0) overall</p>	2

Question Number	Correct Answer	Reject	Mark
4 (d)(i) QWC	<ul style="list-style-type: none"> Add MgO to acid/react MgO with acid/dissolve MgO in acid (1) <p>[NOTE: mention of heating not required. IGNORE water bath/reflux]</p> <ul style="list-style-type: none"> Filter (1) Heat/boil filtrate /MgSO₄ solution (until volume reduced by half) (1) Leave to cool/leave to crystallise/evaporate slowly/leave to evaporate (1) <p>(decant / filter / pick out crystals, then) Leave to dry/pat dry/dry between filter papers/put in an oven/put in a desiccator/dry the crystals (1)</p> <p>IGNORE any washing of crystals immediately prior to drying them</p>	<p>Just "warm" the filtrate/MgSO₄ solution</p> <p>Use of a desiccant (added to crystals)</p>	5

Question Number	Correct Answer	Reject	Mark
4 (d)(ii)	Rinse with (plenty of) water /use a damp cloth or damp (paper) towel / add a (named) weak alkali (e.g. solid or aqueous sodium hydrogencarbonate)	Any named strong alkali/just "strong alkali"	1

Question Number	Correct Answer	Reject	Mark
4 (e)(i)	Insoluble strontium sulfate/insoluble SrSO ₄ (forms on the strontium carbonate)		1

Question Number	Correct Answer	Reject	Mark
4 (e)(ii)	<p> $\text{Sr}^{2+}(\text{aq}) + \text{SO}_4^{2-}(\text{aq}) \rightarrow \text{SrSO}_4(\text{s})$ species (1) state symbols (1) </p> <p> 2nd mark is cq on first mark </p> <p> $\text{Sr}^{2+}(\text{aq}) + 2\text{Cl}^{-}(\text{aq}) + 2\text{Na}^{+}(\text{aq}) + \text{SO}_4^{2-}(\text{aq}) \rightarrow \text{SrSO}_4(\text{s}) + 2\text{Cl}^{-}(\text{aq}) + 2\text{Na}^{+}(\text{aq})$ scores (1) </p> <p> $\text{SrCl}_2(\text{aq}) + \text{Na}_2\text{SO}_4(\text{aq}) \rightarrow \text{SrSO}_4(\text{s}) + 2\text{NaCl}(\text{aq})$ scores (1) </p>		2