**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 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*
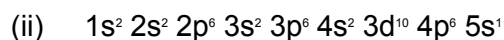*If converse stated it must be obvious it refers to Na*
*Answer should be comparative.*

**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)    $\underline{(85 \times 2.5) + 87 \times 1}$        3.5

  *M1 is for top line*

**1**
**1**

= 85.6

  *Only*

**1**

**OR**

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

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

**1**
**1**

85.6

  *M3 = 85.6*

**1**

(f)    Detector

  *Mark independently*
  *Allow detection (plate).*

**1**

Current / digital pulses / electrical signal related to abundance

  *Not electrical 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]**

**M2.** (a) $2Ca_5F(PO_4)_3 + 9SiO_2 +$**15**$C \longrightarrow 9CaSiO_3 + CaF_2 +$**15**$CO +$**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 <u>addition of water</u> (**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)   $\dfrac{(82 \times 2) + (83 \times 2) + (84 \times 10) + (86 \times 3)}{17}$      $\dfrac{(1428)}{(17\ \ \ )}$

        *M1 for the top line*
        *M2 is for division by 17*

**1**

**1**

   = <u>84.0</u>
        *Not 84*
        *No consequential marking from M1 or M2*
        *Ignore units*

**1**

The $A_r$ in the Periodic table takes account of the <u>other isotopes</u> /<u>different amounts of
isotopes</u> (or words to that effect regarding isotopes)
        *Award independently*

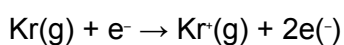*Comparison implied*
*Isotope(s) alone, M4 = 0*

**1**

(b)    (Beam of electrons from) an electron gun / high speed / high energy electrons
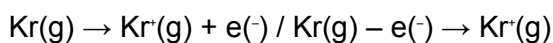
**1**

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*

(Average) mass of one mole of atoms
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*

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

8 neutrons

**[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*

(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*

(b)    <u>Average mass of 1 atom (of an element)</u>
1/12 mass atom of $^{12}C$

OR

<u>Average/mean mass of atoms of an element</u>
1/12 mass of one atom of $^{12}C$

OR

<u>(Average) mass of one mole of atoms</u>
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

> *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)    $$\frac{(64 \times 12) + (66 \times 8) + (67 \times 1) + (68 \times 6)}{27} \quad \frac{(=1771)}{27}$$
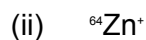
= <u>65.6</u>

> *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]**