Mass Number and Isotopes

Question paper 1

Level	A Level
Subject	Chemistry
Exam Board	AQA
Module	3.1 Physical Chemistry
Topic	3.1.1 Atomic Structure
Sub-Topic	3.1.1.2 Mass Number and Isotopes
Booklet	Question Paper 1

Time Allowed: **60 minutes**

Score: **/57**

Percentage: **/100**

Grade Boundaries:

A*	A	B	C	D	E	U
>85%	75%	70%	60%	55%	50%	<50%

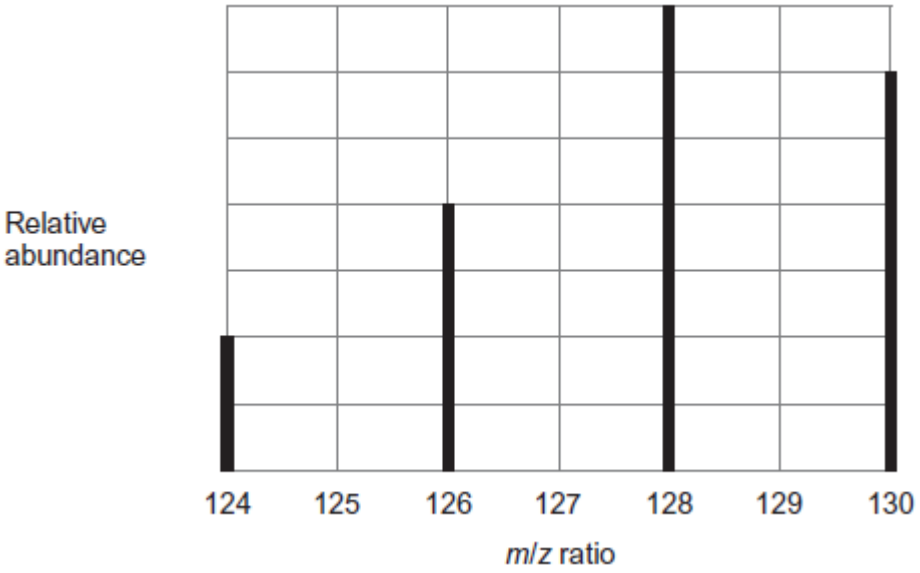
Q1. Tellurium is the element with atomic number of 52

(a) Using information from the Periodic Table, complete the electron configuration of tellurium.

[Kr] .....

(1)

(b) The mass spectrum of a sample of tellurium is shown in the graph.



(i) Use the graph to calculate the relative atomic mass of this sample of tellurium. Give your answer to one decimal place.

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(3)

(ii) Suggest what might cause the relative atomic mass of this sample to be different from the relative atomic mass given in the Periodic Table.

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(1)

(c) Write an equation for the reaction that occurs when a tellurium ion hits the detector.

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(1)

(d) State the *m* / *z* value of the ions that produce the biggest current at the detector when the spectrum in the graph is recorded.
Give a reason for your answer.

m / *z* value .....

Reason .....

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(2)

(e) The mass spectrum of tellurium also has a small peak at *m* / *z* = 64

Explain the existence of this peak.

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(2)

(f) Predict whether the atomic radius of ^{124}Te is larger than, smaller than or the same as the atomic radius of ^{130}Te
Explain your answer.

Atomic radius of ^{124}Te compared to ^{130}Te .....

Explanation .....

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(2)
(Total 12 marks)

Q2.(a) A sample of sulfur consisting of three isotopes has a relative atomic mass of 32.16. The following table gives the relative abundance of two of these isotopes.

Mass number of isotope	32	33
Relative abundance / %	91.0	1.8

Use this information to determine the relative abundance and hence the mass number of the third isotope.
Give your answer to the appropriate number of significant figures.

Mass number = ...

(4)

(b) Describe how ions are formed in a time of flight (TOF) mass spectrometer.

