M1. (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) <u>delocalised</u> 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]

M2. (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)**

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[16]

M3. (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

(d) (i) 2 **(1)**

(ii) <u>Two elements</u> (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]

M4. (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: $SO_2 + H_2O \rightarrow H_2\ SO_3$ **(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 ΔH_{soln} is very positive
or ΔG is positive
or sum of hydration energies less than covalent bond energies **(1)**

6

[15]