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 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]

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

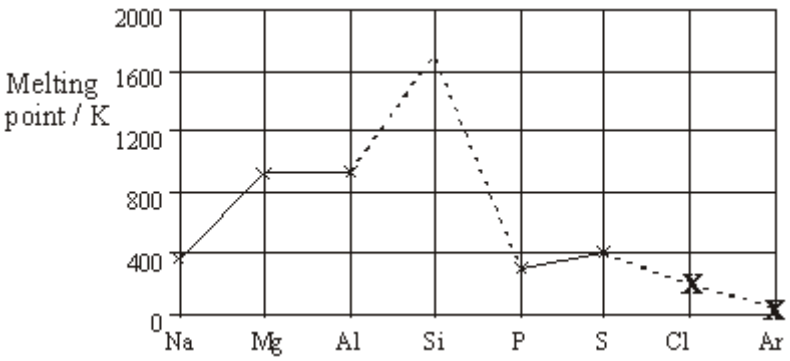
Many or strong covalent bonds need to be broken/ lots of energy needed to break the covalent bonds;

Not loosened bonds

1

[11]

M5. (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]

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]