Mini Mock Unit 1 Periodicity AS Chemistry Questions

Q1. (a) Explain why certain elements in the Periodic Table are classified as p-block elements. Illustrate your answer with an example of a p-block element and give its electronic configuration. (3)

(b) Explain the meaning of the term periodicity as applied to the properties of rows of elements in the Periodic Table. Describe and explain the trends in atomic radius, in electronegativity and in conductivity for the elements sodium to argon. (13) **(Total 16 marks)**

Q2. (a) Complete the following table. **(3)**

Particle	Relative charge	Relative mass
Proton		
Neutron		
Electron		

(b) An atom of element Z has two more protons and two more neutrons than an atom of $^{34}_{16}S$. Give the symbol, including mass number and atomic number, for this atom of Z. (2)

(c) Complete the electronic configurations for the sulphur atom, S, and the sulphide ion, S^{2-}

S 1s2 ....

S^{2-} 1s2 ....(2)

(d) State the block in the Periodic Table in which sulphur is placed and explain your answer. (2)

(e) Sodium sulphide, Na_2S, is a high melting point solid which conducts electricity when molten. Carbon disulphide, CS_2, is a liquid which does not conduct electricity.

(i) Deduce the type of bonding present in Na_2S and that present in CS_2

(ii) By reference to all the atoms involved explain, in terms of electrons, how Na_2S is formed from its atoms.

(iii) Draw a diagram, including all the outer electrons, to represent the bonding present in CS_2

(iv) When heated with steam, CS2 reacts to form hydrogen sulphide, H_2S, and carbon dioxide.

Write an equation for this reaction.(7) **(Total 16 marks)**

Q3. (a) The table below gives the melting point for each of the Period 3 elements Na – Ar.

Element	Na	Mg	Al	Si	P	S	Cl	Ar
Melting point / K	371	923	933	1680	317	392	172	84

In terms of structure and bonding, explain why silicon has a high melting point, and why the melting point of sulphur is higher than that of phosphorus.(7)

(b) Draw a diagram to show the structure of sodium chloride. Explain, in terms of bonding, why sodium chloride has a high melting point.(4)

(c) Give the conditions under which, if at all, beryllium and magnesium react with water. For any reaction that occurs, state one observation you would make and write an equation.(4) **(Total 15 marks)**

Q4. (a) (i) Complete the electronic configuration of aluminium. 1s2 ....

(ii) State the block in the Periodic Table to which aluminium belongs. (2)

(b) Describe the bonding in metals. (2)

(c) Explain why the melting point of magnesium is higher than that of sodium. (3)

(d) Explain how metals conduct electricity. (2) **(Total 9 marks)**

Q5. (a) When aluminium is added to an aqueous solution of copper(II) chloride, CuCl2, copper metal and aluminium chloride, AlCl3, are formed. Write an equation to represent this reaction. (1)

(b) (i) State the general trend in the first ionisation energy of the Period 3 elements from Na to Ar.

(ii) State how, and explain why, the first ionisation energy of aluminium does not follow this general trend. (4)

(c) Give the equation, including state symbols, for the process which represents the second ionisation energy of aluminium. (1)

(d) State and explain the trend in the melting points of the Period 3 metals Na, Mg and Al. (3)**(Total 9 marks)**

Q6. (a) State the meaning of the term first ionisation energy of an atom. (2)

(b) Complete the electron arrangement for the Mg2+ ion. 1s2...(1)

(c) Identify the block in the Periodic Table to which magnesium belongs. (1)

(d) Write an equation to illustrate the process occurring when the second ionisation energy of magnesium is measured. (1)

(e) The Ne atom and the Mg2+ ion have the same number of electrons. Give two reasons why the first ionisation energy of neon is lower than the third ionisation energy of magnesium. (2)

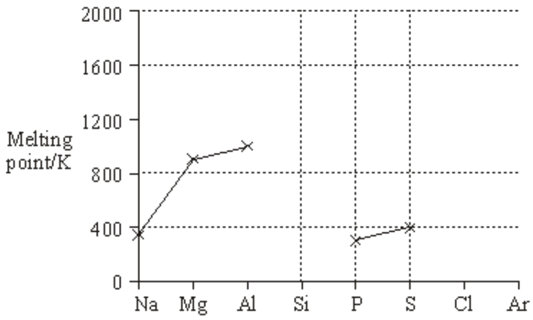
(f) There is a general trend in the first ionisation energies of the Period 3 elements, Na – Ar

(i) State and explain this general trend.

