**M1.** (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 bigg<u>er</u> (atom) / e furth<u>er</u> from nucleus / electron lost from a high<u>er</u> energy level/ <u>More</u> shielding in Rb / <u>less</u> attraction of nucleus in Rb for outer electron / <u>more</u> 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) <u>(85 × 2.5) + 87 ×1</u> 3.5

*M1 is for top line*

1

1

= <u>85.6</u>

*Only*

1

***OR***

<u>(58 × 5) + 87 ×2</u> 7

*M1 $^{85}$Rb 71.4% and $^{87}$Rb 28.6%*

*M2 divide by 100*

1

1

<u>85.6</u>

*M3 = <u>85.6</u>*

1

(f) Detector

*Mark independently*

*Allow detection (plate).*

1

Current / digital pulses / electrical signal related to abundance

*Not electrical <u>charge</u>.*

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]**

**M2.** (a) $\mathbf{2}Ca_5F(PO_4)_3 + 9SiO_2 + \mathbf{15}C \longrightarrow 9CaSiO_3 + CaF_2 + \mathbf{15}CO + \mathbf{6}P$

1

(b) **M1** ($P_4$ =) **0**

**M2** ($H_3PO_4$ =) **(+) 5**

*Accept Roman numeral V for **M2***

2

(c) $H_2SO_4$

***Both numbers** required*

$M_r$ = 2(1.00794) + 32.06550 + 4(15.99491)
= **98.06102 or 98.0610 or 98.061 or 98.06 or 98.1**

*Calculations not required*

<u>**and**</u>

$H_3PO_4$

$M_r$ = 3(1.00794) + 30.97376 + 4(15.99491)
= **97.97722 or 97.9772 or 97.977 or 97.98 or 98.0**

1

(d) (i) A substance that <u>speeds up</u> a reaction OR <u>alters / increases the rate</u> of a reaction **AND** is <u>chemically unchanged at the end / not used up</u>.

***Both ideas** needed*

*Ignore reference to activation energy or alternative route.*

1

(ii) The addition of water (**QoL** ) to a molecule / compound

***QoL- for the underlined words***

1

(iii) **M1** $CH_3CH{=}CH_2 + H_2O \longrightarrow CH_3CH(OH)CH_3$

($C_3H_6$)

*For **M1** insist on correct structure for the alcohol but credit correct equations using either $C_3H_6$ or double bond not given.*

**M2** propan-2-ol

2

**[8]**

**M3.**(a) $$\frac{(82\times2)+(83\times2)+(84\times10)+(86\times3)}{17} \qquad \frac{(1428)}{(17\quad)}$$

*M1 for the top line*

*M2 is for division by 17*

1

1

= 84.0

*Not 84*

*No consequential marking from M1 or M2*

*Ignore units*

1

The $A_r$ in the Periodic table takes account of the other isotopes /different amounts of isotopes (or words to that effect regarding isotopes)

*Award independently*

*Comparison implied*
*Isotope(s) alone, M4 = 0*

1

(b) (Beam of electrons from) an electron gun / high speed / high energy electrons

1

Knocks out electron(s) (to form a positive ion)

1

$Kr(g) + e^- \rightarrow Kr^+(g) + 2e^{(-)}$
*State symbols must clearly be (g)*

1

***OR***

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

The $^{84}Kr$ isotope
*One mark for identifying the 84 isotope*

1

Has 2 electrons knocked out / gets a 2+ charge
*One mark for the idea of losing 2 electrons (from this isotope)*

1

**[9]**

**M4.** (a) Average/mean mass of (1) atom(s) (of an element)

1

1/12 mass of one atom of $^{12}C$
*Accept answer in words*
*Can have top line × 12 instead of bottom line ÷ 12*

1

***OR***

$$\frac{\text{(Average) mass of one mole of atoms}}{\text{1/12 mass of one mole of } ^{12}C}$$

***OR***

<u>(Weighted) average mass of all the isotopes</u>
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

$$\frac{(95.12 \times 14) + (4.88 \times 15)}{100}$$

*Allow 95.12 + 4.88 instead of 100*

**1**

= 14.05

*If not to 2 d.p. then lose last mark*
*Not 14.04*

**1**

(b) $^{15}N$ is heavier/$^{15}N$ has a bigger m/z/different m/z values

*Not different no's of neutrons*
*Not ionisation potential*

**1**

Electromagnet/electric field/magnet/accelerating potential or voltage/electric current

**1**

(c) No difference

**1**

Same no of electrons (in outer orbital/shell/sub shell)/same electron configuration

*M2 dependent on M1*
*Not just electrons determine chemical properties*
*Ignore protons*

**1**

**[8]**

**M5.** Mass number = number of protons + neutrons (in the nucleus/atom)

*Not in a substance or compound or element*

1

7 protons <u>and</u> 7 electrons

1

8 neutrons

1

**[3]**

**M6.** (a) (i) Different number / amount of neutrons

*Not different neutrons*

*Ignore same protons and/or electrons*

*CE incorrect statement relating to protons / electrons*

1

(ii) Same electron configuration / same number of electrons (in the outer shell)

*Ignore same no of protons*

*Ignore electrons determine chemical properties*

*CE if wrong statement relating to protons / neutrons*

1

(b) $\frac{\text{Average mass of 1 atom (of an element)}}{\text{1/12 mass atom of } ^{12}\text{C}}$

OR

$\frac{\text{Average/mean mass of atoms of an element}}{\text{1/12 mass of one atom of } ^{12}\text{C}}$

OR

$\frac{\text{(Average) mass of one mole of atoms}}{\text{1/12 mass of one mole of } ^{12}\text{C}}$

OR

$\frac{\text{(Weighted) average mass of all the isotopes}}{\text{1/12 mass of one atom of } ^{12}\text{C}}$

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

*If moles and atoms mixes Max = 1*

*Mark top and bottom line independently*

*1/12 on bottom line can be represented as x 12 on top line*

*This expression = 2 marks*

**2**

(c) (i) $$\frac{(64 \times 12) + (66 \times 8) + (67 \times 1) + (68 \times 6)}{27} \; \frac{(= 1771)}{27}$$

= <u>65.6</u>

*If not 27 max 1 mark (for top line)*

*Mark is for dividing by 27 or string*

*If **evidence** of arithmetic or transcription error seen in M1 or M2 allow consequential M3 and consequential (c)(ii)*

*65.6 = 3 marks*

**3**

(ii) $^{64}Zn^{+}$

*M1 for identifying Zn / zinc*

*M2 is for the + sign and the 64*

*M2 is dependent on M1*

**2**

(d) Size of the charge (on the ion) / different charges / different m/z

*Allow forms 2+ ions*

*QWC*

**1**

(e) (ions hit detector and) cause current/(ions) accept electrons/cause electron flow/electric pulse caused
bigger current = more of that isotope/current proportional to abundance

*Implication that current depends on the number of ions*

*M2 dependent on M1*

**2**

**[12]**