M1.(a) Percentage of oxygen is 36.4%

% of oxygen stated or shown in calculation.

1

Correct calculation of ratios (C 4.54, H 9.10, O 2.28)

Mark is for correct method, dividing % by A_r

1

Empirical formula C_2H_4O

Allow consequential answer from wrong percentage of oxygen (max 2 marks).

1

(b) 88

Accept 88.0

Do not penalise correct answer in g.

1

(c) Ratio MF / EF of 2 (88 / 44.0 = 2)

If use 132 / 44 = 3, molecular formula $C_6H_{12}O_3$ scores 2 marks.

1

Molecular formula is $C_4H_8O_2$

Accept consequential answers from (a) and (b)

1

[6]

##

(a) <u>Average/mean mass of (1) atom(s) (of an element)</u>

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

1

If moles and atoms mixes Max = 1

1

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) d block

Allow 3d/D
Other numbers lose M1
Ignore transition metals

1

[Ar] $3d^2 4s^2$

1

Can be written in full
Allow subscripts
$3d^2$ and $4s^2$ can be in either order

27

1

(c) $$\frac{(90 \times 9) + (91 \times 2) + (92 \times 3) + (94 \times 3)}{17}$$

(= 1550)

1

(or ∑ their abundances)

If one graph reading error lose M1 and allow consequential M2 and M3.
If 2 GR errors penalise M1 and M2 but allow consequential M3
If not 17 or ∑ their abundances lose M2 and M3

1

= 91.2

91.2 = 3 marks provided working shown.

1

Zr/Zirconium

M4 -allow nearest consequential element from M3
accept Zr in any circumstance

1

(d) High energy electrons/bombarded or hit with electrons

accept electron gun

1

knocks out electron(s) (to form ions)

1

Z^+ = <u>90</u> deflected most

If not 90 lose M3 and M4
If charge is wrong on 90 isotope lose M3 only
Accept any symbol in place of Z

1

since lowest mass/lowest m/z

Allow lightest

1

(e) (ions hit detector and) cause current/(ions) accept electrons/cause electron flow

QWC

1

bigger current = more of that isotope/current proportional to abundance

Implication that current depends on the number of ions

1

[15]

M3. (a)

Particle	Relative Charge	Relative mass	
Proton	+1	1	1
Neutron	0	1	1

Need +1 for proton

(b) d block/ D block;

Or D or d

1

(c) (i) 74;

Not 74.0

1

(ii) 112;

Not 112.0

1

(d) (i) To accelerate/ make go faster;

1

To deflect/ to bend the beam;

Any order
Not just attract to negative plate

1

(ii) Electromagnet / magnet / electric field /accelerating potential or voltage;

Not electric current
Not electronic field

1

(e) None/ nothing;

If blank mark on.
If incorrect CE = 0

1

Same number of electrons (in outer orbital/shell)/ both have 74 electrons/same electron configuration;

Not just electrons determine chemical properties
Ignore protons and neutrons unless wrong statement.

1

(f) $$\frac{(182 \times 26.4) + (183 \times 14.3) + (184 \times 30.7) + (186 \times 28.6)}{100};$$

If transcription error then

M1 = AE = –1 and mark
M2 consequentially

1

= 183.90; allow range from 183.90 – 184.00;

1

[12]

M4. (a) Proton mass = 1 charge = +1
Electron mass $\leq$ 1/1800 Or $\leq$ 5.6×10^{-4} charge = –1
(Do not accept +1 for proton mass or 'g' units)

2

(b) (i) 13

1

(ii) Si

1

Mass number = 28 **and** atomic number = 14
(Do not accept 28.1 or 28.0 or 'Silicon')

5

(c) Mean (average) mass of an atom / all the isotopes
1/12th mass of atom of ^{12}C
Or Mass of 1 mole of atoms of an element **(1)**
1/12th mass of 1 mole of ^{12}C **(1)**
Or Average mass of an atom / all the isotopes **(1)**
relative to the mass of a ^{12}C atom taken as exactly 12 / 12.000 **(1)**
(Penalise 'weight' once only) (Ignore 'average' mass of ^{12}C)
(Do not allow 'mass of average atom')

2

(d) $A_r = (24 \times 0.735) + (25 \times 0.101) + (26 \times 0.164)$ 1 = 24.4 1
(mark M2 conseq on transcription error or incorrect addition of %)

(e) M_r = highest m/z value 1
(NOT 'highest/largest/right-hand' peak)

3

[10]

M5. (a) Number of protons in the nucleus **1**

(b) They may have different numbers of neutrons **1**

(c) (i) Mass spectrometer **1**

(ii) $\dfrac{\text{Mean mass of an atom}}{\text{Mass of 1 atom of } ^{12}\text{C}} \times 12$ **2**

(iii) $A_r = \dfrac{\text{sum of relative m/z} \times \text{rel. abundance}}{\text{Total abundance}}$ **1**

$= (82 \times 12 + 83 \times 12 + 84 \times 50 + 86 \times 26)/100 = 84.16$ **1**

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

(e) Krypton was thought to be an inert gas
(or has 8 electrons in outer shell) **1**

(f) (i) Krypton has more protons than bromine **1**

But its outer electrons are in the same shell
(or have similar shielding) **1**

(ii) Al electron is in a 3p orbital, magnesium in 3s **1**

Energy of 3p is greater than 3s

1

[13]