

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) 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'

- 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)**

13

[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) 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]

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**: Na₂O or sodium oxide (1)

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

Equation: Na₂O + H₂O → 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**: SO₂ or sulphur dioxide (1)

Equation: SO₂ + H₂O → H₂SO₃(1)

NB Allow max one for SO₃

4

(b) (i) Amphoteric (1)

(ii) Equation with NaOH

Al(OH)₃ + NaOH → NaAl(OH)₄

OR Al(OH)₃(H₂O)₃ + OH⁻ → [Al(OH)₄(H₂O)₂]⁻ + H₂O

OR Al(OH)₃ + OH⁻ → [Al(OH)₄]⁻

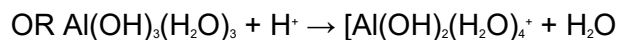
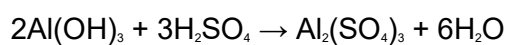
R identified as Al(OH)₃ or Al(OH)₃(H₂O)₃ (1)

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 H₂SO₄



NB Allow equations with six co-ordinate Aluminium and up to six H₂O 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]