(ii) Explain why the first ionisation energy of sulphur is lower than would be predicted from the general trend. (5)

(Total 12 marks)

Q7. (a) The diagram below shows the melting points of some of the elements in Period 3.



(i) On the diagram, use crosses to mark the approximate positions of the melting points for the elements silicon, chlorine and argon. Complete the diagram by joining the crosses.
(ii) By referring to its structure and bonding, explain your choice of position for the melting point of silicon.
(iii) Explain why the melting point of sulphur, S8, is higher than that of phosphorus, P4 (8)
(b) State and explain the trend in melting point of the Group II elements Ca–Ba. (3) **(Total 11 marks)**

Q8. The elements phosphorus, sulfur, chlorine and argon are in the p block of the Periodic Table.
(a) State why these elements are classified as p block elements. (1)
(b) State the **trend** in atomic radius from phosphorus to chlorine and **explain** the trend.(3)
(c) In terms of structure and bonding, explain why sulfur has a higher melting point than phosphorus.(3)
(d) Using atomic structure, explain why the van der Waals' forces in liquid Ar are very weak.(2) **(Total 9 marks)**

Q9. This question is about the elements in Period 3 from Na to P
(a) (i) Explain the meaning of the term first ionisation energy. (2)
(ii) **State** and **explain** the general trend in first ionisation energies for the elements Na to P **(3)**
(iii) **State** which one of the elements from Na to P deviates from this general trend and **explain** why this occurs. (3)
(b) **State** which elements from Na to P has the highest melting point and **explain** why. (3) **(Total 11 marks)**

Q10. (a) Complete the electronic configuration for the sodium ion, Na^+ Is^2 ....(1)
(b) (i) Write an equation, including state symbols, to represent the process for which the energy change is the second ionisation energy of sodium. (2)
(ii) Explain why the second ionisation energy of Na is greater than the second ionisation energy of Mg. (3)
(iii) An element X in Period 3 of the Periodic Table has the following successive ionisation energies.

	First	Second	Third	Fourth
Ionisation energies / kJ mol–1	577	1820	2740	11600

Deduce the identity of element X. (1)
(c) **State** and **explain** the trend in atomic radius of the Period 3 elements from sodium to chlorine. (3)
(d) Explain why sodium has a lower melting point than magnesium. (3)
(e) Sodium reacts with ammonia to form the compound $NaNH_2$ which contains the NH_2^- ion.
Draw the shape of the NH_2^- ion, including any lone pairs of electrons.
Name the shape made by the three atoms in the NH_2^- ion.(2)
(f) In terms of its electronic configuration, give one reason why neon does not form compounds with sodium. (1)
(Total 16 marks)

Q11. Ionisation energies provide evidence for the arrangement of electrons in atoms.
(a) Complete the electron configuration of the Mg+ ion. $1s^2$ ....(1)
(b) (i) State the meaning of the term first ionisation energy. (2)
(ii) Write an equation, including state symbols, to show the reaction that occurs when the second ionisation energy of magnesium is measured. (1)
(iii) Explain why the second ionisation energy of magnesium is greater than the first ionisation energy of magnesium. (1)
(iv) Use your understanding of electron arrangement to complete the table by suggesting a value for the third ionisation energy of magnesium.(1)

	First	Second	Third	Fourth	Fifth
Ionisation energies of magnesium / kJ mol–1	736	1450		10 500	13 629

(c) State and explain the general trend in the first ionisation energies of Period 3 elements Na to Cl. (3)
(d) State how sulfur deviates from the general trend in first ionisation energies across Period 3. (3)
(e) A general trend exists in the first ionisation energies of the Period 2 elements lithium to fluorine. Identify one element which deviates from this general trend. (1)
(Total 13 marks)

Q12. The following table gives the melting points of some elements in Period 3.

