

M1.(a) $5s^2 4d^{10} 5p^4$ / $4d^{10} 5s^2 5p^4$
 $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^{10} 5p^4$
 or $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6 4d^{10} 5s^2 5p^4$
 Allow any order but must finish with $5p^4$

1

(b) (i)
$$\frac{(124 \times 2) + (126 \times 4) + (128 \times 7) + (130 \times 6)}{19}$$
 or $\frac{2428}{19}$

M1 for top line

1

127.8

M2 for correct denominator

1

127.8 with no working shown scores 3 marks

1

Or

$$\frac{(124 \times 10.5) + (126 \times 21.1) + (128 \times 36.8) + (130 \times 31.6)}{100}$$

1

Mark for 100 dependent on top line correct

1

127.8

1

(ii) Other isotopes present / some isotopes absent / different abundances of isotopes

1

(c) $\text{Te}^+ + e^{(-)} \rightarrow \text{Te}$

Ignore state symbols

Allow $\text{Te}^{2+} + 2e^{(-)} \rightarrow \text{Te}$

1

(d) 128

Only

1

Most abundant ion (QoL – superlative)

M2 dependent on correct M1

1

- (e) 2+ ion formed / 2 electrons removed
Due to $^{128}\text{Te}^{2+} = 2$ marks

1

From ^{128}Te
Mark independently

1

- (f) Same
If not same CE = 0 / 2

1

(Each isotope has the) same number of protons / same nuclear charge and
same number of electrons / electronic configuration
Ignore more neutrons in ^{130}Te

1

[12]

M2.(a) Abundance of third isotope = $100 - 91.0 - 1.8 = 7.2\%$

1

$$\frac{(32 \times 91) + (33 \times 1.8) + (y \times 7.2)}{100} = 32.16$$

1

$$7.2y = 32.16 \times 100 - 32 \times 91 - 33 \times 1.8 = 244.6$$

1

$$y = 244.6 / 7.2 = 33.97$$

$$y = 34$$

Answer must be rounded to the nearest integer

1

- (b) (for electrospray ionisation)

A high voltage is applied to a sample in a polar solvent

1

the sample molecule, M, gains a proton forming MH^+

1

OR

(for electron impact ionisation)

the sample is bombarded by high energy electrons

1

the sample molecule loses an electron forming M^+

1

(c) Ions, not molecules, will interact with and be accelerated by an electric field

1

Only ions will create a current when hitting the detector

1

[8]

M3.D

[1]

M4.(a) (Total number of) protons and neutrons (in nucleus of atom)
(number of) nucleons

1

(b) Zn

*Do not allow Zn^{-1} or Zn^{+1} or ZN
Ignore numbers*

1

(c) (i) P = ionise (sample)

Allow removing an electron / forms (+) ions

1

Q = accelerate (sample)
Allow speeds (ions) up
Penalise molecules / atoms

1

(ii) m / z
Allow mass / charge

1

(relative) abundance / (relative) intensity
QoL
Allow M1 + M2 in any order

1

(d) (i)
$$\frac{206 + 207 + (208 \times 2)}{4} = \frac{829}{4}$$

M1 = topline

1

M2 = ÷ 4

1

= 207.3
Only
207.3 = 3 marks

1

(ii) Lead / Pb
Not PB

1

(iii) Same number of electrons (in outer shell) / same electronic configuration
Ignore electrons determine chemical properties
Ignore reference to p and n if correct
Penalise if incorrect

1

[11]

M5.(a) Average / mean mass of 1 atom (of an element)

1/12 mass of one atom of ^{12}C

If moles and atoms mixed, max = 1

1

*Mark top and bottom line independently.
All key terms must be present for each mark.*

1

OR

Average / mean mass of atoms of an element

1/12 mass of one atom of ^{12}C

OR

Average / mean mass of atoms of an element $\times 12$

mass of one atom of ^{12}C

OR

(Average) mass of one mole of atoms

1/12 mass of one mole of ^{12}C

OR

(Weighted) average mass of all the isotopes

1/12 mass of one atom of ^{12}C

OR

Average mass of an atom / isotope (compared to C-12) on a scale in which an atom of C-12 has a mass of 12

This expression = 2 marks.

$$(b) \quad \frac{(70 \times 3) + (72 \times 4) + 73 + (74 \times 5)}{13} = \frac{941}{13}$$

$$= \underline{72.4}$$

72.4 only

1
1

1

(c) $^{72}\text{Ge}^+$ or germanium⁺
Must show '+' sign.
Penalise wrong mass number

1

(d) 70
If M1 incorrect or blank CE = 0/2
Ignore symbols and charge even if wrong.

1

Lowest mass / lowest m/z
Accept lightest.
Accept fewest neutrons.

1

(e) Electron(s) transferred / flow (at the detector)
M1 must refer to electron flow at the detector.
If M1 incorrect CE = 0/2

1

(From detector / plate) to the (+) ion
Do not allow from a charged plate.

1

(f) They do not have the same electron configuration / they have different number of electrons (in the outer shell)
Ignore electrons determine the properties of an atom.
Ignore they are different elements or different number of protons.

1

[11]

M6.(a) $[\text{CH}_3\text{OCOCOOH}]^+$
Allow names

1



Do not allow molecular formula

1

(b) Positive ions are accelerated by an electric field

1

To a constant kinetic energy

1

The positive ions with m/z of 104 have the same kinetic energy as those with m/z of 118 and move faster

1

Therefore, ions with m/z of 104 arrive at the detector first

1

[6]

M7.(a) (i) 1.6734×10^{-24} (g)

Only.

$$1.6734 \times 10^{-27} \text{ kg}$$

Not 1.67×10^{-24} (g).

1

(ii) **B**

1

(b) (i) $\frac{10x + 11y}{x + y} = 10.8$

OR ratio 10:11 = 1:4 **OR** 20:80 etc

Allow idea that there are 5×0.2 divisions between 10 and 11.

1

abundance of ^{10}B is 20(%)

OR

$$\frac{10x}{100} + \frac{11(100-x)}{100} = 10.8$$

$$10x + 1100 - 11x = 1080$$

$$\therefore x = 1100 - 1080 = 20\%$$

Correct answer scores M1 and M2.

1

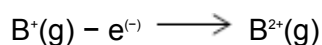
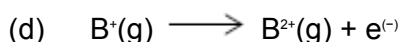
- (ii) Same number of electrons (in outer shell or orbital)
Ignore electrons determine chemical properties.

Same electronic configuration / arrangement
Ignore protons unless wrong.

1

- (c) Range between 3500 and 10 000 kJ mol^{-1}

1



Ignore state symbol on electron even if wrong.

1

- (e) Electron being removed from a positive ion (therefore needs more energy) /
electron being removed is closer to the nucleus

Must imply removal of an electron.

*Allow electron removed from a + particle / species or from a
2+ ion.*

*Not electron removed from a higher / lower energy level /
shell.*

*Not electron removed from a higher energy sub-level /
orbital.*

Ignore electron removed from a lower energy sub-level /

orbital.

Ignore 'more protons than electrons'.

Not 'greater nuclear charge'.

Ignore 'greater effective nuclear charge'.

Ignore shielding.

1

[8]