M1. (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 <u>gaseous</u> 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) <u>Mg^{2+}</u> ion smaller than Ne atom / Mg^{2+} e^- closer to nucleus

(Not '<u>atomic</u>' radius fo Mg^{2+})

1

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

(accept converse arguments)
(If used 'It' or Mg/magnesium/Mg^{3+} etc. & <u>2</u> 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

Page 2

(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)
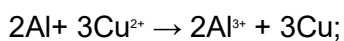   *(mark M4 and M5 separately)*

1

[12]

M2.B

[1]

M3.   (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 <u>3s</u> 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]

M4.   (a)   (i)   Energy/enthalpy (change)/ΔH/ 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
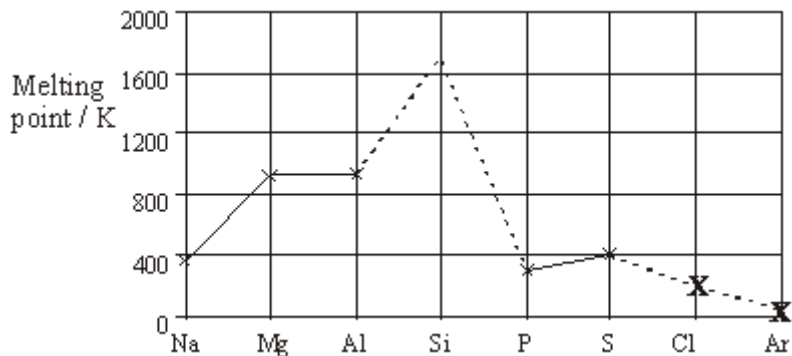*If silicone, silica Si_8, Si_4 mark on.*

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]

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

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[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]

M6.   (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]