EXAM PAPERS PRACTICE

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Detailed mark scheme

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# Periodicity 1


# CHEMISTRY

## Mark Scheme

AQA

AS & A LEVEL

Inorganic Chemistry

# Mark schemes

**1** (a) Silicon / Si

*If not silicon then CE = 0 / 3*

1

covalent (bonds)

*M3 dependent on correct M2*

1

Strong or many of the (covalent) bonds need to be broken / needs a lot of energy to break the (covalent) bonds

*Ignore hard to break*

1

(b) Argon / Ar

*If not argon then CE = 0 / 3. But if Kr chosen, lose M1 and allow M2+M3*

1

Large(st) number of protons / large(st) nuclear charge

*Ignore smallest atomic radius*

1

Same amount of shielding / same number of shells / same number of energy levels

*Allow similar shielding*

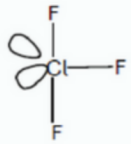
1

(c) Chlorine / Cl

*Not $Cl_2$, Not C**L**, Not $Cl^2$*

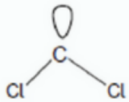
1

(d) (i)




*Or any structure with 3 bonds and 2 lone pairs*
*Ignore any angles shown*

1




*Or a structure with 2 bonds and 1 lone pair*

1

(ii) Bent / v shape
*Ignore non-linear, angular and triangular*
*Apply list principle*

1

(iii) $\frac{1}{2}Cl_2 + \frac{3}{2}F_2 \longrightarrow ClF_3$
*No multiples*
*Ignore state symbols*

1

**[11]**

**2** B

**[1]**

**3** A

**[1]**

**4** (a) The number of protons increases (across the period) / nuclear charge increases

1

Therefore, the attraction between the nucleus and electrons increases
*Can only score M2 if M1 is correct*

1

(b) $S_8$ molecules are bigger than $P_4$ molecules

*Allow sulfur molecules have bigger surface area and sulfur molecules have bigger $M_r$*

1

Therefore, van der Waals / dispersion / London forces between molecules are stronger in sulfur

1

(c) Sodium oxide contains $O^{2-}$ ions

1

These $O^{2-}$ ions react with water forming $OH^-$ ions

*$O^{2-} + H_2O \longrightarrow 2OH^-$ scores M1 and M2*

1

(d) $P_4O_{10} + 12OH^- \longrightarrow 4PO_4^{3-} + 6H_2O$

1

**[7]**

**5** (a) Ability (or power) of an atom to attract electron density (or electrons or -ve charge) **(1)** in a covalent bond **(1)**

*or shared pair*
*If remove an electron lose first mark*

2

(b) *Trend:* increases **(1)**
*Explanation:* nuclear charge (number of protons) increases **(1)** electrons in same shell **(1)**

*OR similar shielding*
*OR atoms similar size or smaller*
*OR 1 mol of $e^-$*

3

(c) Heat / enthalpy / energy for removal of one electron **(1)** from a gaseous atom **(1)**
can score in an equation

*must have first mark to score the second*

2

(ii) Two elements (or Na / Mg) before the drop (in energy) to Al **(1)**

(iii) ionisation energy of Al < that for Mg **(1)**

(iv) fall in energy from P to S **(1)**

*or discontinuity in trend*

From Al to P there are 3 additional electrons **(1)**

*or three elements*

*For second mark idea of block of 3 elements*

5

**[12]**

**6** (a) (i) d (block) **OR** D (block)

*Ignore transition metals / series.*

*Do not allow any numbers in the answer.*

1

(ii) Contains positive (metal) ions or protons or nuclei and delocalised / mobile / free / sea of electrons

*Ignore atoms.*

1

Strong attraction between them or strong metallic bonds

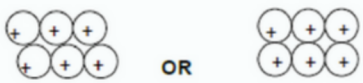
*Allow 'needs a lot of energy to break / overcome' instead of 'strong'.*

*If strong attraction between incorrect particles, then CE = 0 / 2.*

*If molecules / intermolecular forces / covalent bonding / ionic bonding mentioned then CE=0.*

1

(iii)



