



A-Level Chemistry

Fundamental Particles

Question Paper

Time available: 50 minutes

Marks available: 47 marks

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1.

In 1913 Niels Bohr proposed a model of the atom with a central nucleus, made up of protons and neutrons, around which electrons moved in orbits. After further research, the model was refined when the existence of energy levels and sub-levels was recognised.

- (a) Complete the following table for the particles in the nucleus.

Particle	Relative charge	Relative mass
proton		
neutron		

(2)

- (b) State the block in the Periodic Table to which the element tungsten, W, belongs.

(1)

- (c) Isotopes of tungsten include ^{182}W and ^{186}W

- (i) Deduce the number of protons in ^{182}W

(1)

- (ii) Deduce the number of neutrons in ^{186}W

(1)

- (d) In order to detect the isotopes of tungsten using a mass spectrometer, a sample containing the isotopes must be vaporised and then ionised.

- (i) Give **two** reasons why the sample must be ionised.

1. _____

2. _____

(2)

- (ii) State what can be adjusted in the mass spectrometer to enable ions formed by the different isotopes to be directed onto the detector.

(1)

- (e) State and explain the difference, if any, between the chemical properties of the isotopes ^{182}W and ^{186}W

Difference _____

Explanation _____

(2)

- (f) The table below gives the relative abundance of each isotope in the mass spectrum of a sample of tungsten.

m/z	182	183	184	186
Relative abundance / %	26.4	14.3	30.7	28.6

Use the data above to calculate a value for the relative atomic mass of this sample of tungsten. Give your answer to 2 decimal places.

(2)

(Total 12 marks)

2.

In one model of atomic structure, the atom has a nucleus surrounded by electrons in levels and sub-levels.

- (a) Define the term *atomic number*.

(1)

- (b) Explain why atoms of an element may have different mass numbers.

(1)

- (c) The table below refers to a sample of krypton.

Relative m/z	82	83	84	86
Relative abundance / %	12	12	50	26

(i) Name an instrument which is used to measure the relative abundance of isotopes.

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

(iii) Calculate the relative atomic mass of this sample of krypton.

(5)

(d) Give the complete electronic configuration of krypton in terms of s, p and d sub-levels.

(1)

(e) In 1963, krypton was found to react with fluorine. State why this discovery was unexpected.

(1)

(f) Use a suitable model of atomic structure to explain the following experimental observations.

(i) The first ionisation energy of krypton is greater than that of bromine.

(ii) The first ionisation energy of aluminium is less than the first ionisation energy of magnesium.

(4)

(Total 13 marks)

3.

- (a) Complete the following table.

Particle	Relative charge	Relative mass
Proton		
Neutron		
Electron		

(3)

- (b) An atom of element **Z** has two more protons and two more neutrons than an atom of $^{34}_{16}\text{S}$. Give the symbol, including mass number and atomic number, for this atom of **Z**.

(2)

- (c) Complete the electronic configurations for the sulphur atom, S, and the sulphide ion, S^{2-} .

S $1s^2$ _____

S^{2-} $1s^2$ _____

(2)

- (d) State the block in the Periodic Table in which sulphur is placed and explain your answer.

Block _____

Explanation _____

(2)

- (e) Sodium sulphide, Na_2S , is a high melting point solid which conducts electricity when molten. Carbon disulphide, CS_2 , is a liquid which does not conduct electricity.

- (i) Deduce the type of bonding present in Na_2S and that present in CS_2

Bonding in Na_2S _____

Bonding in CS_2 _____

- (ii) By reference to all the atoms involved explain, in terms of electrons, how Na_2S is formed from its atoms.

- (iii) Draw a diagram, including all the outer electrons, to represent the bonding present in CS_2

- (iv) When heated with steam, CS_2 reacts to form hydrogen sulphide, H_2S , and carbon dioxide.
Write an equation for this reaction.

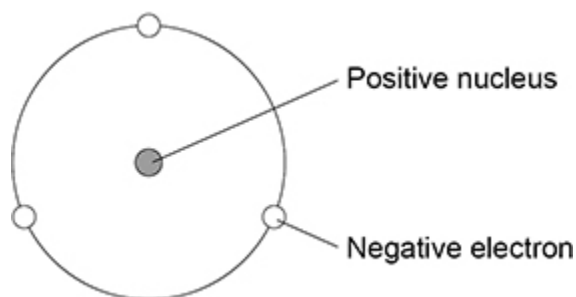
(7)

(Total 16 marks)

4.

This question is about atomic structure.

- (a) The figure below is a model proposed by Rutherford to show the structure of an atom.



State **two** features of the current model that are not shown in the Rutherford model.

Feature 1 of the current model _____

Feature 2 of the current model _____

(2)

- (b) A sample of tin is analysed in a time of flight mass spectrometer. The sample is ionised by electron impact to form $1+$ ions.

The table below shows data about the four peaks in this spectrum.

m/z	Percentage abundance
112	22.41
114	11.78
117	34.97
120	To be determined

Give the symbol, including mass number, of the ion that reaches the detector first.

Calculate the relative atomic mass of tin in this sample. Give your answer to 1 decimal place.

Symbol of ion _____

Relative atomic mass _____

(4)
(Total 6 marks)