

1. (i) ^{153}Eu has (2) more neutrons

OR

^{153}Eu has 90 neutrons **AND** ^{151}Eu has 88 neutrons ✓

ALLOW There are a different number of neutrons

IGNORE Correct references to protons / electrons

DO NOT ALLOW Incorrect references to protons / electrons

1

- (ii) (It has the) same number of protons **AND** electrons

OR

Both have 63 protons and 63 electrons ✓

ALLOW Same number of protons **AND** same electron configuration

DO NOT ALLOW 'Same number of protons' without reference to electrons (and vice versa)

1

[2]

2. (a) **Mass** of the **isotope** compared to 1/12th

OR

mass of the **atom** compared to 1/12th ✓

(the mass of a) carbon-12 **OR** ^{12}C (atom) ✓

IGNORE Reference to average **OR** weighted mean

(i.e. correct definition of relative atomic mass will score both marks)

ALLOW mass of a **mole** of the isotope/atom with 1/12th the mass of a **mole** **OR** 12 g of carbon-12 for two marks.

ALLOW 2 marks for:

'Mass of the isotope **OR** mass of the atom compared to ^{12}C atom given a mass of 12.0'

i.e. 'given a mass of 12' **OR** C12 is 12 communicates the same idea as 1/12th.'

ALLOW 12C **OR** C12

ALLOW 2 marks for:

$$\frac{\text{mass of the isotope}}{\text{mass of 1/12th mass of carbon-12}}$$

ALLOW 1 mark for a mix of mass of atom and mass of mole of atoms, i.e. 'mass of the isotope/mass of an atom compared with 1/12th the mass of a **mole** **OR** 12 g of carbon-12.'

DO NOT ALLOW mass of 'ions' **OR** mass of element

2

(b)
$$\frac{(151 \times 47.77) + (153 \times 52.23)}{100}$$

OR

$72.1327 + 79.9119$

OR

152.0446 (calculator value) ✓

$A_r = 152.04$ ✓

ALLOW Correct answer for two marks

ALLOW One mark for ECF from transcription error in first sum provided final answer is to 2 decimal points and is to between 151 and 153 and is a correct calculation of the transcription

2

[4]

3. (i) (atoms of the) same element **OR** same atomic no.
OR no. of protons

AND

with different numbers of neutrons **OR** different masses ✓

IGNORE 'same number of electrons'

DO NOT ALLOW 'different numbers of electrons'

DO NOT ALLOW 'different relative atomic masses'

DO NOT ALLOW 'elements with different numbers of neutrons' *without* mention of same protons **OR** same atomic number

1

- (ii) same (number of) **electrons** (in the outer shell)

OR

same **electron** configuration **OR** structure ✓

DO NOT ALLOW different number of protons

IGNORE 'same number of protons'

IGNORE 'they are both carbon' **OR** 'they are both the same element'

1

- (iii) **mass** of the isotope compared to 1/12th
OR
mass of the atom compared to 1/12th ✓

(the mass of a) carbon-12 **OR** ^{12}C (atom) ✓

IGNORE reference to average **OR** weighted mean
(i.e. correct definition of relative atomic mass will score both marks)

ALLOW mass of a **mole** of the isotope/atom with 1/12th the mass of a **mole** **OR** 12 g of ✓
 carbon –12 ✓

ALLOW 2 marks for:

*'mass of the isotope **OR** mass of the atom compared to ^{12}C atom given a mass of 12.0'*

i.e. 'given a mass of 12' communicates the same idea as 1/12th.'