**OR**

*M1 is for regular arrangement of atoms / ions (min 6 metal particles).*

*M2 for + sign in each metal atom / ion.*

*Allow $2^+$ sign.*

2

*QoL.*

1

(b) (i) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^8\ (4s^0)$

*Only.*

1

(ii) $NiCl_2.6H_2O + \mathbf{6}\ SOCl_2 \longrightarrow NiCl_2 + \mathbf{6}\ SO_2 + \mathbf{12}\ HCl$

*Allow multiples.*

1

$NaOH / NH_3 / CaCO_3 / CaO$

*Allow any name or formula of alkali or base.*

*Allow water.*

1

**[9]**

**7** (a) Carbon / C

*If M1 incorrect, CE = 0 / 3*

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) <u>Increase</u>

1

Oxygen / O

*If not oxygen, then cannot score M2, M3 and M4*

1

<u>Paired</u> electrons in a (2)<u>p</u> orbital

*If paired electrons in incorrect p orbital, lose M3 but can award M4*

(Paired electrons in a p orbital) repel

1

(c) $C(g) \rightarrow C^{+}(g) + e^{(-)}$

***OR***

$C(g) + e^{(-)} \rightarrow C^{+}(g) + 2e^{(-)}$

***OR***

$C(g) - e^{(-)} \rightarrow C^{+}(g)$

*Ignore state symbols for electron.*

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

If formula given, upper and lower case letters must be as shown.

1

**[10]**

**8** (a) 37

*These answers only.*
*Allow answers in words.*

1

48

*Ignore any sum(s) shown to work out the answers.*

1

(b) (i) Electron gun / high speed/high energy electrons

*Not just electrons.*
*Not highly charged electrons.*

1

Knock out electron(s)

*Remove an electron.*

1

(ii) $Rb(g) \rightarrow Rb^{+}(g) + e^{(-)}$

***OR***

$Rb(g) + e^{(-)} \rightarrow Rb^{+}(g) + 2e^{(-)}$

***OR***

$Rb(g) - e^{(-)} \rightarrow Rb^{+}(g)$

*Ignore state symbols for electron.*

**1**

(c) Rb is a bigger (atom) / e further from nucleus / electron lost from a higher energy level/ More shielding in Rb / less attraction of nucleus in Rb for outer electron / more shells

