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2002

XVIII

1583

Time allowed
84 Minutes

Score

/70

Percentage

%

CHEMISTRY

**OCR
AS & A LEVEL**

Mark Schemes

Module 2: Foundations in chemistry

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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

$$152.0446 \text{ (calculator value) } \checkmark$$

$$A_r = 152.04 \checkmark$$

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 \checkmark

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 \checkmark

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:

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

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 $1/12^{\text{th}}$ (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.

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

$$= 85.6 \quad \checkmark \quad \text{2nd mark for significant figures}$$

2

$$71/29: 85.58 = 85.6$$

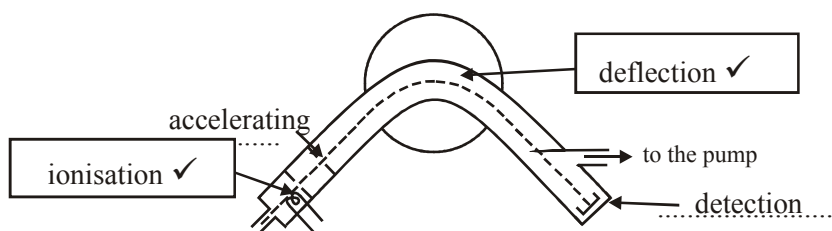
$$73/27: 85.54 = 85.5$$

- (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
"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]