

M1. (a) $2s^2 2p^6 3s^1$
1s² can be rewritten
Allow $2s^2 2p_x^2 2p_y^2 2p_z^2 3s^1$
Allow subscripts and capitals

1

(b) (i) Energy/enthalpy (needed) to remove one mole of electrons from one mole of atoms/compounds/molecules/elements

1

OR

Energy to form one mole of positive ions from one mole of atoms

OR

Energy/enthalpy to remove one electron from one atom

In the gaseous state (to form 1 mol of gaseous ions)

Energy given out loses M1

M2 is dependent on a reasonable attempt at M1

Energy needed for this change

$X(g) \rightarrow X^+(g) + e^{-}$ = 2 marks

This equation alone scores one mark

1

(ii) $Mg^+(g) \rightarrow Mg^{2+}(g) + e^{-}$
 $Mg^+(g) + e^{-} \rightarrow Mg^{2+}(g) + 2e^{-}$
 $Mg^+(g) - e^{-} \rightarrow Mg^{2+}(g)$

Do not penalise MG

Not equation with X

1

(iii) Electron being removed from a positive ion (therefore need more energy)/electron being removed is closer to the nucleus/ Mg^+ smaller (than Mg)/ Mg^+ more positive than Mg

Allow from a + particle/species

Not electron from a higher energy level/or higher sub-level

More protons = 0

1

(iv) Range from 5000 to 9000 kJ mol^{-1}

1

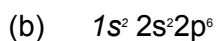
- (c) Increase
If decrease CE = 0/3
If blank mark on 1
- Bigger nuclear charge (from Na to Cl)/more protons
 QWC 1
- electron (taken) from same (sub)shell/similar or same shielding/
 electron closer to the nucleus/smaller atomic radius
If no shielding = 0
Smaller ionic radius = 0 1
- (d) Lower
If not lower CE = 0/3
If blank mark on
Allow does not increase 1
- Two/pair of electrons in (3)p orbital or implied
Not 2p 1
- repel (each other)
M3 dependent upon a reasonable attempt at M2 1
- (e) Boron/B or oxygen/O/O₂ 1

[13]

- M2.** (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



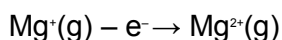
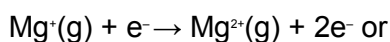
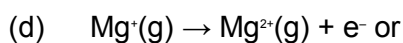
(accept capitals and subscripts)

1

(c) 's' block

(not a specific 's' orbital – e.g. 2s)

1



1

(e) Mg²⁺ ion smaller than Ne atom / Mg²⁺ e⁻ closer to nucleus

(Not 'atomic' radius fo Mg²⁺)

1

Mg²⁺ has more protons than Ne / higher nuclear charge or
e⁻ is removed from a charged Mg²⁺ ion / neutral neon atom

(accept converse arguments)

*(If used 'It' or Mg/magnesium/Mg³⁺ etc. & 2 correct reasons,
allow (1))*

1

(f) (i) trend: increases

(if 'decreases', CE = 0/3)

1

Explⁿ: 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

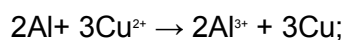
[12]

M3.A

[1]

M4. (a) $2\text{Al} + 3\text{CuCl}_2 \rightarrow 2\text{AlCl}_3 + 3\text{Cu}$;
(accept multiples/fractions)

OR



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 3s e⁻s;

1

(c) $\text{Al}(g) \rightarrow \text{Al}^{2+}(g) + e^-$;

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]

M5.D

[1]

M6. (a) 2s² 2p⁶;

*If ignored the 1s² given and written 1s²2s²2p⁶ mark as correct
Allow capitals and subscripts*

1

(b) (i) Na⁺(g) → Na²⁺(g) + e⁻;

One mark for equation and one mark for state symbols

Na⁺(g) + e⁻ → Na²⁺(g) + 2e⁻;

M2 dependent on M1

Allow Na⁺(g) - e⁻ → Na(g)

Allow X⁺(g) → X²⁺(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 Mg²⁺ 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]