ALLOW ^{12}C **OR C12**

ALLOW FOR 2 MARKS:

$$\frac{\text{mass of the isotope}}{\text{mass of } 1/12\text{th mass of carbon } -12}$$

i.e. fraction is equivalent to 'compared to'

ALLOW 1 MARK FOR a mix of mass of atom and mass of mole of atoms, **i.e.:**

*'mass of the isotope/mass of an atom compared with 1/12th the mass of a **mole** **OR** 12 g of carbon –12.'*

2

[4]

4. (i)

	protons	neutrons	electrons
^{24}Mg	12	12	12
^{25}Mg	12	13	12

^{24}Mg line correct ✓

^{25}Mg line correct ✓

mark by row

2

(ii)
$$\frac{24 \times 78.60 + 25 \times 10.11 + 26 \times 11.29}{100}$$

OR 18.8640 + 2.5275 + 2.9354

OR 24.3269 ✓

$A_r = 24.33$ (to 4 sig figs) ✓

ALLOW two marks for $A_r = 24.33$ with no working out

ALLOW one mark for ecf from incorrect sum provided final answer is between 24 and 26 and is to 4 significant figures, e.g. 24.3235 ✗ gives ecf of 24.32 ✓

2

- (iii) The (weighted) mean **mass** of an **atom**
OR (weighted) average **mass** of an **atom** ✓

relative to $1/12^{\text{th}}$ (the mass) ✓

of (one atom of) ^{12}C ✓

ALLOW The (weighted) mean mass

OR (weighted) average mass of an atom

OR average atomic mass ✓

compared with (the mass of) carbon-12 ✓

which is 12 ✓

For 1st marking point, *ALLOW* mean mass of the isotopes

OR average mass of the isotopes

Do **NOT ALLOW** the singular: isotope

ALLOW mass of **one mole of atoms** ✓

compared to $1/12^{\text{th}}$ ✓

(the mass) of **one mole** / 12 g of carbon-12 ✓

mass of one mole of atoms ✓

$1/12^{\text{th}}$ ✓ the mass of one mole / 12 g of carbon-12 ✓

3

[7]

5. (i) atoms of the same element with different numbers of neutrons/different masses (1) 1
- (ii) ^{79}Br 35 protons, 44 neutrons, 35 electrons (1)
- ^{81}Br 35 protons, 46 neutrons, 35 electrons (1) 2
- (iii) $(1s^2)2s^22p^63s^23p^63d^{10}4s^24p^5$ (1) 1

[4]

6. Molar mass of anhydrous calcium nitrate = 164.1 g mol^{-1} (1)
 Ratio $\text{Ca}(\text{NO}_3)_2 : \text{H}_2\text{O} = 69.50/164.1 : 30.50/18$
 or $0.4235 : 1.694$ or $1 : 4$ (1)
 Formula = $\text{Ca}(\text{NO}_3)_2 \cdot 4\text{H}_2\text{O}$ (1)

[3]

7. (a) (atoms of) **same element/same atomic number**..... with
 different numbers of neutrons/different masses ✓

1

(b)

3

isotope	percentage composition	number of		
		protons	neutrons	electrons
^{85}Rb	71 to 73	37	48	37
^{87}Rb	27 to 29	37	50	37

mark must add
 up to 100 ✓

ie 1 mark for each atomic structure; 1 for % compositions.

$$A_r = \frac{(85 \times 72) + (87 \times 28)}{100} / 85.56 \quad \checkmark$$

= 85.6 ✓ 2nd mark for significant figures

2

$$71/29: 85.58 = 85.6$$

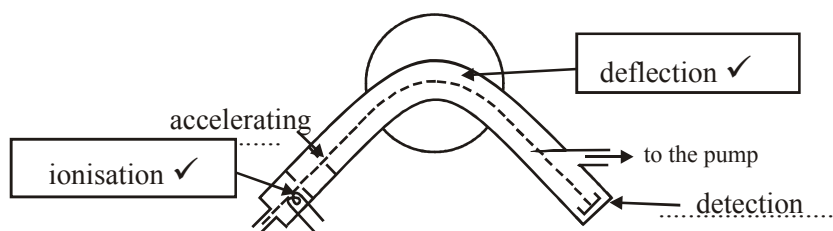
$$73/27: 85.54 = 85.5$$

- (c) carbon-12/ ^{12}C ✓

1

[7]

