Mark schemes

1

(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]

2 (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]

3 (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

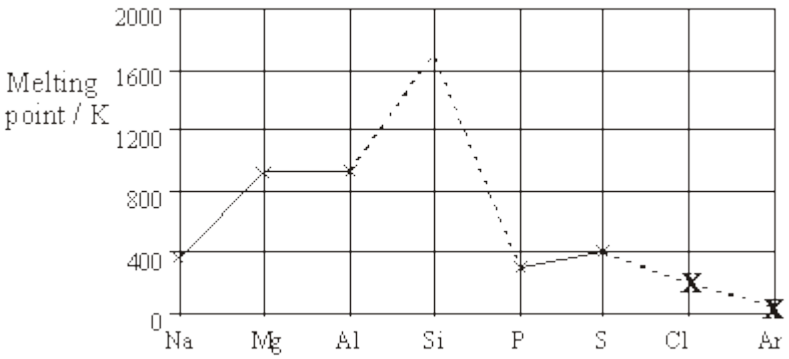
Cannot easily be polarised (or electron cloud not easily distorted)

1

[9]

4

(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]

5 (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]

6

(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]