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(2)

(c) A TOF mass spectrometer can be used to determine the relative molecular mass of molecular substances.

Explain why it is necessary to ionise molecules when measuring their mass in a TOF mass spectrometer.

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(2)
(Total 8 marks)

Q3. Which of these atoms has the smallest number of neutrons?

A ^{3}H ⬭

B ^{4}He ⬭

C ^{5}He ⬭

D ^{4}Li ⬭

(Total 1 mark)

Q4.(a) State the meaning of the term *mass number* of an isotope.

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(1)

(b) Give the symbol of the element that has an isotope with a mass number of 68 and has 38 neutrons in its nucleus.

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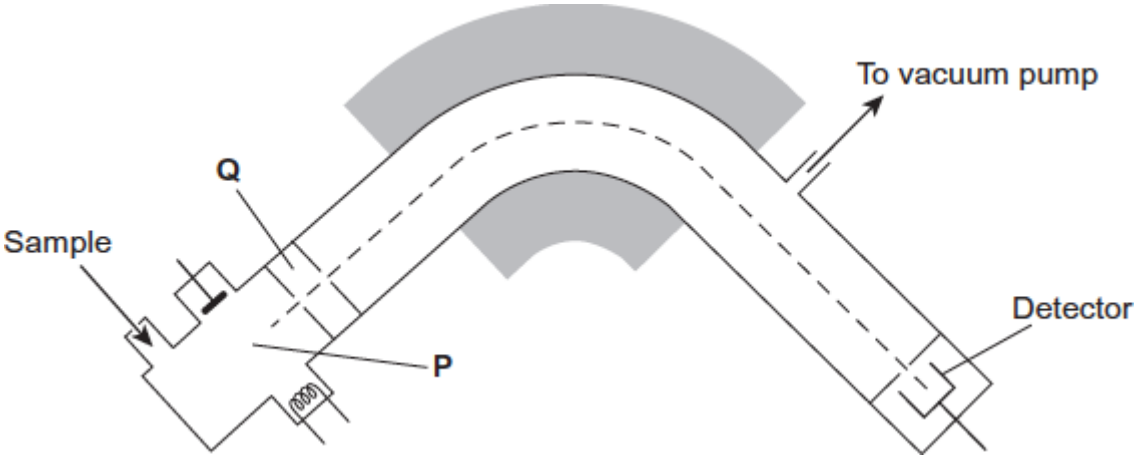
(1)

(c) The following shows a simplified diagram of a mass spectrometer.



(i) State what happens to the sample in the parts labelled **P** and **Q**.

P .....

Q .....

(2)

(ii) In a mass spectrometer, the isotopes of an element are separated.
Two measurements for each isotope are recorded on the mass spectrum.

State the **two** measurements that are recorded for each isotope.

Measurement 1 .....

Measurement 2 .....

(2)

(d) A sample of element **R** contains isotopes with mass numbers of 206, 207 and 208 in a 1:1:2 ratio of abundance.

(i) Calculate the relative atomic mass of **R**. Give your answer to one decimal place.

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(3)

(ii) Identify **R**.

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(1)

(iii) All the isotopes of **R** react in the same way with concentrated nitric acid.

State why isotopes of an element have the same chemical properties.

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(Extra space) .....