*Answer should refer to Rb not Rb molecule*

*If converse stated it must be obvious it refers to Na*

*Answer should be comparative.*

**1**

(d) (i) s / block s / group s

*Only*

**1**

(ii) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^{10}\ 4p^6\ 5s^1$

*Allow $3d^{10}$ before $4s^2$*

*Allow in any order.*

**1**

(e) $\frac{(85 \times 2.5) + 87 \times 1}{3.5}$

*M1 is for top line*

1
1

$= \underline{85.6}$

*Only*

1

***OR***

$\frac{(58 \times 5) + 87 \times 2}{7}$

*M1 $^{85}Rb$ 71.4% and $^{87}Rb$ 28.6%*
*M2 divide by 100*

1
1

$\underline{85.6}$

*M3 = $\underline{85.6}$*

1

(f) Detector

*Mark independently*
*Allow detection (plate).*

1

Current / digital pulses / electrical signal related to abundance

*Not electrical $\underline{charge}$.*

1

(g) Smaller

*Chemical error if not smaller, CE = 0/3*
*If blank mark on.*

1

Bigger nuclear charge / more protons in Sr

*Not bigger nucleus.*

1

Similar/same shielding

*QWC*

*(Outer) electron entering same shell/sub shell/orbital/same number of shells.*

*Do not allow incorrect orbital.*

1

**[16]**

**9** (a) Lithium / Li

*Penalise obvious capital I (second letter).*

1

(b) (i) Increase / gets bigger

*Ignore exceptions to trend here even if wrong*

1

(ii) Boron / B

*If not Boron, CE = 0/3*

1

Electron removed from (2)p orbital /sub-shell / (2)p electrons removed

*If p orbital specified it must be 2p*

1

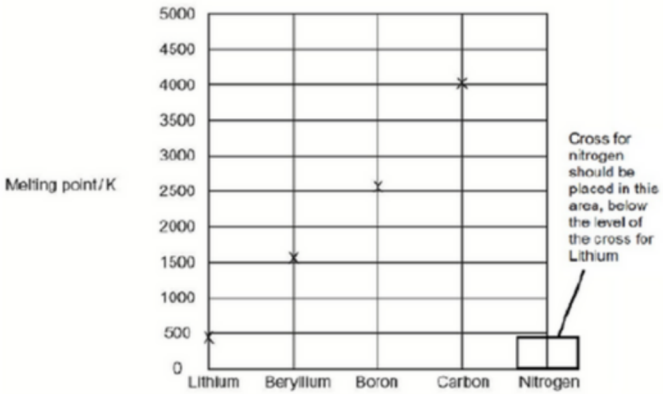
Which is higher in energy (so more easily lost) / more shielded (so more easily lost) / further from nucleus

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 bonds*

*If ionic / metallic/molecular/ dipole dipole/ H bonds/ bonds between molecules, CE = 0/3*

*Ignore van der Waals forces*

*Ignore hard to break*

1

**[10]**

**10** (a) $Li(g) \rightarrow Li^+(g) + e^-(g)$

$Li(g) - e^-(g) \rightarrow Li^+(g)$

$Li(g) + e^-(g) \rightarrow Li^+(g) + 2e^-$

*One mark for balanced equation with state symbols*

*Charge and state on electron need not be shown*

**1**

(b) Increases

*If trend wrong then CE = 0/3 for (b). If blank mark on.*

**1**

Increasing nuclear charge / increasing no of protons

*Ignore effective with regard to nuclear charge*

**1**

Same or similar shielding / same no of shells / electron (taken) from same (sub)shell / electron closer to the nucleus / smaller atomic radius

**1**

(c) Lower

*If not lower then CE = 0/3*

**1**

Paired electrons in a (4) p orbital

*If incorrect p orbital then M2 = 0*

**1**

(Paired electrons) repel

*If shared pair of electrons M2 + M3 = 0*

**1**

(d) Kr is a bigger atom / has more shells / more shielding in Kr / electron removed further from nucleus/ electron removed from a higher (principal or main) energy level

*CE if molecule mentioned*

*Must be comparative answer*

*QWC*

**1**

(e) 2 / two / II

1

(f) Arsenic / As

1

[10]

**11** (a) $\underline{4d^{10}\ 5s^2\ 5p^1}$ in any order

*Allow subscripts for numbers*

*Allow capitals*

1

(b) (i) Using an electron gun/(beam of) high energy/fast moving electrons

*Ignore 'knocks out an electron'*

1

(ii) $In(g) + e^- \rightarrow In^+(g) + 2e^-$

***OR***

$In(g) \rightarrow In^+(g) + e^-$

$In(g) - e^- \rightarrow In^+(g)$

*The state symbols need not be present for the electron - but if they are they must be (g)*

*No need to show charge on electron*

*If I CE = 0*

*Ignore any equations using M*

1

(iii) So no more than 1 electron is knocked out/so only one electron is knocked out/prevent further ionisation

*Allow stop 2+ and 3+/other ions being formed*

*Not to get wrong m/z*

1

(iv) Any two processes from

- Accelerate (owtte)
- Deflect (owtte)
- Detect (owtte)

*Ignore wrong causes of process*

**2 max**

(c) (i) Average/mean mass of (1) atom(s) (of an element)

**1**

1/12 mass of one atom of $^{12}C$

**1**

***OR***

(Average) mass of one mole of atoms

1/12 mass of one mole of $^{12}C$

***OR***

(Weighted) average mass of all the isotopes

1/12 mass of one atom of $^{12}C$

***OR***

Average mass of an atom/isotope compared to C-12 on a scale in which an atom of C-12 has a mass of 12

*Not average mass of 1 molecule*

*Allow the wording Average mass of 1 atom of an element compared to 1/12 mass atom of $^{12}C$ (or mass 1/12 atom of $^{12}C$)*

