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:

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

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.'*

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:

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

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.'*

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 $1/12^{th}$ (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 $1/12^{th}$ ✓
(the mass) of ***one mole*** */ 12 g of carbon-12* ✓

mass of one mole of atoms ✓

$1/12^{th}$ ✓ *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) $(1s^2)2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^5$ **(1)** 1

[4]

6. Molar mass of anhydrous calcium nitrate = 164.1 g mol^{-1} **(1)**
Ratio $Ca(NO_3)_2 : H_2O = 69.50/164.1 : 30.50/18$
or 0.4235 : 1.694 or 1 : 4 **(1)**
Formula = $Ca(NO_3)_2 \cdot 4H_2O$ **(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.

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

= 85.6 ✓ 2nd mark for significant figures 2

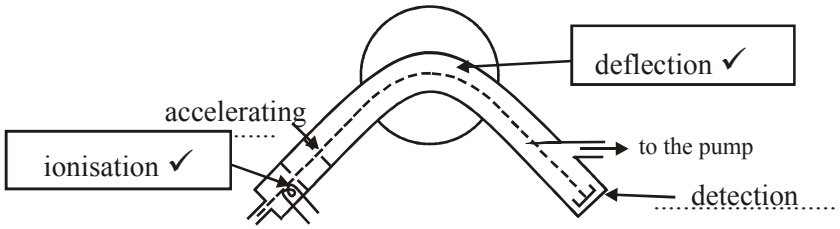
71/29: 85.58 = 85.6

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) $1s^2 2s^2 2p^6 3s^2$✓

$24 \times 78.60/100 + 25 \times 10.11/100 + 26 \times 11.29/100$✓ 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 ✓ 3

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

= 121.9 ✓ 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 × 95/100 + 13 × 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) $A_r = \frac{(46 \times 8.9) + (47 \times 9.8) + (48 \times 81.3)}{100} / 47.724$ ✓

= 47.7 ✓ 2

[5]

14. (i) ^{79}Br has two ✓ less neutrons than ^{81}Br ✓ 2

(ii) ^{79}Br have same numbers of protons ✓
and same number of electrons ✓ 2

[4]

15.

isotope	protons	neutrons	electrons
nickel-58	28	30	28
nickel-60	28	32	28
nickel-62	28	34	28
	✓	✓	✓

For ecf, 3rd column same as first column.

[3]

16. (i) mass spectrometry ✓
mass spec… /mass spectrometer should also be credited 1

(ii) average mass/weighted mean mass **of an atom** ✓
compared with carbon-12 ✓
1/12th of mass of carbon-12/on a scale where carbon-12 is 12 ✓
*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 × 77.2/100 + 65.0 × 22.8/100 / 63.456 ✓ 2
= 63.5 (mark for significant figures) ✓

(iv) copper/ Cu ✓ 1

[7]