Questions

Q1.

This question is about the structure of the atom and isotopes.

The following excerpt is taken from the book *Inorganic Chemistry* by Bailey and Snellgrove, fourth impression 1938.

> "Some of the electrons are also contained in the nucleus, whilst the remainder are ..... arranged in rings revolving round the nucleus ..... The two isotopes [of chlorine] have therefore 18 and 20 electrons respectively in the nucleus and 17 [electrons] external to it."

(a) Identify and correct **two** errors in the excerpt.

(2)

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(b) What is the structure of a 1+ ion of the carbon-13 isotope?

(1)

- ☒ **A** six protons, six neutrons and five electrons
- ☒ **B** six protons, seven neutrons and six electrons
- ☒ **C** six protons, seven neutrons and five electrons
- ☒ **D** seven protons, six neutrons and six electrons

Q2.

Bromine exists as two stable isotopes. The two isotopes are represented by the symbols $^{79}_{35}Br$ and $^{81}_{35}Br$.

Give one similarity and one difference between these two isotopes by referring to the **number of particles** in the nuclei of the two isotopes.

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(Total for question = 2 marks)

Q3.

This is a question about atoms, isotopes and ions.

The percentage composition of the two bromine isotopes in a sample is given in the table.

Isotope	Relative isotopic mass	Percentage abundance
bromine-79	78.918	50.52
bromine-81	80.916	49.48

Calculate the relative atomic mass of bromine in this sample.
Give your answer to two decimal places.

(2)

(Total for question = 2 marks)

Q4.

This question is about magnesium.

The relative atomic mass of a sample of magnesium was found to be 24.3. The percentage composition for two of the three isotopes is given in the table. Use these data to calculate the percentage composition of the third isotope and hence its relative isotopic mass. Give your answer to an appropriate number of significant figures. You **must** show your working.

Relative isotopic mass	Percentage abundance
25.0	10.00
26.0	11.01

(4)

Q5.

(i) State what is meant by the term **relative atomic mass**.

(2)

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(ii) A 5.000 g sample of lithium, containing the two isotopes lithium-6 and lithium-7, was found to contain 0.460 g of the isotope lithium-6.

Calculate the relative atomic mass of lithium for this sample. Give your answer to an appropriate number of significant figures.

Isotope	Relative isotopic mass
Lithium-6	6.015
Lithium-7	7.016

(3)

(Total for question = 5 marks)

Q6.

Bromine exists as two stable isotopes. The two isotopes are represented by the symbols $^{79}_{35}Br$ and $^{81}_{35}Br$.

The relative abundance of the two isotopes in a sample cannot be found in a chemical test.

(i) Give the reason why, despite the difference in atomic structure, the isotopes have the same chemical reactions.

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(ii) State how the relative abundance of the two isotopes can be found.

(2)

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(Total for question = 3 marks)

Q7.

A phosphorus atom has mass number 31.

Phosphorus has one naturally occurring isotope with mass number 31.
Chlorine exists as two isotopes with mass numbers 35 and 37.

Give the formulae and mass/charge ratio of the ions responsible for the molecular ion peaks in the mass spectrum of phosphorus(III) chloride, PCl_3.

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(Total for question = 2 marks)

Q8.

This question is about atoms, molecules and ions.

The mass spectrum of a diatomic molecule, X_2, has peaks at the following m/z values for the X_2^+ ion:

$$32, \quad 33, \quad 34, \quad 35, \quad 36$$

Deduce the formulae of all the species responsible for **each** of the peaks in the mass spectrum of X_2, identifying element X and showing clearly the isotopes present.

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(Total for question = 3 marks)

Q9.

This question is about hydrogen, the element with atomic number $Z = 1$.

(i) Hydrogen has two stable isotopes, ^1_1H and ^2_1H. Complete the table to show the number of subatomic particles present in the nuclei of these two isotopes of hydrogen.