*Allow if moles of atoms on both lines*

*Accept answer in words*

*Can have top line × 12 instead of bottom line ÷12*

*If atoms/moles mixed, max = 1*

(ii) $\frac{113x + 115y}{x + y} = 114.5$

*Allow idea that there are 4 × 0.5 divisions between 113 and 115*

1

ratio (113:115) = 1:3 **OR** 25:75 **OR** 0.5:1.5 etc

*Correct answer scores M1 and M2*

*If 1:3 for ln(115):ln(113), max = 1*

1

(d) None

1

Same no of electrons (in the outer shell)/same electron configuration)

*Ignore electrons determine chemical properties/ignore protons*

*M2 dependent on M1 being correct*

1

(e) 29.0%/29% O

*If no O calculated, allow M2 if In and H divided by the correct $A_r$*

1

$\frac{69.2}{114.8/114.5} \quad \frac{1.8}{1} \quad \frac{29.0}{16}$

1

or

0.603 1.8 1.81

1 3 3

EF = In $H_3O_3$

*Allow $In(OH)_3$*

*Do not allow last mark just for ratio 1:3:3*

*If $InO_3H_3$ given with no working then allow 3 marks*

*If I not In, lose M3*

1

**[15]**

**12** (a) Macromolecular/giant covalent/giant molecular/giant atomic

*If IMF/H-bonds/Ionic/metallic CE = 0/3*

*covalent bond between molecules CE = 0/3*

*If giant unqualified M1 = 0 but mark on*

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

*QoL*

*Do not allow simple covalent for M1*

*Giant covalent/ionic/metallic, CE = 0*

*If breaking covalent bonds CE= 0/3*

1

S bigger molecule (than P) or $S_8$ and $P_4$ references

*QoL*

*Allow more electrons in sulfur molecule or $S_8$*

*Do not allow S is bigger then P*

*Allow S molecule has a bigger $M_r$*

*Do not allow contradictions*

1

So more/stronger van der Waals' forces (to be broken or overcome)

*Not just more energy to break*

1

(c) Regular arrangement of minimum of 6 particles in minimum of 2 rows

*Ignore e–*

*Do not allow ring arrangements OR structures bonded with electrons*

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

*M3 independent*

*If ionic bonding/molecules/IMF/vdw/covalent, penalise M3*

*Ignore layers of electrons sliding*

1

(d) Bigger charge (3+ compared to 1+)

*CE = 0 if molecules, ionic, covalent, IMF*

*(Allow $Al^{2+}$)*

***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]**

**13** (a) (i) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^1$ **(1)**

*Allow subscripted electron numbers*

(ii) p (block) **(1)**

*Allow upper or lower case 's' and 'p' in (a)(i) and (a)(ii)*

2

(b) Lattice of metal / +ve ions/ cations / atoms **(1)**

*Not +ve nuclei/centres*

*Accept regular array/close packed/tightly packed/uniformly arranged*

(Surrounded by) delocalised electrons **(1)**

*Note: Description as a 'giant ionic lattice' = CE*

**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*

*Note: 'intermolecular attraction/ forces' or covalent molecules = CE*

*Accept stronger 'electrostatic attraction' if phrase prescribed elsewhere*

*Ignore references to m/z values*

*If Mg or Na compared to Al, rather than to each other, then:* ***Max 2***

*Treat description that is effectively one for Ionisation Energy as a '**contradiction**'*

**3**

(d) (Delocalised) electrons **(1)**

Move / flow in a given direction (idea of moving non-randomly) **or** under the influence applied pd *QoL mark* **(1)**

*Allow 'flow through metal'*

*Not: 'Carry the charge'; 'along the layers'; 'move through the metal'*

**2**

**[9]**

**14** (a) Cross between the Na cross and the Mg cross

**1**

(b) $Al(g) \rightarrow Al^{+}(g) + e-$

$Al(g) - e- \rightarrow Al^{+}(g)$

$Al(g) + e- \rightarrow Al^{+}(g) + 2e-$

*One mark for state symbols consequential on getting equation correct.*

*Electron does not have to have the – sign on it*

*Ignore (g) if put as state symbol with $e^-$ but penalise state symbol mark if other state symbols on $e^-$*