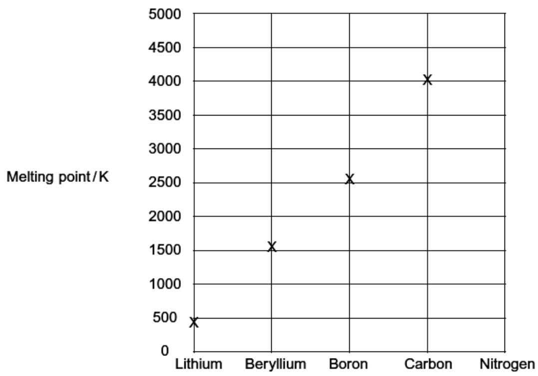
Element	Na	Al	Si	P	S
Melting point / K	371	933	1680	317	392

a) State the type of structure shown by a crystal of silicon.Explain why the melting point of silicon is very high. (3)

(b) State the type of structure shown by crystals of sulfur and phosphorus.Explain why the melting point of sulfur is higher than the melting point of phosphorus. (3)
(c) Draw a diagram to show how the particles are arranged in aluminium and explain why aluminium is malleable. (You should show a minimum of six aluminium particles arranged in two dimensions.) (3)
(d) Explain why the melting point of aluminium is higher than the melting point of sodium. (3)**(Total 12 marks)**

Q13.Trends in physical properties occur across all Periods in the Periodic Table.
This question is about trends in the Period 2 elements from lithium to nitrogen.
(a) Identify, from the Period 2 elements lithium to nitrogen, the element that has the largest atomic radius. (1)
(b) (i) State the general trend in first ionisation energies for the Period 2 elements lithium to nitrogen. (1)
(ii) **Identify the element** that deviates from this general trend, from Li to N, and **explain** your answer. (3)
(c) Identify the Period 2 element that has the following successive ionisation energies.(1)

	First	Second	Third	Fourth	Fifth	Sixth
Ionisation energy / kJ mol–1	1090	2350	4610	6220	37 800	47 000



(d) Draw a cross on the diagram to show the melting point of nitrogen.(1)

(e) Explain, in terms of structure and bonding, why the melting point of carbon is high.(3) **(Total 10 marks)**

Q14. (a) Boron trichloride (BCl_3) can be prepared as shown by the following equation.

$B_2O_3(s) + 3C(s) + 3Cl_2(g) \longrightarrow 2BCl_3(g) + 3CO(g)$

A sample of boron oxide (B2O3) was reacted completely with carbon and chlorine.
The two gases produced occupied a total volume of 5000 cm3 at a pressure of 100 kPa and a temperature of 298 K.
Calculate the mass of boron oxide that reacted.Give your answer to 3 significant figures.
(The gas constant R = 8.31 J K–1 mol–1) (5)
(b) Boron trichloride can also be prepared from its elements.Write an equation for this reaction.
Explain why boron trichloride has a trigonal planar shape with equal bond angles. (3)
(c) (i) Boron trichloride is easily hydrolysed to form two different acids as shown in the following equation.

$BCl_3(g) + 3H2O(l) \longrightarrow H_3BO_3(aq) + 3HCl(aq)$

Calculate the concentration, in mol dm–3, of hydrochloric acid produced when 43.2 g of boron trichloride are added to water to form 500 cm3 of solution.Give your answer to 3 significant figures. (4)
(ii) Boric acid (H3BO3) can react with sodium hydroxide to form sodium borate and water.
Write an equation for this reaction.(1)
(d) Boron trichloride can be reduced by using hydrogen to form pure boron.

