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
☒ **A**	8	9	9
☒ **B**	9	9	10
☒ **C**	9	10	9
☒ **D**	9	10	10

(Total for Question 1 = 1 mark)

2 A sample of oxygen contains the isotopes ^{16}O, ^{17}O, ^{18}O.

How many peaks would there be for the O_2^+ 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)

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4 Which of the following contains one mole of neutrons?

- ☒ **A** 1 g of $^{1}_{1}H$
- ☒ **B** 1 g of $^{12}_{6}C$
- ☒ **C** 2 g of $^{24}_{12}Mg$
- ☒ **D** 2 g of $^{22}_{10}Ne$

(Total for Question 4 = 1 mark)

5 Which of the following species has 50 neutrons?

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

(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}Re and ^{187}Re. The relative atomic mass of rhenium is 186.2.

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

- ☒ **A** 12% ^{185}Re and 88% ^{187}Re
- ☒ **B** 40% ^{185}Re and 60% ^{187}Re
- ☒ **C** 60% ^{185}Re and 40% ^{187}Re
- ☒ **D** 88% ^{185}Re and 12% ^{187}Re

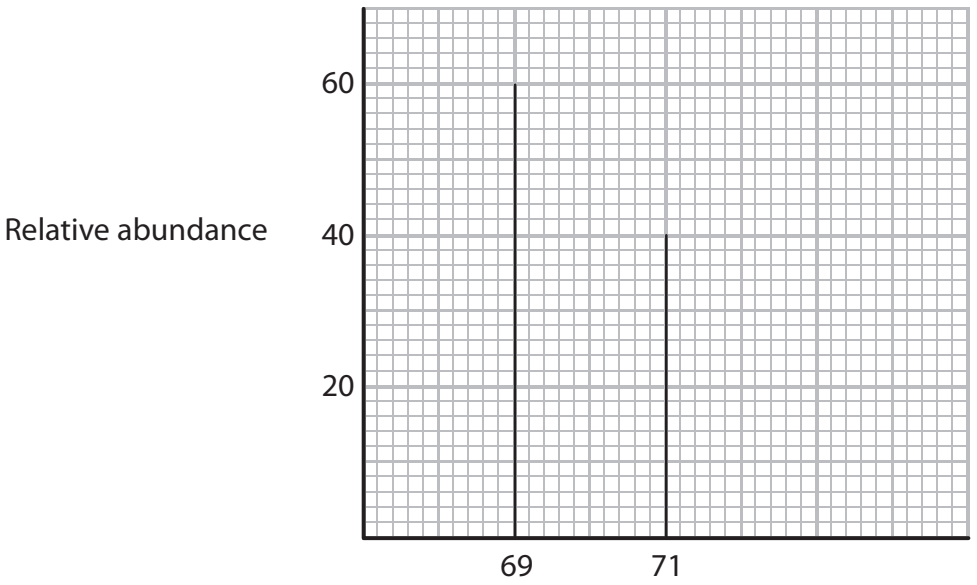
(Total for Question 7 = 1 mark)

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

- ☒ **A** $^{35}Cl^{+}$
- ☒ **B** $^{35}Cl^{2+}$
- ☒ **C** $^{37}Cl^{+}$
- ☒ **D** $^{37}Cl^{2+}$

(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, CH_2OHCH_2OH.

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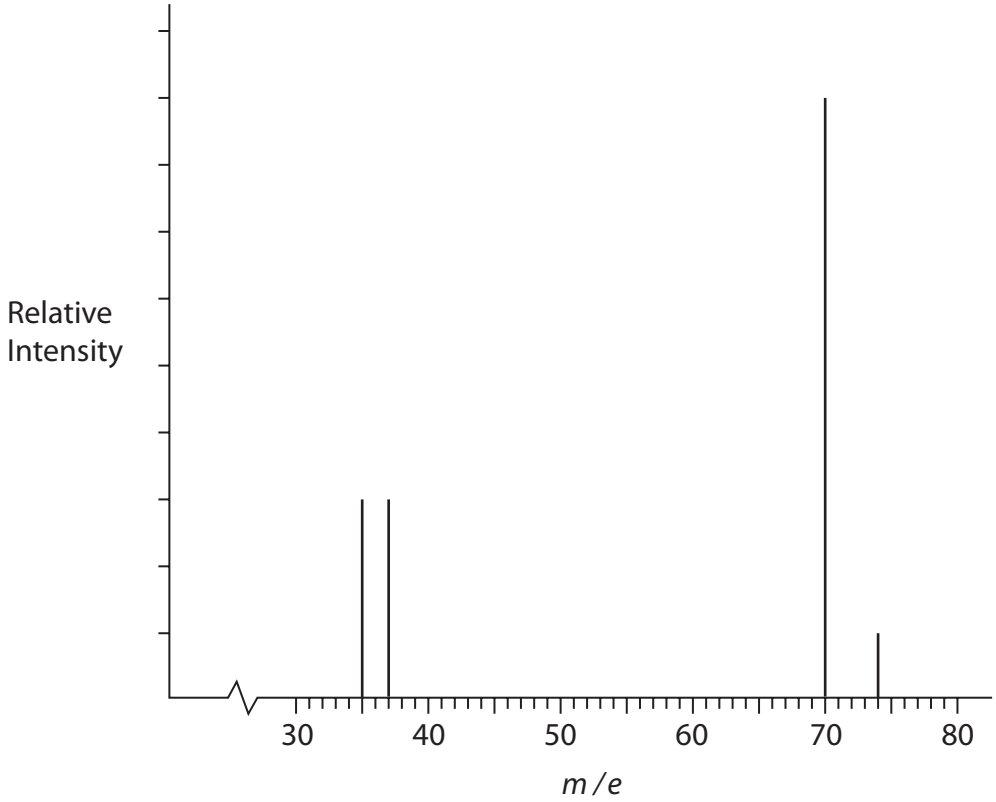
(c) A student sketched the mass spectrum of chlorine gas which contained 75% of the ^{35}Cl isotope and 25% of the ^{37}Cl isotope.



(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)

.....

(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)

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

(2)

(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)

(Total for Question 12 = 15 marks)

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.

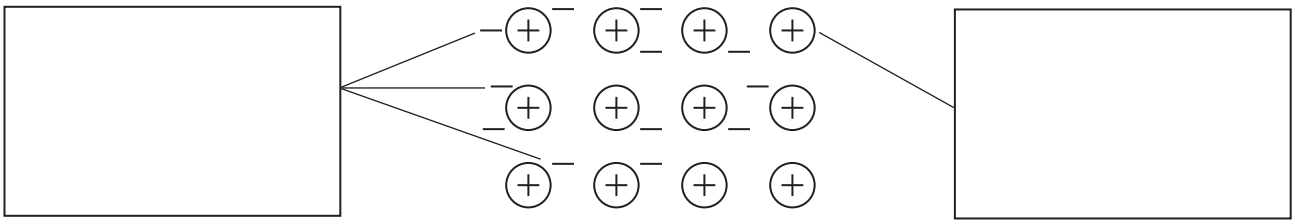
(3)

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)