**2**

(c) $2^{nd}$/second/2/II

*Only*

**1**

(d) Paired electrons <u>in (3)p orbital</u>

*Penalise wrong number*

*If paired electrons repel allow M2*

**1**

repel

**1**

(e) Neon/Ne

*No consequential marking from wrong element*

**1**

$1s^2 2s^2 2p^6$/[He}$2s^2 2p^6$

*Allow capital s and p*

*Allow subscript numbers*

**1**

(f) Decreases

*CE if wrong*

1

Atomic radius increases/electron removed further from nucleus
or nuclear charge/electron in higher energy level/Atoms
get larger/more shells

*Accept more repulsion between more electrons for M2*
*Mark is for distance from nucleus*
*Must be comparative answers from M2 and M3*
*CE M2 and M3 if mention molecules*
*Not more sub-shells*

1

As group is descended more shielding

1

**[11]**

**15** (a)

| Particle | Relative charge | Relative mass | |
|---|---|---|---|
| Proton | +1 **or** 1+ | 1 | **(1)** |
| Neutron | 0 **or** no charge/neutral/zero | 1 (<u>not</u> – 1) | **(1)** |
| Electron | –1 or 1– | 1/1800 to 1/2000 | **(1)** |

**or** negligible
**or** zero
**or** $5.0 \times 10^{-4}$ to $5.6 \times 10^{-4}$

*if 'g' in mass column - wrong*
*penalise once*

3

(b) $^{38}_{18}Ar$ **(1)(1)**

*Allow numbers before or after Ar*

2

(c) *S*: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^4$ **(1)**

*Allow upper case letters*

$S^{2-}$: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6$ **(1)**

*If use subscript penalise once*

**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)**

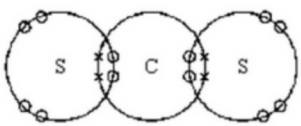
*ignore other words such as dative / polar / co-ordinate*

(ii) Clear indication of electron transfer from Na to S **(1)**

1 $e^-$ from each (of 2) Na atoms or 2 $e^-$ from 2 Na atoms **(1)**

*QoL correct English*

(iii)




Correct covalent bonds **(1)**

<u>All correct</u> including <u>lone pairs</u> **(1)**

*Allow all •s or all ×s*

*M2 tied to M1*

*NOT separate e⁻s in S•- 2 l p*

(iv) $CS_2 + 2H_2O \rightarrow CO_2 + 2H_2S$ **(1)**

*Ignore state symbols even if wrong*

**7**

**[16]**

**16** (a) (i) Deductions:

Ionic **(1)**
Ions not free to move in the solid state **(1)**
Ions free to move when molten or in aqueous solution **(1)**
Identity of **P**: $Na_2O$ or sodium oxide **(1)**

*N.B. If a formula given this must be correct*

Equation: $Na_2O + H_2O \rightarrow 2\ NaOH$ **(1)**

**5**

(ii) Deductions:

Covalent
Intermolecular forces are weak or van der Waals forces,
or dipole-dipole

*N.B. Any answer including a reference to hydrogen bonding is incorrect*

Identity of **Q**: $SO_2$ or sulphur dioxide **(1)**

Equation: $SO_2 + H_2O \rightarrow H_2SO_3$ **(1)**

*NB Allow max one for $SO_3$*

**4**

(b) (i) Amphoteric **(1)**

(ii) Equation with NaOH

$Al(OH)_3 + NaOH \rightarrow NaAl(OH)_4$

*OR* $Al(OH)_3(H_2O)_3 + OH^- \rightarrow [Al(OH)_4(H_2O)_2]^- + H_2O$
*OR* $Al(OH)_3 + OH^- \rightarrow [Al(OH)_4]^-$

**R** identified as $Al(OH)_3$ or $Al(OH)_3(H_2O)_3$ **(1)**
A balanced equation **(1)**

*N.B. Allow equation with six co-ordinate Aluminium and up to six $OH^-$ ligands*
*N.B. Allow equation mark if $M(OH)_3$ given in a balanced equation*

Equation with $H_2SO_4$

$2Al(OH)_3 + 3H_2SO_4 \rightarrow Al_2(SO_4)_3 + 6H_2O$

OR $Al(OH)_3(H_2O)_3 + H^+ \rightarrow [Al(OH)_2(H_2O)_4]^+ + H_2O$

*NB Allow equations with six co-ordinate Aluminium and up to six $H_2O$ ligands NB Allow equation mark if $M(OH)_3$ given in a balanced equation*