$BCl_3(g) + 1\frac{1}{2} H_2(g) \longrightarrow B(s) + 3HCl(g)$

Calculate the percentage atom economy for the formation of boron in this reaction.
Apart from changing the reaction conditions, suggest one way a company producing pure boron could increase its profits from this reaction.(3)
(e) A different compound of boron and chlorine has a relative molecular mass of 163.6 and contains 13.2% of boron by mass. Calculate the molecular formula of this compound.(4) **(Total 20 marks)**

Q15.The elements in Period 2 show periodic trends.
(a) Identify the Period 2 element, from carbon to fluorine, that has the largest atomic radius. Explain your answer.(3)
(b) State the general trend in first ionisation energies from carbon to neon.Deduce the element that deviates from this trend and explain why this element deviates from the trend.
Trend ....
Element that deviates ....
Explanation .... (4)
(c) Write an equation, including state symbols, for the reaction that occurs when the first ionisation energy of carbon is measured. (1)
(d) Explain why the second ionisation energy of carbon is higher than the first ionisation energy of carbon. (1)
(e) Deduce the element in Period 2, from Li to Ne, that has the highest second ionisation energy. (1)**(Total 10 marks)**

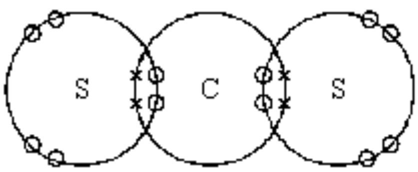
Mini Mock Unit 1 Periodicity AS Chemistry Questions

M1. (a) Elements in the p block have their outer electron(s) in
p orbital(s) or levels or sub-shells (1) example of element (1) correct electronic configuration (1) 3
(b) Pattern in the change in the properties of a row of elements (1) OR Trend in the properties of elements across a period; Repeated in the next row (1) OR element underneath (or in same group) has similar properties
atomic radius decreases across the row (1)
number of protons increases (1) (or nuclear charge increases)
more attraction for electrons in the same shell (1)
electronegativity: increases across the row (1)
number of protons increases (1) (or nuclear charge)
atomic radius decreases (1) (or shielding remains the same or electrons in the same shell) more attraction for bonding or shared electrons (1)
conductivity decreases row (1) OR significant drop from Al to Si Na–Al metals (1)
OR metallic bonding or description of metallic bonding
Two of Si - Ar non metals (1) OR molecular or covalent
EITHER electrons free to move (or delocalised) in metals OR electrons unable to move in non-metals (1) 13 [16]

M2. (a) [3 marks]

Particle	Relative charge	Relative mass	
Proton	+1 or 1+	1	(1)
Neutron	0	1 (not – 1)	(1)
Electron	–1 or 1–	1/1800 to 1/2000	(1)

(b) $^{38}_{18}Ar$ (1)(1)
Allow numbers before or after Ar 2
(c) S: 1s2 2s2 2p6 3s2 3p4 (1) S2–: 1s2 2s2 2p6 3s2 3p6 (1) 2
(d) Block: p (1); Explanation: Highest energy or outer orbital is (3) p OR outer electron, valency electron in (3) p NOT 2p etc. 2
(e) (i) Bonding in Na_2S: ionic (1) Bonding in CS_2: covalent (1); ignore other words such as dative / polar / co-ordinate
(ii) Clear indication of electron transfer from Na to S (1); 1 e– from each (of 2) Na atoms or 2e– from 2 Na atoms (1)

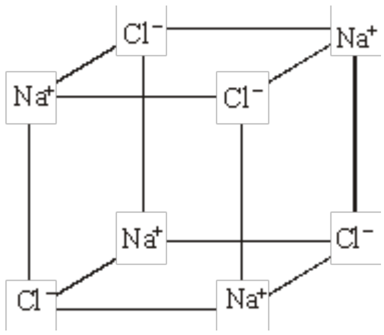


iii) Correct covalent bonds (1)
All correct including lone pairs (1)
Allow all •s or all ×s
M2 tied to M1
NOT separate e–s in S•- 2 l p

(iv) CS2 + 2H2O → CO2 + 2H2S (1) 7[16]

