M1. (a) Enthalpy change/required when an electron is removed/knocked out/displaced (Ignore 'minimum' energy)

1

From a gaseous atom

(could get this mark from equation)

1

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

1

Or $Mg^{+}(g) + e^{-} \rightarrow Mg^{2+}(g) + 2e^{-}$ State symbols (*Tied to M1*)

1

(c) Increased/stronger nuclear charge **or** more protons

1

Smaller atom **or** electrons enter the same shell **or** same/similar shielding

1

(d) Electron removed from a shell of lower energy **or** smaller atom **or** e^{-} nearer

1

nucleus **or** e^{-} removed from 2p rather than from 3s
Less shielding

(Do not accept 'e^{-} from inner shell')

1

[8]

M2. (a) **4**LiH + $AlCl_3 \rightarrow LiAlH_4$ + **3**LiCl

1

(b) $H^{-} = 1s^2$ **or** $1s_2$

1

(c) Tetrahedral or diagram

(Not distorted tetrahedral)

1

(Equal) repulsion

1

between four bonding pairs / bonds

(Not repulsion between H atoms loses M2 and M3)
(Not 'separate as far as possible')
('4' may be inferred from a correct diagram)

1

(d) Dative (covalent) or coordinate

1

Lone pair **or** non-bonding pair of electron **or** both e^-

1

QoL Donated from H^- to Al **or** shared between H and Al

(tied to M2)
(Not 'from H atom') (Not 'to Al ion') (Not 'e^-s transferred')

1

[8]

M3. (a) Ability (or power) of an atom to attract electron density (or electrons or ⁻ ve charge) **(1)**
in a covalent bond **(1)**

or shared pair
If remove an electron lose first mark

2

(b) *Trend:* increases **(1)**
Explanation: nuclear charge (number of protons) increases **(1)**
electrons in same shell **(1)**

OR similar shielding
OR atoms similar size or smaller
OR 1 mol of e^-

3

(c) Heat / enthalpy / energy for removal of one electron **(1)**

from a gaseous atom **(1)**
can score in an equation

must have first mark to score the second

2

(d) (i) 2 **(1)**

(ii) Two elements (or Na / Mg) before the drop (in energy) to Al **(1)**

(iii) ionisation energy of Al < that for Mg **(1)**

(iv) fall in energy from P to S **(1)**

or discontinuity in trend

From Al to P there are 3 additional electrons **(1)**

or three elements

For second mark idea of block of 3 elements

5

[12]

M4. D

[1]

M5. (a) $Na(g) \rightarrow Na^{+}(g) + e^{-}$
OR $Na(g) + e^{-} \rightarrow Na^{+}(g) + 2e^{-}$

($^{-}$) on electron not essential
equation (1)
state symbols (1)
Ignore state symbols on electrons

2

(b) *Trend* : Increases **(1)**

Explanation : Increased nuclear charge or proton number **(1)**
Stronger attraction (between nucleus and (outer) e^{-}) **(1)**

Trend wrong
Allow M2 only if M3 correct (con)

3

(c) *How values deviate from trend*: (both values) too low **(1)**
Explanation for Al: e^- removed from (3) p **(1)**
e^- or orbital is higher in energy or better shielded than (3)**s**
or p electron is shielded by 3s electrons **(1)**
Allow e^- is further away

Mark independently

Explanation for S: e^- removed from (3)p electron pair **(1)**
repulsion between paired e^- (reduces energy required) **(1)**
Mark separately
If deviation wrong allow M2 and M4
If M3 and / or M5 right (con)
If used 'd' rather than 'p' orbital - lose M2 + M4 but may get M3, M5 (explanation marks)

5

[10]

M6. (a) (i) Atoms with the same number of protons / proton number **(1)**
NOT same atomic number

with different numbers of neutrons **(1)**
***NOT** different mass number / fewer neutrons*

(ii) Chemical properties depend on the number or amount of (outer) electrons **(1)** OR, isotopes have the same electron configuration / same number of e^-

(iii) $23/6.023 \times 10^{23}$ **(1)**
CE = 0 if inverted or multiplied

tied to M1 $3.8(2) \times 10^{-23}$ [2-5 sig figs] **(1)**

5

(b) $1s^2\ 2s^2\ 2p^6\ 3s^1$ **(1)**
accept subscripted figures

1

(c) Highest energy e^- / outer e^-s / last e^- in (3)d sub-shell **(1)**

OR d sub-shell being filled / is incomplete
OR highest energy sub-shell is (3)d
NOT transition element / e^- configuration ends at 3d
Q of L

1

(d) $^{15}_{7}N$ N correct symbol **(1)**

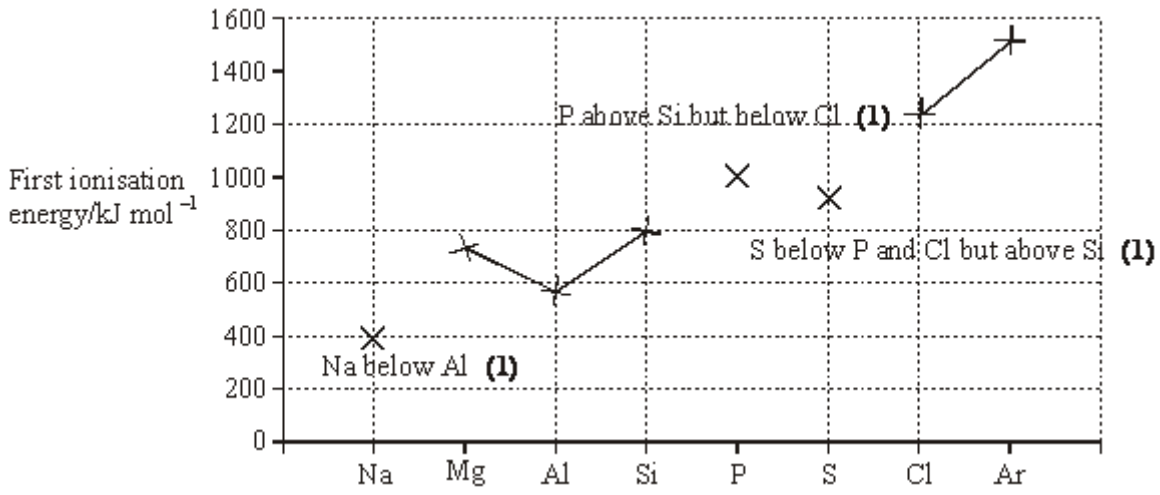
allow N^{15}_{7}

Mass number = 15 AND atomic number = 7 **(1)**

2

[9]

M7. (a)



1

(b) Increased nuclear charge / proton number **(1)**

NOT increased atomic number

Electrons enter same shell / energy level OR atoms get smaller
OR same shielding **(1)**

Stronger attraction between nucleus and (outer) electrons **(1)**

Q of L

3

(c) *Explanation for aluminium*: (third) electron in (3)p sub-shell **(1)**
Sub-shell further away from nucleus OR of higher energy **(1)**
OR extra shielding from (3)s

Explanation for sulphur: Pair of electrons in (3)p orbital **(1)**
Repulsion between electrons **(1)**

tied to reference to e^- pair in M3

Penalise '2p' once only

4

[10]