M1. (a) Macromolecular/giant covalent/giant molecular/giant atomic

If IMF/H-bonds/Ionic/metallic CE = 0/3

covalent bond between molecules CE = 0/3

If giant unqualified M1 = 0 but mark on

1

Many/strong covalent bonds

M2 and M3 can only be scored if covalent mentioned in answer

Ignore metalloid and carbon

Ignore bp

1

Bonds must be broken/overcome

Ignore numbers of bonds and references to energy

1

(b) (Simple) molecular

QoL

Do not allow simple covalent for M1

Giant covalent/ionic/metallic, CE = 0

If breaking covalent bonds CE= 0/3

1

S bigger molecule (than P) or S_8 and P_4 references

QoL

Allow more electrons in sulfur molecule or S_8

Do not allow S is bigger then P

Allow S molecule has a bigger M_r

Do not allow contradictions

1

So more/stronger van der Waals' forces (to be broken or overcome)

Not just more energy to break

1

(c) Regular arrangement of minimum of 6 particles in minimum of 2 rows

Ignore e–

Do not allow ring arrangements OR structures bonded with electrons

1

+ charge in each one (of 6)

Allow +, (1+, 2+ or 3+) in ions/or in words

1

Rows/planes/sheets/layers (of atoms/ions) can slide (owtte) over one another

M3 independent

If ionic bonding/molecules/IMF/vdw/covalent, penalise M3

Ignore layers of electrons sliding

1

(d) Bigger charge (3+ compared to 1+)

CE = 0 if molecules, ionic, covalent, IMF

(Allow Al^{2+})

OR smaller atom/ion in Al/more protons/bigger nuclear charge

1

More free/delocalised electrons (in Al)/bigger sea of electrons in Al

Accept 2 or 3 delocalised electrons compared to 1 in Na

1

Stronger metallic bonding/stronger (electrostatic) attraction between the (+) ions or nuclei and the (delocalised) electrons (or implied)

Must be implied that the electrons are the delocalised ones not the electrons in the shells.

Accept converse arguments

1

[12]

M2. (a) Cross between the Na cross and the Mg cross

1

(b) $Al(g) \rightarrow Al^{+}(g) + e-$

$Al(g) - e- \rightarrow Al^{+}(g)$

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

One mark for state symbols consequential on getting equation correct.

Electron does not have to have the – sign on it

Ignore (g) if put as state symbol with e^- but penalise state symbol mark if other state symbols on e^-

2

(c) 2nd/second/2/II

Only

1

(d) Paired electrons in (3)p orbital

Penalise wrong number
If paired electrons repel allow M2

1

repel

1

(e) Neon/Ne

No consequential marking from wrong element

1

$1s^2 2s^2 2p^6$/[He}$2s^2 2p^6$

Allow capital s and p
Allow subscript numbers

1

(f) Decreases

CE if wrong

1

Atomic radius increases/electron removed further from nucleus or nuclear charge/electron in higher energy level/Atoms get larger/more shells

Accept more repulsion between more electrons for M2
Mark is for distance from nucleus
Must be comparative answers from M2 and M3
CE M2 and M3 if mention molecules
Not more sub-shells

1

As group is descended more shielding

1

[11]

M3. (a) $2s^2 2p^6 3s^1$

$1s^2$ 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 <u>charge</u> (from Na to Cl)/more <u>protons</u>

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/O_2

1

[13]

M4. (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]