M3. (a) Macromolecular or giant structure (1)
Accept diamond shaped lattice; Intermolecular forces / molecular lattice / comparison to graphite structure, = 'con'
Held together by covalent bonds (1)
'Giant covalent structure' earns both M1 and M2
(Much) energy needed to break bonds Or many bonds to be broken (1)
Vand der Waal / temporary induced dipole-dipole / London / disperse forces (1)
Forces increase with size or with number of electrons or with surface area etc. (1)
Description must be of the molecules of P and S: P_4 or Mr = 124 (1) S_8 or Mr = 256 (1)
Allow S molecule bigger /more surface area than P molecule for 1 mark 7

(b) Diagram NaCl = cubic (1)



Allow if 3 full faces shown correctly
Ions identified and placed properly (1)
If diagram shows '+' and '–' signs rather than symbols for ions, identification of the ions could be from the text(Bonding) identified in writing as being ionic (1)
Not ionic molecule
Due to strong electrostatic attractions or similar description about attraction between oppositely charged ions.(1) QoL
Not just: 'ionic bonds are strong' / 'need much energy to break bonding' (4)

(c) Be – no reaction with water or steam (1)
Not: Be does not dissolve
Mg reacts with steam or reacts slowly with cold/hot water (1)
White solid (not precipitate) formed Bubbles (1)
or Mg glows or burns (with bright white light) Not 'fizzes' or 'gas evolved'
Mg + H2O → MgO + H2 Mg + 2H2O → Mg(OH)2 + H2 (1)
Condition, equation and observation marks are tied. Candidate can't mix-and-match but, when both conditions quoted, select the higher scoring option 4 [15]

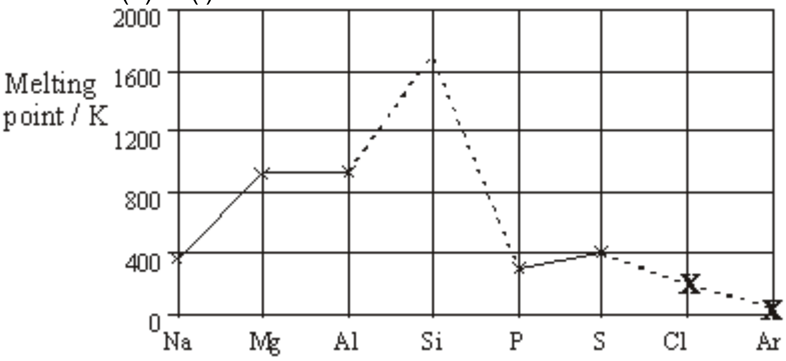
M4. (a) (i) 1s2 2s2 2p6 3s2 3p1 (1)
(ii) p (block) (1)
(b) Lattice of metal / +ve ions/ cations / atoms (1)
Accept regular array/close packed/tightly packed/uniformly arranged (surrounded by) delocalised electrons (1)2
(c) Greater nuclear or ionic charge or more protons (1) Smaller atoms / ions (1); accept greater charge density for either M1 or M2; more delocalised electrons / e– in sea of e– / free e– (1); stronger attraction between ions and delocalised / free electrons etc. (1) Max 3
Accept stronger 'electrostatic attraction' if phrase prescribed elsewhere

(d) (Delocalised) electrons (1)
Move / flow in a given direction (idea of moving non-randomly) or under the influence applied pd mark (1)
Allow 'flow through metal' 2 [9]

M5. (a) $2Al + 3CuCl_2 \rightarrow 2AlCl_3 + 3Cu$; OR $2Al + 3Cu^{2+} \rightarrow 2Al^{3+} + 3Cu$; 1
(b) (i) increases; 1
(ii) lower than expected / lower than Mg / 1
less energy needed to ionise; e– removed from (3)p sub-level; 1
('e– removed' may be implied) of higher energy / further away from nucleus / shielded by 3s e–s; 1
(c) Al+(g) → Al2+(g) + e–; 1
(d) trend: increases; 1
more protons / higher charge on cation / more delocalised e– / smaller atomic/ionic radius;
stronger attraction between (cat)ions and delocalised/free/mobile e– 1
OR stronger metallic bonding; 1 [9]