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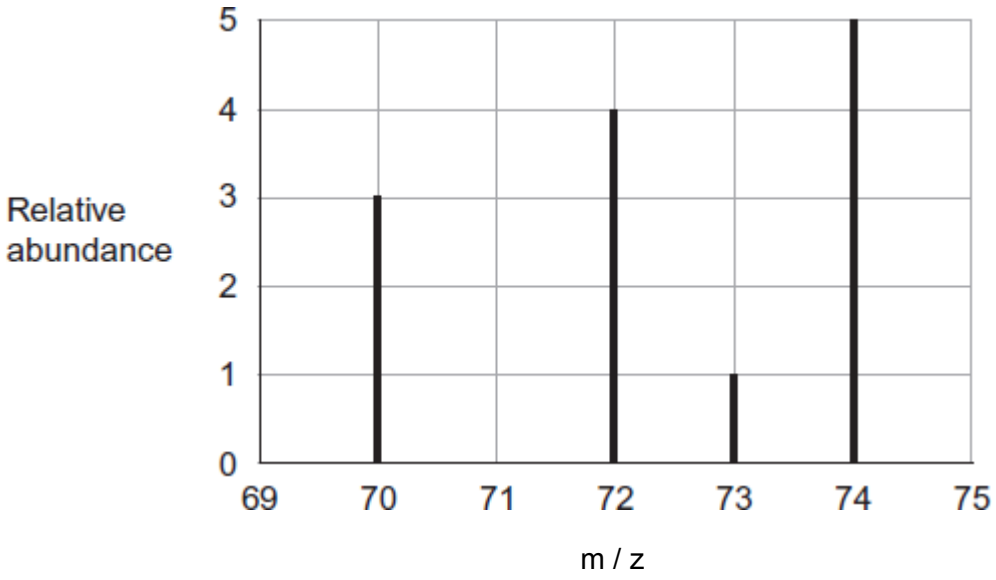
(1)

(Total 11 marks)

Q5. The mass spectrum of the isotopes of element **X** is shown in the diagram.



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

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(2)

(b) Use data from the diagram to calculate the relative atomic mass of **X**.

Give your answer to one decimal place.

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(3)

(c) Identify the ion responsible for the peak at 72

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(1)

(d) Identify which one of the isotopes of **X** is deflected the most in the magnetic field of a mass spectrometer. Give a reason for your answer.

Isotope .....

Reason .....

(2)

(e) In a mass spectrometer, the relative abundance of each isotope is proportional to the current generated by that isotope at the detector.

Explain how this current is generated.

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(2)

(f) **X** and **Zn** are different elements.

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Explain why the chemical properties of ^{70}**X** and ^{70}**Zn** are different.

(1)

(Total 11 marks)

Q6. A sample of ethanedioic acid was treated with an excess of an unknown alcohol in the presence of a strong acid catalyst. The products of the reaction were separated and analysed in a time of flight (TOF) mass spectrometer. Two peaks were observed at m / z = 104 and 118.

(a) Identify the species responsible for the two peaks.

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(2)

(b) Outline how the TOF mass spectrometer is able to separate these two species to give two peaks.

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(4)

(Total 6 marks)

Q7.(a) **Table 1** shows some data about fundamental particles in an atom.

Table 1

Particle	proton	neutron	electron
Mass / g	1.6725×10^{-24}	1.6748×10^{-24}	0.0009×10^{-24}

(i) An atom of hydrogen can be represented as ^{1}H

Use data from **Table 1** to calculate the mass of this hydrogen atom.

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(1)

(ii) Which **one** of the following is a fundamental particle that would **not** be deflected by an electric field?

A electron

B neutron

C proton

Write the correct letter, **A**, **B** or **C**, in the box.

(1)

(b) A naturally occurring sample of the element boron has a relative atomic mass of 10.8.
In this sample, boron exists as two isotopes, ^{10}B and ^{11}B

(i) Calculate the percentage abundance of ^{10}B in this naturally occurring sample of boron.

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(2)

(ii) State, in terms of fundamental particles, why the isotopes ^{10}B and ^{11}B have similar chemical reactions.

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(1)

(c) Complete **Table 2** by suggesting a value for the third ionisation energy of boron.

Table 2

	First	**Second**	**Third**	**Fourth**	**Fifth**
Ionisation energy / kJ mol^{-1}	799	2420		25 000	32 800

(1)

(d) Write an equation to show the process that occurs when the **second** ionisation energy of boron is measured. Include state symbols in your equation.

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(1)

(e) Explain why the second ionisation energy of boron is higher than the first ionisation energy of boron.

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(1)
(Total 8 marks)