A-Level Chemistry

Periodicity

Mark Scheme

Time available: 54 minutes
Marks available: 49 marks

1.

(a) Aluminium / Al

*Allow **M2/M3** if a Group 3 element is given*

1

(Outer) electron in (3)p orbital / sub-shell (level)

Not energy level

1

(3p) higher in energy / slightly more shielded (than 3s) / slightly further away (than 3s)

1

or

OR

Sulfur / S

*Allow **M2/M3** if a Group 6 element is given*

1

(Outer) electrons in (3)p orbital begin to pair

Do not allow just p^4 vs p^3

1

Repel

1

(b) $Na^{2+}(g) \rightarrow Na^{3+}(g) + e^-$

State symbols essential.

Allow

$Na^{2+}(g) + e^- \rightarrow Na^{3+}(g) + 2\ e^-$

1

(c) **M1** Phosphorus / P

Mark independently

M2 large jump in ionisation energy for the 6th ionisation energy

Large jump after the 5 e^- is removed / when the 6th e^- is removed

M3 This is when the electron is being removed from the 2nd (principle) energy level / from a lower energy level / from a lower shell / from 2p / from an energy level that is closer to the nucleus

3

[7]

2.

(a) Cross at 1580

Allow a cross drawn for Si that is between the values for Mg and Al

1

(b) **M1** Na

1

M2 $Na^+(g) \rightarrow Na^{2+}(g) + e^-$

M2 *Allow* $Q^+(g) \rightarrow Q^{2+}(g) + e^-$

State symbols essential

Allow correct equation consequential on their element

1

(c) The number of protons increases OR nuclear charge increases

1

Shielding is similar/same OR electrons are added to the same shell

Allow same number of shells

1

(d) Chlorine/Cl

1

(e) $4P + 5O_2 \rightarrow P_4O_{10}$ OR $P_4 + 5O_2 \rightarrow P_4O_{10}$

Allow multiples

Ignore state symbols

Do not allow equations with P_2O_5

1

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3.

(a) Repeating pattern/trends (of physical or chemical properties/reactions)

Allow named property

Penalise groups

1

(b) Bromine/Br

Not Br_2

Accept Kr or Krypton

1

(c) Potassium /K

If Na or Rb lose ***M1*** *but allow access to* ***M2*** *and* ***M3***

If other incorrect elements 0/3

1

Smallest number of protons/smallest nuclear charge

1

Similar shielding / same number of shells (as other elements in period 4)

Allow same shielding

1

(d) Amphoteric

1

(e) $As_2O_3 + 6\ Zn + 12\ HNO_3 \rightarrow 2\ AsH_3 + 6\ Zn(NO_3)_2 + 3\ H_2O$

Accept multiples

1

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4. (a) $Mg(^{2+})$ or Magnesium

Na^+ CE=0

1

Because Mg^{2+} has more protons
AND
With the <u>same</u> shielding/screening/electron arrangement/number of electrons (or isoelectronic)

Allow larger/stronger nuclear charge

Ignore atomic radius

1

(b) $Na(g) \rightarrow Na^+(g) + e^-$

1 for correct species and gas phase

Allow e without charge

Allow $Na(g) - e^- \rightarrow Na^+(g)$

$Na(g) + e^- \rightarrow Na^+(g) + 2e^-$

1

(c) Mg between 600-800

1

S between 800-1040

If S not lower than P on graph then M1 only

If no plots on graph must state S below P to access M3 & M4

1

e^- paired in (3)p orbital in S (owtte)

Allow (3)p subshell/sublevel provided pair mentioned

1

Paired e^- repel (so less energy needed to remove)

1

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5. (a) Silicon / Si

If not silicon then CE = 0 / 3

1

<u>covalent</u> (bonds)

M3 dependent on correct M2

1

Strong or many of the (covalent) bonds need to be <u>broken</u> / needs a lot of energy to <u>break</u> the (covalent) bonds