M6.
(a) enthalpy when an electron is removed/ knocked out / displaced/ to form a uni-positive ion (1)
from a gaseous atom (1)
(b) $1s^2 2s^2 2p^6$ 1
(c) 's' block 1
(d) Mg+(g) → Mg2+(g) + e– or Mg+(g) + e– → Mg2+(g) + 2e– or Mg+(g) – e– → Mg2+(g) 1
(e) Mg2+ ion smaller than Ne atom / Mg2+ e– closer to nucleus 1
Mg2+ has more protons than Ne / higher nuclear charge or e– is removed from a charged Mg2+ion / neutral neon atom (accept converse arguments) (1)
(f) (i) trend: increases 1
Expln: more protons / increased proton number / increased nuclear charge (NOT increased atomic number) 1
same shell / same shielding / smaller size 1
(ii) QoL reference to the e– pair in the 3p sub-level 1
repulsion between the e–in this e–pair 1 [12]

M7. (a) (i)



M1 Si: cross ≥ 1200 1
M2 Cl: cross below S 1
M3 Ar: cross below Cl 1

(ii) Si is macromolecular/giant molecular/giant covalent/ giant atomic 1
Covalent bonds need to be broken/accept 'overcome' 1
Covalent bonds are strong / many covalent bonds involved/ requires much energy/hard to break 1
(iii) Intermolecular force = van der Waals'/induced ; dipole–dipole/dispersion forces 1
Sulphur has greater Mr / size / surface area/more electrons/more atoms so stronger intermolecular forces (comparison) 1
(b) Trend: Decreases 1
Increase in size of ion/atom / more shells / decrease in charge density / decrease in charge size ratio 1
Weaker attraction for delocalised/free/sea of electrons / weaker metallic bonding 1 [11]

M8. (a) Outer electrons are in p orbitals 1
(b) decreases 1
Number of protons increases 1
Attracting outer electrons in the same shell (or similar shielding) 1
(c) Sulfur molecules (S8) are larger than phosphorus (P4) 1
Therefore van der Waals' forces between molecules are stronger 1
Therefore more energy needed to loosen forces between molecules 1
(d) Argon particles are single atoms with electrons closer to nucleus 1
Cannot easily be polarised (or electron cloud not easily distorted) 1 [9]

M9.
(a) (i)Energy/enthalpy (change)/ΔH/ needed to remove 1 mole of electrons; Allow 1 electron; 1
From 1 mol of gaseous atoms; From 1 gaseous atom; Not mix and match moles and one electron; 1
Allow 1 for balanced eq with ss
(ii) Increase; 1
Increasing nuclear charge/ increasing number of protons;Not increasing atomic number 1
Same or similar shielding /same number of shells or energy levels/ (atomic) radius decreases/electron closer to nucleus; Not same distance from nucleus. 1
(iii) Aluminium/Al; 1
Electron in higher energy /p or 3p orbital; Not 2p; Ignore shielding 1
Less energy needed to lose electron/ electron more easily lost/ ionisation energy less; 1
(b) Silicon/Si;1
Macromolecular/ Giant molecular or atomic or covalent; 1
Many or strong covalent bonds need to be broken/ lots of energy needed to break the covalent bonds;
Not loosened bonds 1 [11]

M10. (a) …2s2 2p6; 1
(b) (i) Na+(g) → Na2+ (g) + e(–);
One mark for equation and one mark for state symbols
Na+(g) + e(–) → Na2+ (g) + 2e(–);
Allow Na+(g) – e(–) → Na(g)
Allow X+(g) → X2+ (g) + e = 1 mark 2

(ii) Na(2+) requires loss of e– from a 2(p) orbital or 2nd energy level or 2nd shell and Mg(2+) requires loss of e– from a 3(s) orbital or 3rd energy level or 3rd shell / Na(2+) loses e from a lower (energy) orbital/ or vice versa;
Not from 3p 1
Less shielding (in Na); Or vice versa for Mg 1
e(–) closer to nucleus/ more attraction (of electron to nucleus) (in Na); M3 needs to be comparative 1
(iii) Aluminium /Al;1
(c) Decreases; 1
Increasing nuclear charge/ increasing number of protons; 1
Electrons in same shell or level/ same shielding/ similar shielding; 1

