

Isotopes, Mass Spec & RAM/ RMM

Question Paper

Level	International A Level
Subject	Chemistry
Exam Board	Edexcel
Topic	The Core Principles of Chemistry
Sub Topic	Isotopes, Mass Spec & RAM/RMM
Booklet	Question Paper

Time Allowed: 59 minutes

Score: /49

Percentage: /100

Grade Boundaries:

A*	A	B	C	D	E	U
>85%	77.5%	70%	62.5%	57.5%	45%	<45%

- 1 Which row in the table shows the number of protons, neutrons and electrons in a fluoride ion, F⁻?

Use the Periodic Table as a source of data.

	Protons	Neutrons	Electrons
<input type="checkbox"/> A	8	9	9
<input type="checkbox"/> B	9	9	10
<input type="checkbox"/> C	9	10	9
<input type="checkbox"/> D	9	10	10

(Total for Question 1 = 1 mark)

- 2 A sample of oxygen contains the isotopes ¹⁶O, ¹⁷O, ¹⁸O.

How many peaks would there be for the O₂⁺ ions in the mass spectrum of this sample of oxygen?

- A 3
- B 5
- C 6
- D 9

(Total for Question 2 = 1 mark)

3 Ions are separated in the mass spectrometer by

- A a vacuum pump.
- B a magnetic field.
- C an ionization chamber.
- D electron bombardment.

(Total for Question 3 = 1 mark)

4 Which of the following contains one mole of neutrons?

- A 1 g of ${}^1_1\text{H}$
- B 1 g of ${}^{12}_6\text{C}$
- C 2 g of ${}^{24}_{12}\text{Mg}$
- D 2 g of ${}^{22}_{10}\text{Ne}$

(Total for Question 4 = 1 mark)

5 Which of the following species has 50 neutrons?

- A ${}^{50}_{23}\text{V}$
- B ${}^{86}_{37}\text{Rb}^{-}$
- C ${}^{89}_{39}\text{Y}^{+}$
- D ${}^{91}_{40}\text{Zr}^{+}$

(Total for Question 5 = 1 mark)

6 Which of the following statements is correct about **all** isotopes of an element? They have

- A the same mass number.
- B the same number of neutrons.
- C more protons than neutrons.
- D the same electronic configuration.

(Total for Question 6 = 1 mark)

7 The element rhenium has two naturally-occurring isotopes, ${}^{185}\text{Re}$ and ${}^{187}\text{Re}$. The relative atomic mass of rhenium is 186.2.

From this information, the percentage abundances of these two isotopes are

- A 12% ${}^{185}\text{Re}$ and 88% ${}^{187}\text{Re}$
- B 40% ${}^{185}\text{Re}$ and 60% ${}^{187}\text{Re}$
- C 60% ${}^{185}\text{Re}$ and 40% ${}^{187}\text{Re}$
- D 88% ${}^{185}\text{Re}$ and 12% ${}^{187}\text{Re}$

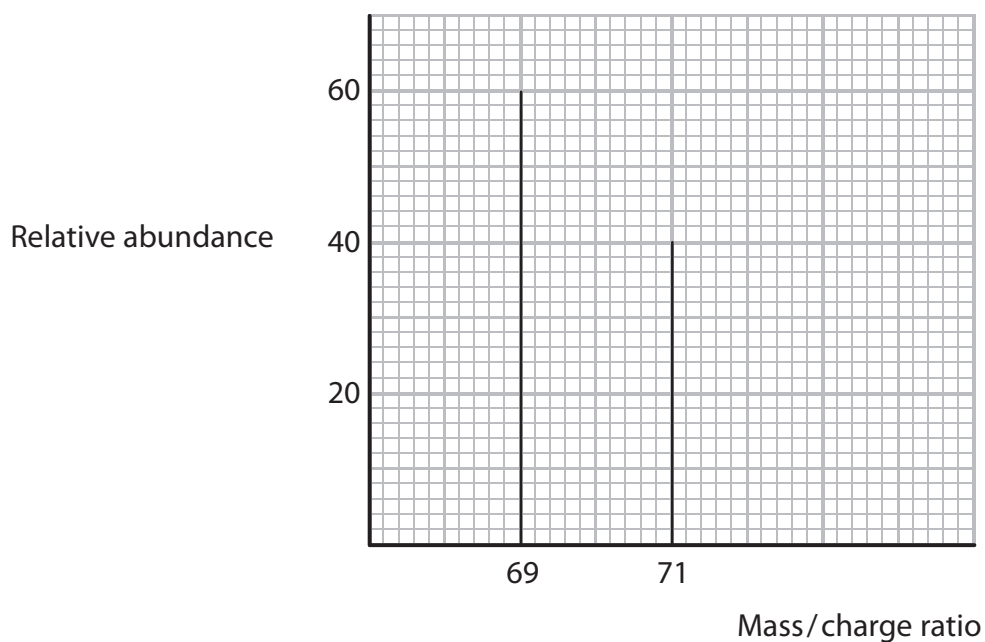
(Total for Question 7 = 1 mark)

