

Structured Questions

The Nuclear Atom

Nuclear Model of the Atom / Subatomic Particles / Isotopes

Easy (3 questions)	/17
Medium (3 questions)	/19
Hard (3 questions)	/23
Total Marks	/59

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Easy Questions

1 (a) Deduce the missing information using section 6 of the data booklet, and complete the following table.

Symbol	Protons	Neutrons	Electrons
^{23}Na			
$^{32}\text{S}^{2-}$			
$^{86}\text{Sr}^{2+}$			

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(3 marks)

(b) A sample of Rh contains the following isotopes. Calculate the relative atomic mass of Rh in the sample. Give your answer to 2 dp.

Isotope	% Abundance
^{101}Rh	85
^{102}Rh	15

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(2 marks)

(c) Deduce the number of protons, neutrons and electrons in an atom of ^{102}Rh .

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(2 marks)

- (d)** Give the atomic symbol of an element which has more protons than neutrons. Use its most common isotope.

(1 mark)

2 (a) The atomic mass of each element in the periodic table is based on the carbon-12 scale.

Describe the composition of an atom of carbon-12.

(1 mark)

(b) Carbon also exists as the isotope ^{14}C . How does the composition of this isotope differ from that of carbon-12.

(1 mark)

(c) The relative abundance of isotopes in a sample of carbon is 94% ^{12}C and 6% ^{14}C .

How would this information be obtained.

(1 mark)

(d) Calculate the relative atomic mass of the carbon sample in part c)

(1 mark)

- 3 (a)** Boron contains two isotopes ^{10}B and ^{11}B with a relative abundance of 20% and 80% respectively.

State the difference between these isotopes of boron.

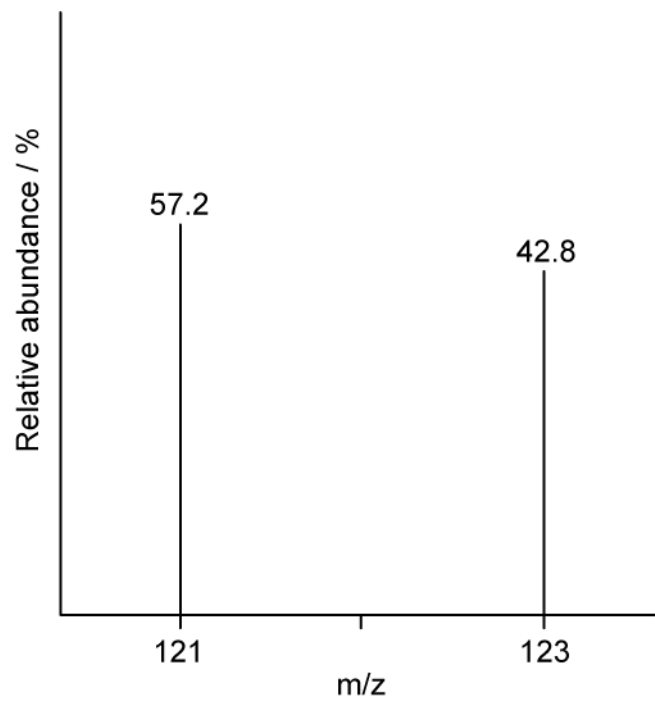
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(1 mark)

- (b)** A sample of antimony was analysed in the mass spectrometer and two main isotopes were found, ^{121}Sb and ^{123}Sb .

Calculate the number of protons and neutrons in both isotopes of antimony.

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(3 marks)

- (c)** The graph represents the mass spectrum of antimony. Use the information in the image to calculate the relative atomic mass of antimony.



(1 mark)

Medium Questions

1 (a) Using your knowledge of atomic structure, complete the table below for the particles found in an atom.

Particle	Relative charge	Relative mass
Proton		
Neutron		
Electron		

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(3 marks)

(b) The actual mass of protons, neutrons and electrons is given.

	Proton	Neutron	Electron
Mass (kg)	1.672622×10^{-27}	1.674927×10^{-27}	9.109383×10^{-31}

Calculate the mass, in g, of a nitrogen molecule.