(1)

Isotope	Number of protons	Number of neutrons
^1_1H		
^2_1H		

(ii) Use the data in the table to explain the term isotopes.

(2)

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(Total for question = 3 marks)

Q10.

This question is about isotopes.

The table shows data for some isotopes of potassium.

Isotope	Relative isotopic mass	Abundance %
^{39}K	38.9637	93.218
^{40}K	39.9340	0.012
^{41}K	40.9618	6.770

(i) State what is meant by the terms 'relative isotopic mass' and 'relative atomic mass'.

(3)

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(ii) State what is meant by the term 'isotopes'. Illustrate your answer by referring to the isotopes of potassium.

(2)

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(iii) Use the data in the table to calculate the relative atomic mass of potassium. Give your answer to 4 significant figures.

(2)

(Total for question = 7 marks)

Q11.

This question is about isotopes.

State, in terms of subatomic particles, what is meant by the term **isotopes**.

(2)

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(Total for question = 2 marks)

Q12.

This question is about chlorine.

Chlorine has two isotopes with mass numbers 35 and 37.

(i) Complete the table to show the numbers of subatomic particles in a ^{35}Cl atom and a $^{37}Cl^-$ ion.

(2)

Particle	Protons	Neutrons	Electrons
^{35}Cl atom			
$^{37}Cl^-$ ion			

(ii) A sample of chlorine contained 75 % of ^{35}Cl and 25 % of ^{37}Cl.

Complete the mass spectrum to show the peaks you would expect for the molecular ion Cl_2^+ from this sample of chlorine gas.

(2)
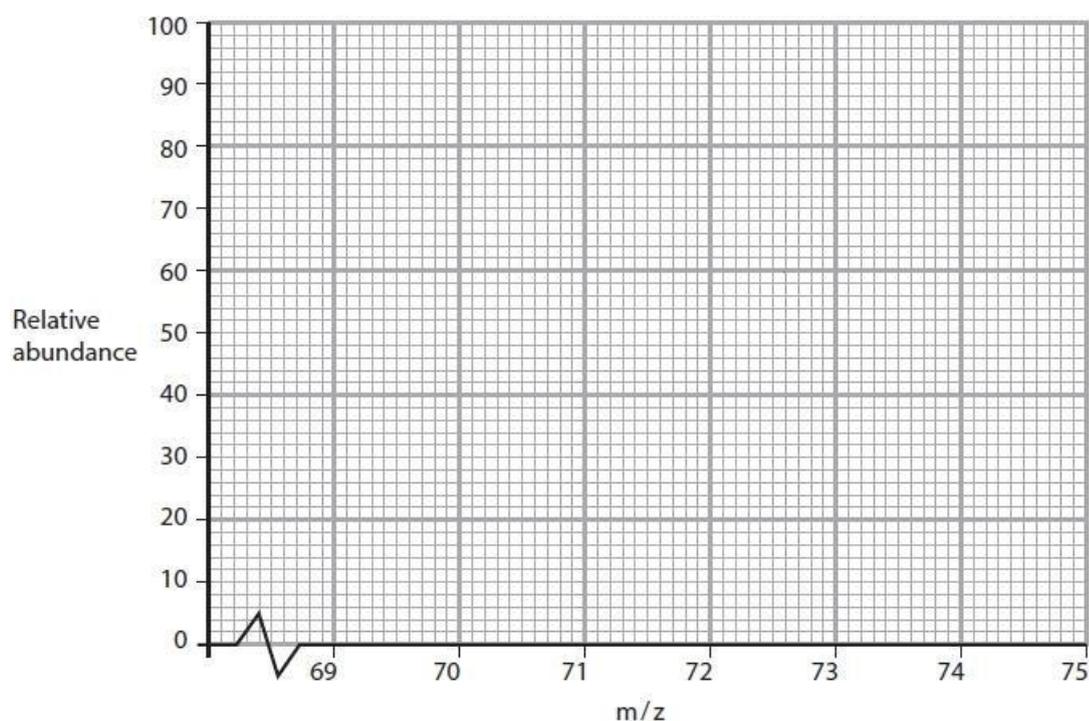
(Total for question = 4 marks)

Q13.

