

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:

mass of the isotope

mass of 1/12th 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.'

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 12C **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

$$71/29: 85.58 = 85.6$$

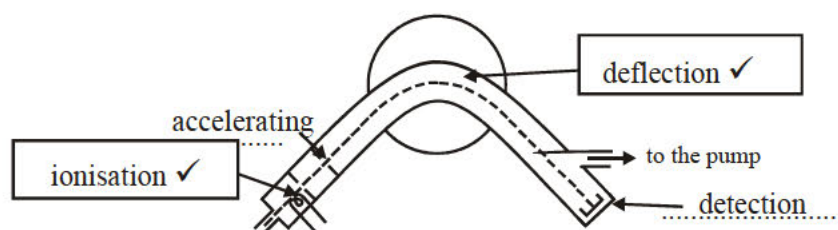
$$73/27: 85.54 = 85.5$$

- (c) carbon-12/ ^{12}C ✓

1

[7]

8. (i)



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

2

(ii) $1s^2 2s^2 2p^6 3s^2$ ✓

$$24 \times 78.60/100 + 25 \times 10.11/100 + 26 \times 11.29/100 \text{ ✓}$$

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	-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 ✓

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

$$= 121.9 \checkmark$$

3

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 |
|------------------|---------|----------|-----------|
| ^{46}Ti | 22 | 24 | 22 ✓ |
| ^{47}Ti | 22 | 25 | 22 ✓ |

2

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

$$= 47.7 \quad \checkmark$$

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
"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)

3

(iii) $63.0 \times 77.2/100 + 65.0 \times 22.8/100 / 63.456 \quad \checkmark$
 $= 63.5$ (mark for significant figures) $\checkmark$

2

(iv) copper/ Cu $\checkmark$

1

[7]