Correct Al species as product **(1)**
A balanced equation **(1)**

(iii) Large lattice energy
or strong covalent bonds
or $\Delta H_{soln}$ is very positive
or $\Delta G$ is positive
or sum of hydration energies less than covalent bond energies **(1)**

**6**

**[15]**

**17** (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)**
*CE if trend is wrong*

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]**

**18** (a) $2s^2 2p^6 3s^1$

*$1s^2$ can be rewritten*
*Allow $2s^2 2p_x^2 2p_y^2 2p_z^2 3s^1$*
*Allow subscripts and capitals*

**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 given out loses M1*

*M2 is dependent on a reasonable attempt at M1*

*Energy needed for this change*

*$X(g) \rightarrow X^{+}(g) + e^{(-)}$ = 2 marks*

*This equation alone scores one mark*

1

(ii) $Mg^{+}(g) \rightarrow Mg^{2+}(g) + e^{(-)}$

$Mg^{+}(g) + e^{(-)} \rightarrow Mg^{2+}(g) + 2e^{(-)}$

$Mg^{+}(g) - e^{(-)} \rightarrow Mg^{2+}(g)$

*Do not penalise MG*

*Not equation with X*

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*

*Not electron from a higher energy level/or higher sub-level*

*More protons = 0*

1

(iv) Range from 5000 to 9000 kJ $mol^{-1}$

1

(c) Increase

*If decrease CE = 0/3*
*If blank mark on*

1

Bigger nuclear <u>charge</u> (from Na to Cl)/more <u>protons</u>

*QWC*

1

electron (taken) from same (sub)shell/similar or same shielding/
electron closer to the nucleus/smaller atomic radius

*If no shielding = 0*
*Smaller ionic radius = 0*

1

(d) Lower

*If not lower CE = 0/3*
*If blank mark on*
*Allow does not increase*

1

Two/pair of electrons in (3)p orbital or implied

*Not 2p*

1

repel (each other)

*M3 dependent upon a reasonable attempt at M2*

1

(e) Boron/B or oxygen/O/$O_2$

1

**[13]**

**19** (a) $2s^2\ 2p^6$;

*If ignored the $1s^2$ given and written $1s^2 2s^2 2p^6$ mark as correct*
*Allow capitals and subscripts*

1

(b) (i) $Na^+(g) \rightarrow Na^{2+}(g) + e^{(-)}$;

*One mark for equation and one mark for state symbols*

$Na^+(g) + e^{(-)} \rightarrow Na^{2+}(g) + 2e^{(-)}$;

*M2 dependent on M1*

*Allow $Na^+(g) - e^{(-)} \rightarrow Na(g)$*

*Allow $X^+(g) \rightarrow X^{2+}(g) + e$ = 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;

*If not decreases CE = 0*

*If blank, mark on*

**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;

*Allow converse answers relating to Mg.*

Na fewer protons/smaller nuclear charge/ fewer delocalised electrons;

*Allow Mg is 2+ and Na is +.*
*If vdw CE = 0.*

1

Na is a bigger ion/ atom;

1

Smaller attraction between nucleus and delocalised electrons;

*If mentioned that charge density of $Mg^{2+}$ 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.*
*Bent-linear = contradiction.*

1

(f) Ne has full sub-levels/ can't get any more electrons in the sub-levels/
Ne has full shells;

*Not $2s^2\ 2p^6$ alone.*
*Not stable electron configuration.*

1

**[16]**

**20** (a) $2Al + 3CuCl_2 \rightarrow 2AlCl_3 + 3Cu$;

*(accept multiples/fractions)*

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) $Al^+(g) \rightarrow Al^{2+}(g) + e^-$;

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]**

**21** (a) enthalpy/energy change/required when an electron is removed/ knocked out / displaced/ to form a uni-positive ion

*(ignore 'minimum' energy)*

1

from a gaseous atom

*(could get M2 from a correct equation here)*
*(accept 'Enthalpy/energy change for the process...' followed by an appropriate equation, for both marks)*
*(accept molar definitions)*