This question is about isotopes.

The element gallium has a relative atomic mass of 69.735 and only contains two isotopes.

A sample of gallium contained the isotope ^{69}Ga, with a relative abundance of 63.25 %.

Calculate the mass number of the other isotope.
You **must** show all your working.

(2)

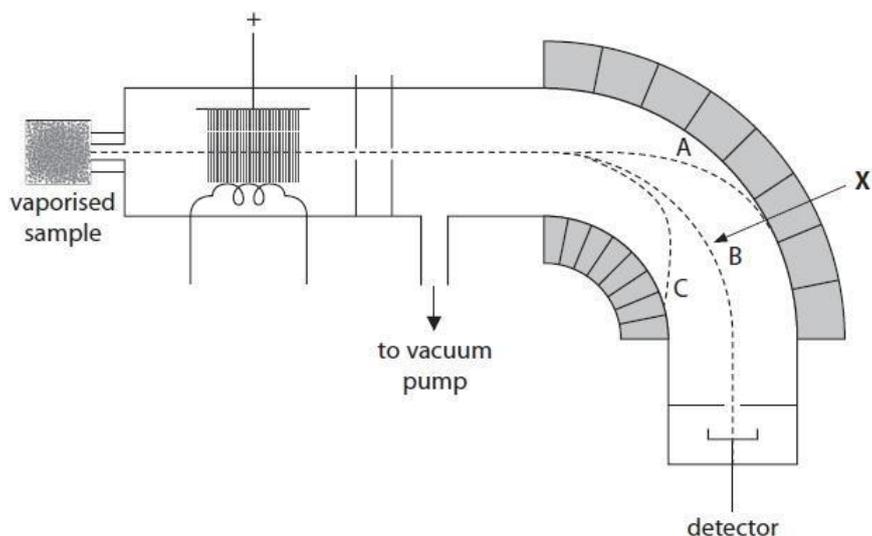**(Total for question = 2 marks)**

Q14.

This question is about isotopes.

The relative isotopic abundances of an element can be measured using a mass spectrometer.

A simplified and incompletely labelled diagram of a mass spectrometer is shown.

(i) Name the feature of the mass spectrometer responsible for the behaviour of the ions in the region indicated by the arrow **X**.

(1)

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(ii) Explain the three ion pathways, A, B and C, shown in the region indicated by the arrow **X**.

(3)

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(iii) Give a reason why the mass spectrometer must be operated under vacuum.

(1)

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(Total for question = 5 marks)

Q15.

This question is about atoms, molecules and ions.

Lithium exists as two isotopes.

Complete the table to show the numbers of subatomic particles in a ^{6}Li **atom** and a ^{7}Li$^+$**ion**.

(2)

Particle	Protons	Neutrons	Electrons
^{6}Li			
^{7}Li$^+$			

(Total for question = 2 marks)

Q16.

This question is about hydrogen, the element with atomic number $Z = 1$.

The relative atomic mass of hydrogen in the Periodic Table is 1.0.
This is correct to two significant figures.

The table gives data for the relative isotopic mass and natural abundance of the two stable isotopes of hydrogen.

Isotope	Relative isotopic mass	Percentage abundance
$^{1}_{1}H$	1.007825	99.9885
$^{2}_{1}H$	2.014101	0.0115

(i) Using the data in the table, give a reason why it can be estimated that the relative atomic mass of hydrogen is greater than 1.0.

(1)

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(ii) Calculate the relative atomic mass of hydrogen from these data, giving your answer to **four** decimal places.

(2)

(Total for question = 3 marks)

Q17.

This question is about magnesium.

Magnesium exists as three stable isotopes. One isotope has a relative isotopic mass of 25.0.

State what is meant by the term **relative isotopic mass**.

(2)

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(Total for question = 2 marks)