8 Which of the following ions would be deflected **least** in a mass spectrometer?

- A $^{35}\text{Cl}^+$
- B $^{35}\text{Cl}^{2+}$
- C $^{37}\text{Cl}^+$
- D $^{37}\text{Cl}^{2+}$

(Total for Question 8 = 1 mark)

9 The mass spectrum of an element is shown below.



The relative atomic mass of the element is

- A 69.4
- B 69.8
- C 70.0
- D 70.2

(Total for Question 9 = 1 mark)

10 In a mass spectrometer, positive ions are accelerated by

- A** bombarding them with fast-moving electrons.
- B** bombarding them with fast-moving protons.
- C** passing them between charged plates.
- D** passing them through a magnetic field.

(Total for Question 10 = 1 mark)

11 This question is about isotopes, and the use of mass spectrometry to detect their presence and measure their abundance.

(a) Boron has two naturally occurring isotopes, ^{10}B and ^{11}B .

(i) A sample of boron contained 13.9% of isotope ^{10}B and 86.1% of isotope ^{11}B . Calculate the relative atomic mass of boron in this sample. Give your answer to **three** significant figures.

(2)

(ii) Complete the following definition of relative atomic mass.

(1)

The relative atomic mass is the weighted mean mass of an atom of an element

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(iii) Boron-12 is a short-lived radioactive isotope.

Name the subatomic particles in an atom of boron-12 and give the number of each.

(2)

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- (b) (i) A mass spectrometer operates under a vacuum. Suggest the effect on the ions in a mass spectrometer if particles from the air were present.

(1)

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- (ii) Suggest how, if at all, the electric field in the mass spectrometer would affect molecules that are **not** ionised.

(1)

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- *(iii) The reaction of ethene with aqueous potassium manganate(VII), KMnO_4 , produces ethane-1,2-diol, $\text{CH}_2\text{OHCH}_2\text{OH}$.

Data: molar mass of ethane-1,2-diol = 62 g mol^{-1}

In an experiment, KMnO_4 containing only ^{18}O reacts with ethene. Suggest how the mass spectrum of ethane-1,2-diol data could be used to decide whether the oxygen atoms in ethane-1,2-diol came from the manganate(VII) ion, water, or a combination of the two.

(2)

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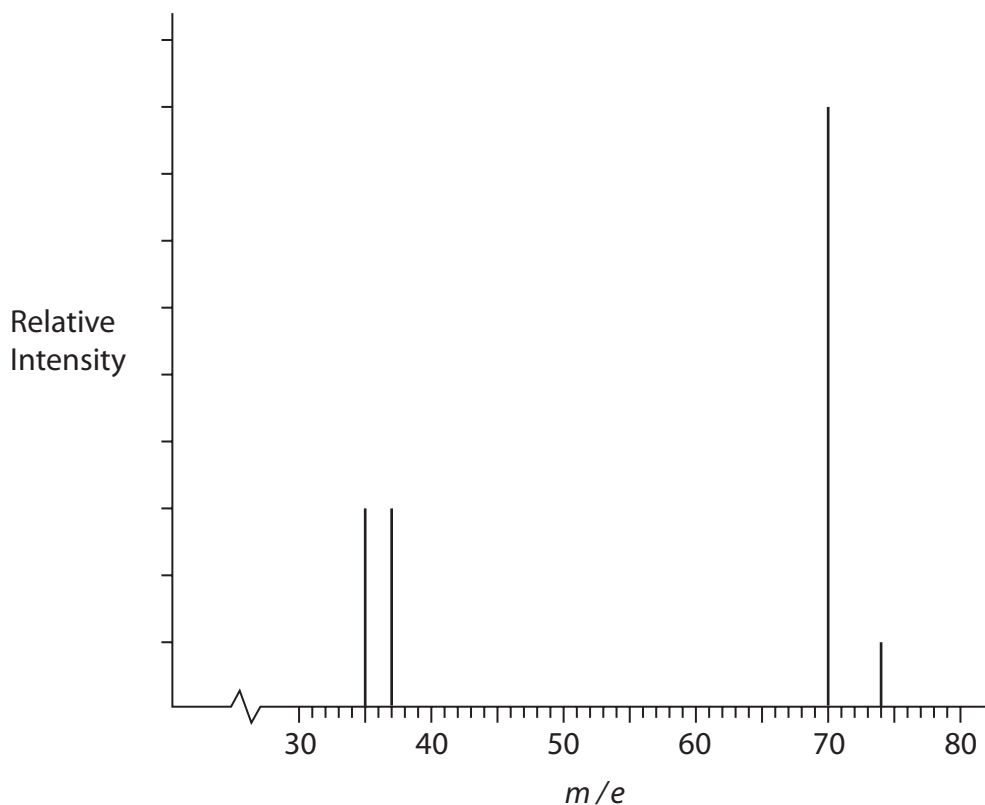
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- (c) A student sketched the mass spectrum of chlorine gas which contained 75% of the ^{35}Cl isotope and 25% of the ^{37}Cl isotope.



