M1.(a) (i) Higher than P

1

(ii) $1s^2\ 2s^2\ 2p^6\ 3s^1$

Allow any order

1

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

OR

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

OR

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

1

(iv) Electron in Si (removed from) (3)p orbital / electron (removed) from higher energy orbital or sub-shell / electron in silicon is more shielded

Accept converse arguments relating to Al
Penalise incorrect p-orbital

1

(b) Sodium / Na

Allow Na^+

1

Electron (removed) from the 2nd shell / 2p (orbital)

M2 is dependent on M1
Allow electron from shell nearer the nucleus (so more attraction)

1

(c) Silicon / Si

Not SI

1

(d) Heat or energy needed to overcome the attraction between the (negative)

electron and the (positive) nucleus or protons

Not breaking bonds

QoL

Or words to that effect eg electron promoted to higher energy level (infinity) so energy must be supplied

1

[8]

M2. (a) 37

These answers only.

Allow answers in words.

1

48

Ignore any sum(s) shown to work out the answers.

1

(b) (i) Electron gun / high speed/high energy electrons

Not just electrons.

Not highly charged electrons.

1

Knock out electron(s)

Remove an electron.

1

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

OR

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

OR

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

Ignore state symbols for electron.

1

(c) Rb is a bigger (atom) / e further from nucleus / electron lost from a higher energy level/ More shielding in Rb / less attraction of nucleus in Rb for outer electron / more shells

Answer should refer to Rb not Rb molecule
If converse stated it must be obvious it refers to Na
Answer should be comparative.

1

(d) (i) s / block s / group s

Only

1

(ii) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^{10}\ 4p^6\ 5s^1$

Allow $3d^{10}$ before $4s^2$
Allow in any order.

1

(e) $\frac{(85 \times 2.5) + 87 \times 1}{}$ 3.5

M1 is for top line

1
1

= $\frac{85.6}{}$

Only

1

OR

$\frac{(58 \times 5) + 87 \times 2}{}$ 7

M1 ^{85}Rb 71.4% and ^{87}Rb 28.6%
M2 divide by 100

1
1

$\frac{85.6}{}$

M3 = $\frac{85.6}{}$

1

(f) Detector

Mark independently
Allow detection (plate).

1

Current / digital pulses / electrical signal related to abundance

Not electrical $\frac{charge}{}$.

1

(g) Smaller

Chemical error if not smaller, CE = 0/3

If blank mark on.

1

Bigger nuclear charge / more protons in Sr

Not bigger nucleus.

1

Similar/same shielding

QWC

(Outer) <u>electron</u> entering same shell/sub shell/orbital/same number of shells.

Do not allow incorrect orbital.

1

[16]

M3.(a) N^{3-} / N^{-3}

1

(b) F^-/ fluoride

Ignore fluorine/F

Penalise FI

1

(c) Li_3N / NLi_3

1

(d) $\frac{81.1}{40.1}$ $\frac{18.9}{14}$

M1 for correct fractions

1

(=2.02 = 1.35)

1.5 1 or 3 : 2

M2 for correct ratio

1

Ca_3N_2

If Ca_3N_2 shown and with no working award 3 marks

If Ca_3N_2 obtained by using atomic numbers then lose M1

1

(e) $3\ Si + 2\ N_2 \rightarrow Si_3N_4$

Accept multiples

1

[7]

M4. (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 <u>in (3)p orbital</u>

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]

M5. (a) $Li(g) \rightarrow Li^+(g) + e^-(g)$

$Li(g) - e^-(g) \rightarrow Li^+(g)$

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

One mark for balanced equation with state symbols
Charge and state on electron need not be shown

1

(b) Increases

If trend wrong then CE = 0/3 for (b). If blank mark on.

1

Increasing nuclear charge / increasing no of protons

Ignore effective with regard to nuclear charge

1

Same or similar shielding / same no of shells / electron (taken) from same (sub)shell / electron closer to the nucleus / smaller atomic radius

1

(c) Lower

If not lower then CE = 0/3

1

Paired electrons in a (4) p orbital

If incorrect p orbital then M2 = 0

1

(Paired electrons) repel

If shared pair of electrons M2 + M3 = 0

1

(d) Kr is a bigger atom / has more shells / more shielding in Kr / electron removed further from nucleus/ electron removed from a higher (principal or main) energy level

CE if molecule mentioned

Must be comparative answer

QWC

1

(e) 2 / two / II

1

(f) Arsenic / As

1

[10]