(d) Answer refers to Na; Na fewer protons/smaller nuclear charge/ fewer delocalised electrons;
Allow Mg is $^{2+}$ and Na is $^{+}$. 1
Na is a bigger ion/ atom; 1
Smaller attraction between nucleus and delocalised electrons
If mentioned that charge density of Mg2+ is greater then allow first 2 marks. (ie charge / size / attraction).
M3 allow weaker metallic bonding. 1

(e) (Bent) shape showing 2 lone pairs + 2N−H bond pairs;
Atoms must be labelled.; Lone pairs can be with or without lobes. 1
Bent / v shape/ triangular; Not tetrahedral.; Allow non-linear 1

(f) Ne has full sub-levels/ can't get any more electrons in the sub-levels/
Ne has full shells; Not 2s2 2p6 alone. 1 [16]

M11. (a) $2s^22p^63s^1$ 1
(b) (i) Energy/enthalpy (needed) to remove one mole of electrons from one mole of atoms/compounds/molecules/elements 1
OR Energy to form one mole of positive ions from one mole of atoms
OR Energy/enthalpy to remove one electron from one atom in the gaseous state (to form 1 mol of gaseous ions)

Energy needed for this change: X(g) → X+(g) + e(–) = 2 marks
This equation alone scores one mark 1

(ii) Mg+(g) → Mg2+(g) + e(–) OR Mg+(g) + e(–) → Mg2+(g) + 2e(–) OR Mg+(g) – e(–) → Mg2+(g) 1

(iii) Electron being removed from a positive ion (therefore need more energy)/electron being removed is closer to the nucleus/Mg+ smaller (than Mg)/Mg+ more positive than Mg; allow from a + particle/species 1
(iv) Range from 5000 to 9000 kJ mol–1 1
(c) Increase 1
Bigger nuclear charge (from Na to Cl)/more protons 1
electron (taken) from same (sub)shell/similar or same shielding/
electron closer to the nucleus/smaller atomic radius 1
(d) Lower 1
Two/pair of electrons in (3)p orbital or implied 1
repel (each other) 1
(e) Boron/B or oxygen/O/O2 1 [13]

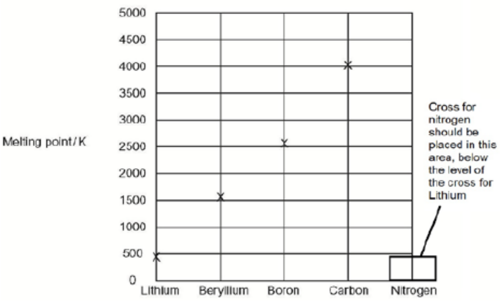
M12. (a) Macromolecular/giant covalent/giant molecular/giant atomic 1
Many/strong covalent bonds
M2 and M3 can only be scored if covalent mentioned in answer; Ignore metalloid and carbon
Ignore bp 1
Bonds must be broken/overcome; ignore numbers of bonds and references to energy 1

(b) (Simple) molecular
Do not allow simple covalent for M1 1
S bigger molecule (than P) or S8 and P4 references
Allow more electrons in sulfur molecule or S8
Do not allow S is bigger then P; Allow S molecule has a bigger Mr; Do not allow contradictions 1
So more/stronger van der Waals' forces (to be broken or overcome) 1

(c) Regular arrangement of minimum of 6 particles in minimum of 2 rows 1
+ charge in each one (of 6)
Allow +, (1+, 2+ or 3+) in ions/or in words 1
Rows/planes/sheets/layers (of atoms/ions) can slide (owtte) over one another 1