- (i) Identify and correct the **two** errors made by the student in this sketch.

(2)

Error 1

Correction 1

Error 2

Correction 2

- (ii) Give the formula of the ion responsible for the peak with $m/e = 74$, showing the isotope(s) present.

(1)

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(Total for Question 11 = 12 marks)

12 (a) The relative atomic masses of elements can be determined using a mass spectrometer.

(i) Define the term **relative atomic mass**.

(3)

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(ii) Describe fully how positive ions are formed from gaseous atoms in a mass spectrometer.

(2)

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(iii) The following data were obtained from the mass spectrum of a sample of strontium.

Mass / charge ratio	% abundance
84.0	0.56
86.0	9.86
87.0	7.02
88.0	82.56

Calculate the relative atomic mass of strontium in this sample.

Give your answer to **three** significant figures.

(2)

(b) In which block of the Periodic Table is strontium found?

(1)

(c) Draw the dot and cross diagram for strontium chloride.

Show **outer** electrons only.

(2)

(d) A solution of strontium nitrate was prepared from strontium oxide and dilute nitric acid.

Write the equation for this reaction, including state symbols.

(2)

(e) A compound of strontium contains 49.9% strontium, 13.7% carbon and 36.4% oxygen, by mass.

Calculate the empirical formula for this compound.

[Use relative atomic masses: Sr = 87.6, C = 12.0, O = 16.0]

(3)

13 A model of the atom describes a nucleus containing protons and neutrons surrounded by electrons in energy levels.

(a) Complete the table below.

(3)

Sub-atomic particle	Relative mass	Relative charge
proton		
neutron		
electron		

(b) State, in terms of the sub-atomic particles present, the meaning of the term **isotopes**.

(2)

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(c) The element rubidium exists as the isotopes ^{85}Rb and ^{87}Rb .

(i) Explain how gaseous atoms of rubidium are ionized in a mass spectrometer.

(2)

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(ii) In a sample of rubidium, the isotope ^{85}Rb has an abundance 2.5 times greater than that of ^{87}Rb .

Calculate the relative atomic mass of rubidium in this sample. Give your answer to **one** decimal place.

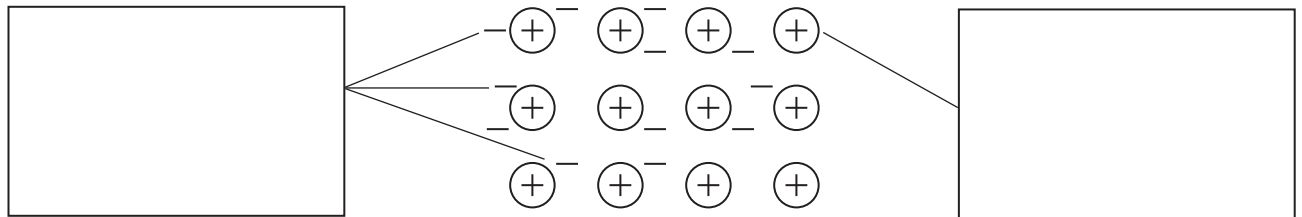
(3)

Relative atomic mass =

(d) The diagram below illustrates a model of the metallic bonding in rubidium.

Write appropriate labels in the two empty boxes in order to complete the diagram.

(2)



(Total for Question 13 = 12 marks)