1

(b) $1s^2\ 2s^2 2p^6$

*(accept capitals and subscripts)*

1

(c) 's' block

*(not a specific 's' orbital – e.g. 2s)*

1

(d) $Mg^+(g) \rightarrow Mg^{2+}(g) + e^-$ or

$Mg^+(g) + e^- \rightarrow Mg^{2+}(g) + 2e^-$ or

$Mg^+(g) - e^- \rightarrow Mg^{2+}(g)$

1

(e) $Mg^{2+}$ ion smaller than Ne atom / $Mg^{2+}$ $e^-$ closer to nucleus

*(Not 'atomic' radius fo $Mg^{2+}$)*

1

$Mg^{2+}$ has more protons than Ne / higher nuclear charge or
$e^-$ is removed from a charged $Mg^{2+}$ ion / neutral neon atom

*(accept converse arguments)*

*(If used 'It' or Mg/magnesium/$Mg^{3+}$ etc. & 2 correct reasons, allow **(1)**)*

1

(f) (i) trend: increases

*(if 'decreases', CE = 0/3)*

1

Expl$^n$: 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

*(penalise if wrong shell, e.g. '2p', quoted)*

1

repulsion between the $e^-$ in this $e^-$ pair

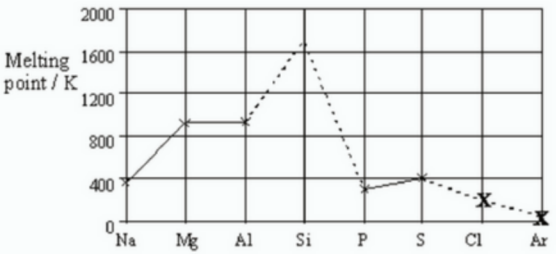
*(if not stated, 'e $^-$ pair' must be clearly implied)*

*(mark M4 and M5 separately)*

1

**[12]**

**22** (a) (i)




**M1** Si: cross ≥ 1200

1

**M2** Cl: cross below S

1

**M3** Ar: cross below Cl

*[allow, even if M2 wrong)*

*[If Cl cross missing and Ar below S, allow M3]*

1

(ii) Si is macromolecular/giant molecular/giant covalent/ giant atomic

1

Covalent bonds need to be broken/accept 'overcome'

*[Not loosened/weakened]*

1

Covalent bonds are strong / many covalent bonds involved/ requires much energy/hard to break

*[Tied to 'break' or near miss in M2] [Not 'structure' is broken]*

*[Must mention 'covalent' somewhere in part (a)(ii) to earn M2/M3]*

*[If van der Waals'/IMF mentioned M2/M3 = CE = 0.*

*[If ions mentioned M1/M2/M3 = CE = 0]*

1

(iii) Intermolecular force = van der Waals'/induced dipole–dipole/dispersion forces

1

**QoL** Sulphur has greater $M_r$ / size / surface area/more electrons/more atoms **so** stronger intermolecular forces (comparison)

*[Mark separately] [Not 'more shells']*

1

(b) Trend: Decreases

*[If trend wrong = CE = 0]*

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

*[Ignore shielding]*

*[van der Waals' etc. = CE = 0 for M2 and M3]*

1

**[11]**

**23** (a) (i) Energy/enthalpy (change)/$\Delta H$/ needed to remove 1 mole of electrons;

*Allow 1 electron*
*Not heat alone*

1

From 1 mol of gaseous atoms;

*From 1 gaseous atom*
*Not mix and match moles and one electron.*
*Allow 1 for balanced eq with ss*

1

(ii) Increase;

*If blank mark on*
*If incorrect CE = 0*

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;

*If incorrect CE = 0*

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;

*If incorrect CE = 0*
*If silicone, silica $Si_8$, $Si_4$ mark on.*

1

Macromolecular/ Giant molecular or atomic or covalent;

*If IMFor ionic or metallic in Silicon then CE = 0 for explanation*

1

Many or strong covalent bonds need to be broken/ lots of energy needed to break the covalent bonds;

*Not loosened bonds*

1

**[11]**

**24** (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 ($S_8$) are larger than phosphorus ($P_4$)

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]**