8. (i)



	protons	neutrons	electrons	
^{25}Mg	12	13	12	✓
^{26}Mg	12	14	12	✓

- (ii) $1s^2 2s^2 2p^6 3s^2$ ✓
 $24 \times 78.60/100 + 25 \times 10.11/100 + 26 \times 11.29/100$ ✓ 1
- (iii) = 24.33 ✓ (calc value: 24.3269. This scores one mark)
 24.32 with no working, award 1 mark only.
 24.3 with no working, no marks (Periodic Table value) 2

[5]

9. (i) (atoms of) same element/same atomic number/number of protons with different numbers of neutrons/diff masses ✓ 1

(ii)

	proton	neutron	electron	
relative mass	1	1	$\frac{1}{1840}$ /	negligible ✓
relative charge	+1	0	0	-1 ✓

*i.e. 1 mark for each correct row
 for electron, accept 1/1500 – 1/2000
 for charges, accept +; 0; –*

2

[3]

10. (i) average **atomic** mass/weighted mean/average mass ✓
 compared with carbon-12 ✓
 1/12th of mass of carbon-12/on a scale where carbon-12 is 12 ✓
 OR

- (ii) The mass of 1 mole of **atoms** of an element
 compared with 12 g ✓ of carbon-12 ✓ 3

$$A_r = \frac{(121 \times 57.21) + (123 \times 42.79)}{100} / 121.8558 \checkmark$$

$$= 121.9 \checkmark \quad 2$$

[5]

11.

isotope	protons	neutrons	electrons
¹² C	6	6	6
¹³ C	6	7	6

✓
✓

[2]

12. (i) mass spectrometry ✓ 1
 (ii) mass of an isotope compared with carbon-12 ✓
 1/12th of mass of carbon-12/on a scale where carbon-12 is 12 ✓ 2

mass of 1 mole of the isotope/mass of 1 mole of carbon-12 is equivalent to the first mark
“mass of the isotope that contains the same number of atoms as are in 1 mole of carbon-12” → 1 mark (mark lost because of mass units)

- (iii) $12 \times 95/100 + 13 \times 5/100$ OR 12.05 ✓
 = 12.1 (mark for significant figures) ✓
 (12.1 scores both marks) 2

[5]

13. (a) (i) atoms of same element/same atomic number..... with different numbers of neutrons/different masses ✓ 1
 (ii) isotope protons neutrons electrons 2
- | | | | |
|------------------|----|----|------|
| ⁴⁶ Ti | 22 | 24 | 22 ✓ |
| ⁴⁷ Ti | 22 | 25 | 22 ✓ |

$$(b) \quad A_r = \frac{(46 \times 8.9) + (47 \times 9.8) + (48 \times 81.3)}{100} / 47.724 \quad \checkmark$$

$$= 47.7 \quad \checkmark$$

2

[5]

14. (i) ^{79}Br has two \checkmark less neutrons than ^{81}Br \checkmark

2

(ii) ^{79}Br have same numbers of protons \checkmark
and same number of electrons \checkmark

2

[4]

15. isotope	protons	neutrons	electrons
nickel-58	28	30	28
nickel-60	28	32	28
nickel-62	28	34	28
	\checkmark	\checkmark	\checkmark

For ecf, 3rd column same as first column.

[3]

16. (i) mass spectrometry \checkmark

mass spec... /mass spectrometer should also be credited

1

(ii) average mass/weighted mean mass **of an atom** \checkmark
compared with carbon-12 \checkmark

1/12th of mass of carbon-12/on a scale where carbon-12 is 12 \checkmark

mass of 1 mole of atoms (of an element) mass of 1 mole of carbon-12 is equivalent to first two marks

3

"mass of the element that contains the same number of atoms as are in 1 mole of carbon-12" → 2 marks (mark lost because of mass units)

(iii) $63.0 \times 77.2/100 + 65.0 \times 22.8/100 / 63.456 \quad \checkmark$

2

= 63.5 (mark for significant figures) \checkmark

(iv) copper/ Cu \checkmark

1

[7]