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(1 mark)

(c) Oxygen consists of three stable isotopes, oxygen-16, oxygen-17, and oxygen-18.

State the particles present in each isotope and outline what differences would be expected in the chemical reactivity of the three isotopes.

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(2 marks)

(d) Suggest why some elements have several isotopes and others, like fluorine, have only one known isotope (known as monoisotopic elements).

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(1 mark)

- 2 (a)** Nitrous oxide is used as a sedative in dentistry and has the formula N_2O . Different sources of N_2O contain different ratios of ^{14}N and ^{15}N .

State the name of the instrument used to distinguish between ^{14}N and ^{15}N and outline two characteristic differences seen in the analysis of ^{14}N and ^{15}N .

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(2 marks)

- (b)** A sample of nitrous oxide was enriched so that it contained 4% by mass of ^{15}N . Calculate the relative molecular mass of the resulting nitrous oxide.

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(2 marks)

- (c)** An atom has twice as many protons, and twice as many neutrons, as an atom of ^{15}N .

Determine the chemical symbol for this atom, including the mass number, and deduce the number of electrons.

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(2 marks)

3 (a) *A* and *B* are different chemical elements, from different groups in the Periodic Table.

State why ${}^m\text{A}$ and ${}^n\text{A}$ have identical chemical properties, but ${}^m\text{A}$ and ${}^p\text{B}$ have different chemical properties.

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(3 marks)

(b) Atoms are made up of three subatomic particles; protons, neutrons and electrons.

Particle	Proton	Neutron	Electron
Mass / kg	1.673×10^{-27}	1.675×10^{-27}	9.000×10^{-31}

Calculate the mass of one atom of carbon in kg.

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(2 marks)

(c) ${}^{12}\text{C}$, ${}^{13}\text{C}$ and ${}^{14}\text{C}$ are all isotopes of carbon.

State the difference between these three isotopes in terms of subatomic particles.

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(1 mark)

Hard Questions

1 (a) Give the full electron configuration of the following atoms and ions.

i) Zinc (II) ion, Zn^{2+}

[1]

ii) Copper (II) ion, Cu^{2+}

[1]

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(2 marks)

(b) Chlorine has two naturally occurring isotopes, ^{35}Cl with a mass of 34.969 and ^{37}Cl with a mass of 36.966. The relative atomic mass of Cl is 35.5. Calculate the percentage abundance of each isotope.

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(3 marks)

(c) Predict whether the atomic radius of ^{35}Cl or ^{37}Cl would be the greater and give a reason for your answer.

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(2 marks)

(d) A sample of cerium, Ce, was analysed in a mass spectrometer. The relative abundances of three of the four main isotopes that were identified are shown in the table below.

A sample of cerium, Ce, has four isotopes that have a known relative abundance. This sample has an A_r of 140.12.

Isotope	^{136}Ce	^{138}Ce	^{140}Ce	^mCe
Abundance (%)	0.19	0.25	88.45	To be calculated

Use the data from the table to calculate m , the mass number and the percentage abundance of isotope ^mCe .

(4 marks)

- 2 (a) A sample of element Z was extracted from a meteorite. The table shows the relative abundance of each isotope in a mass spectrum of this sample of Z. Calculate the relative atomic mass of Z and suggest an identity of Z. Give your answer to 1 d.p.

m/z value	64	66	67	68
Relative abundance (%)	38.9	27.8	14.7	18.6

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(3 marks)

- (b) A naturally occurring sample of the element boron, B, has two isotopes of mass 10 and 11, and a relative atomic mass of 10.8.

Calculate the relative abundances of both isotopes in the sample of boron, B.

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(3 marks)

- (c) Give the full electron configuration of the Cu⁺ ion.

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(1 mark)

- (d) Calculate the percentage abundance of ⁶³Cu with a mass of 62.9296 and ⁶⁵Cu with a mass of 64.9278, when the average mass of the Cu isotope is 63.546. Give your answer to an appropriate number of significant figures.

(3 marks)

3 Outline why the chlorine atom has a smaller atomic radius than the sulfur atom.

(2 marks)