(d) Bigger charge (3+ compared to 1+)
OR smaller atom/ion in Al/more protons/bigger nuclear charge 1
More free/delocalised electrons (in Al)/bigger sea of electrons in Al
Accept 2 or 3 delocalised electrons compared to 1 in Na 1
Stronger metallic bonding/stronger (electrostatic) attraction between the (+) ions or nuclei and the (delocalised) electrons (or implied)
Must be implied that the electrons are the delocalised ones not the electrons in the shells.
Accept converse arguments 1 [12]

M13.(a) Lithium / Li 1 (b) (i) Increase / gets bigger 1
(ii) Boron / B 1
Electron removed from (2)p orbital /sub-shell / (2)p electrons removed if p orbital specified it must be 2p 1
Which is higher in energy (so more easily lost) / more shielded (so more easily lost) / further from nucleus 1
(c) C / carbon 1 (d) Below Li



The cross should be placed on the diagram, on the column for nitrogen, below the level of the cross printed on the diagram for Lithium.
1

(e) Macromolecular / giant molecular / giant atomic
Allow giant covalent (molecule) = 2 1
Covalent bonds in the structure 1
Strong (covalent) bonds must be broken or overcome / (covalent) bonds need a lot of energy to break
Ignore weakening / loosening bond 1 [10]

M14. (a) P = 100 000 (Pa) and V = 5.00 x 10–3 (m3)
M1 is for correctly converting P and V in any expression or list Allow 100 (kPa) and 5 (dm3) for M1. 1

$$n = \frac{PV}{RT} = \frac{100\ 000 \times 5.00 \times 10^{-3}}{8.31 \times 298}$$ 1

= 0.202 moles (of gas produced)

Therefore $\frac{0.202}{5}$ = 0.0404 moles B_2O_3 1
Mass of B_2O_3 = 0.0404 x 69.6
M4 is for their answer to M3 x 69.6 1
= 2.81 (g) 1
(b) B + 1.5 Cl_2 → BCl_3 Accept multiples. 1
3 bonds 1
Pairs repel equally/ by the same amount; Do not allow any lone pairs if a diagram is shown. 1
(c) (i) 43.2/117.3 (= 0.368 moles BCl_3) 1
0.368 x 3 (= 1.105 moles HCl)
Allow their BCl_3 moles x 3 1

Conc HCl = $\frac{1.105 \times 1000}{500}$
Allow moles of HCl × 1000 / 500 1 = 2.20 to 2.22 mol dm^{-3} 1
(ii) $H_3BO_3 + 3NaOH \rightarrow Na_3BO_3 + 3H_2O$ Allow $H_3BO_3 + NaOH \rightarrow NaBO_2 + 2H_2O$ 1

(d) $\frac{10.8}{120.3} (\times 100)$ 1
8.98(%); Allow 9(%). 1
Sell the HCl 1
(e) Alternative method Cl = 86.8% Cl = 142 g 1

B	Cl
$\frac{13.2}{10.8}$	$\frac{86.8}{35.5}$

B	Cl
$\frac{21.6}{10.8}$	$\frac{142}{35.5}$

1

1.22 2.45 or ratio 1:2 or BCl_2; 2:4 ratio 1
BCl_2 has Mr of 81.8 so 81.8 x 2 = 163.6 Formula = B_2Cl_4 1 [20]

M15.(a) Carbon / C 1
Fewest protons / smallest nuclear charge / least attraction between protons (in the nucleus) and electrons / weakest nuclear attraction to electrons. Allow comparative answers. Allow converse answers for M2 1
Similar shielding. Allow same shielding. 1
(b) Increase 1; Oxygen / O 1; Paired electrons in a (2)p orbital 1;
(Paired electrons in a p orbital) repel 1
(c) $C(g) \rightarrow C^+(g) + e(-)$ OR $C(g) + e(-) \rightarrow C^+(g) + 2e(-)$ OR $C(g) - e(-) \rightarrow C^+(g)$ 1
(d) (More energy to) remove an electron from a (more) positive ion / cation;
Allow electron closer to the nucleus in the positive ion. 1
(e) Lithium / lithium / Li 1 [10]