Ignore hard to break

1

(b) Argon / Ar

If not argon then CE = 0 / 3. But if Kr chosen, lose M1 and allow M2+M3

1

Large(st) number of protons / large(st) nuclear charge

Ignore smallest atomic radius

1

Same amount of shielding / same number of shells / same number of energy levels

Allow similar shielding

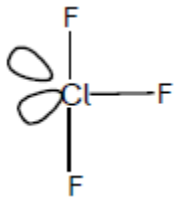
1

(c) Chlorine / Cl

*Not Cl_2, Not C**L**, Not Cl^2*

1

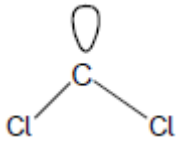
(d) (i)



Or any structure with 3 bonds and 2 lone pairs

Ignore any angles shown

1



Or a structure with 2 bonds and 1 lone pair

1

(ii) Bent / v shape

Ignore non-linear, angular and triangular

Apply list principle

1

(iii) $\frac{1}{2}Cl_2 + \frac{3}{2}F_2 \longrightarrow ClF_3$

No multiples

Ignore state symbols

1

[11]

6. (a) Lithium / Li

Penalise obvious capital I (second letter).

1

(b) (i) Increase / gets bigger

Ignore exceptions to trend here even if wrong

1

(ii) Boron / B

If not Boron, CE = 0/3

1

Electron removed from (2)p orbital /sub-shell / (2)p electrons removed

If p orbital specified it must be 2p

1

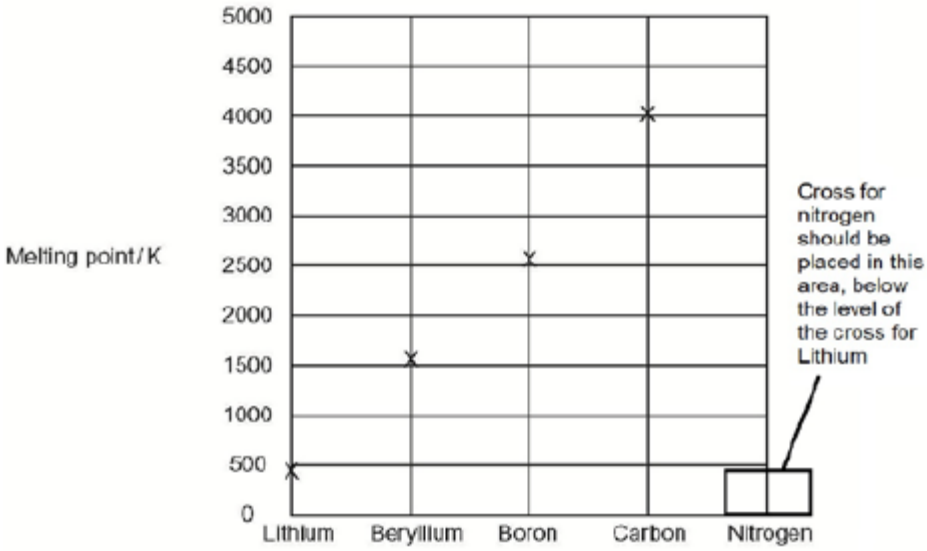
Which is higher in energy (so more easily lost) / more shielded (so more easily lost) / further from nucleus

1

(c) C / carbon

1

(d) Below Li



The cross should be placed on the diagram, on the column for nitrogen, below the level of the cross printed on the diagram for Lithium.

1

(e) Macromolecular / giant molecular / giant atomic

Allow giant covalent (molecule) = 2

1

Covalent bonds in the structure

1

Strong (covalent) bonds must be broken or overcome / (covalent) bonds need a lot of energy to break

Ignore weakening / loosening bonds

If ionic / metallic/molecular/ dipole dipole/ H bonds/ bonds between molecules, CE = 0/3

Ignore van der Waals forces

Ignore hard to break

1

[10]