

Atomic Structure

Mark Scheme



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1. Atomic structure is the study of the building blocks of matter and the subatomic particles that make them up. For each of the following questions **circle** the letter of the correct answer.

- a) An atom of lithium has a mass number of 7 and an atomic number of 3.
Which diagram represents a neutral atom of lithium?

A – is the only correct answer.	1 mark
	Total: 1 mark

- b) How many neutrons are in a nucleus of Chlorine-37?

D – is the only correct answer.	1 mark
	Total: 1 mark

- c) The diagram represents a carbon atom. What is the mass number for this atom?

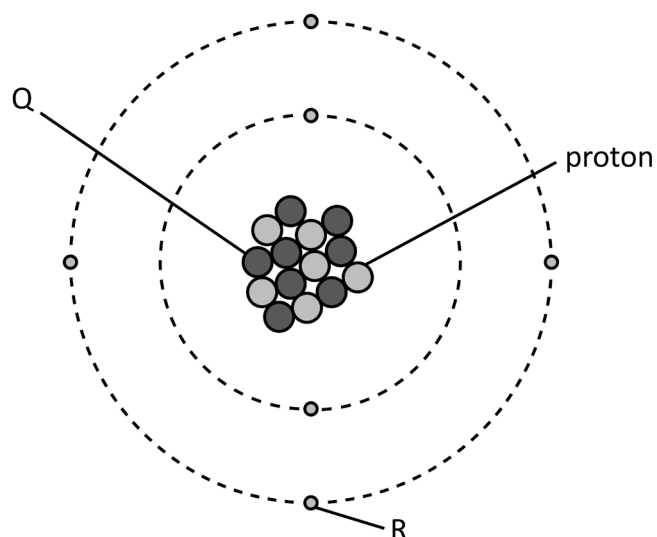
C – is the only correct answer.	1 mark
	Total: 1 mark

- d) A nucleus is represented by the symbol shown below. What is the mass number of the nucleus?

A – is the only correct answer.	1 mark
	Total: 1 mark

(Total for Question 1 is 4 marks)

2. The figure below shows an atom of carbon 14.



a) Identify the particles labelled Q and R.

Q = neutron.	1 mark
R = electron.	1 mark
	Total: 2 marks

b) Explain, using the information in the diagram, why this atom of carbon-14 has an overall **neutral** charge.

Evidence from diagram: There are 6 protons and 6 electrons.	1 mark
Statement: So, it has an equal number of protons and electrons.	1 mark
Explanation of charge: Protons have a positive (+1) charge and electrons have a negative (-1) charge (so the overall charge cancels out / equals zero).	1 mark
	Total: 3 marks

(Total for Question 2 is 5 marks)

3. A table shows the number of subatomic particles present in four unknown atoms, **W**, **X**, **Y**, and **Z**.

Using your knowledge of atomic structure and data from the table above to compare the identities and properties of atoms W, X, Y, and Z.

In your answer, you should explicitly identify:

- Which particles belong to the same element, and which belongs to a completely different element.
- Which particle is an isotope of particle W.
- Which particle is an ion, and what its overall electrical charge is.

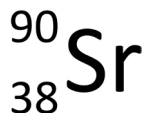
You **must** give reasons for all of your choices based on the subatomic particles shown in the table.

Marking guidance		
Level	Marks	Descriptor
Level 1	1 - 2	Simple, isolated statements are made. The student may correctly identify the charge of a proton/electron, or correctly identify one relationship (e.g., "X is an isotope") without giving a valid scientific reason.
Level 2	3 - 4	The student correctly identifies most of the relationships (e.g., knows Y is an ion and X is an isotope), but the reasoning may be incomplete, or they may mix up which subatomic particles are responsible for which property.
Level 3	5 - 6	A detailed and logically structured explanation. The student correctly identifies the relationships between the particles (same element, isotope, ion, different element) and fully justifies all of them using the correct subatomic particles (protons, neutrons, electrons). Calculates the correct charge of the ion.

Indicative content:	
Identifying the element: • The element a particle belongs to is defined only by its number of protons (its atomic number). • W, X, and Y all have 11 protons, so they belong to the same element (Sodium). • Z has 12 protons, meaning it has a different atomic number, so it is a completely different element (Magnesium). Identifying the isotope: • Isotopes are atoms of the same element (same number of protons) but with a different number of neutrons. • Therefore, X is an isotope of W, because it has the same number of protons (11) but a different number of neutrons (13 instead of 12). Identifying the ion and its charge: • An atom becomes an ion when it gains or loses electrons, meaning the number of protons and electrons are no longer equal. • Y is an ion because it has 11 protons but only 10 electrons. • Protons have a positive (+1) charge and electrons have a negative (-1) charge. Because particle Y has one more positive proton than negative electrons, it has an overall electrical charge of +1.	
	Total: 6 marks

(Total for Question 3 is 6 marks)

4. A nucleus of Strontium-90 is shown below.



- a. Determine the number of neutrons present in the nucleus of Strontium-90.

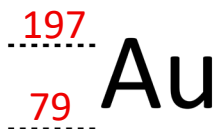
Mass number – the atomic number	
$90 - 38$	1 mark
$= 52$	1 mark
	Total: 2 marks

- b. Determine the number of electrons present in an **atom** of Strontium-90?

38	1 mark
	Total: 1 mark

- c. A different atom, gold (Au), has a mass number of 197 and an atomic number of 79.

- i. Complete the missing values for the atom of gold.



Top value: the Mass number = 197	1 mark
Bottom value: the Atomic number = 79	1 mark
	Total: 2 marks

- ii. Determine the number of neutrons present in the nucleus of gold.

$197 - 79 = 118$	1 mark
	Total: 1 mark

- iii. Gold has a number of radioactive isotopes. One of these is Au-210.
What is an isotope?

Atoms of the same element / with the same number of protons .	1 mark
But with a different number of neutrons / different mass number.	1 mark
	Total: 2 marks

(Total for Question 4 is 8 marks)

5. The radius of a typical gold atom is 1.44×10^{-10} m. The radius of a gold nucleus is 3.40×10^{-15} m
- a. Calculate how many times greater the radius of the gold atom is compared to the radius of its nucleus.
Give your answer to **two** significant figures.

$(1.44 \times 10^{-10}) \div (3.40 \times 10^{-15})$	1 mark
Calculation: 42352(.94...)	1 mark
Significant figures: 42000	1 mark
	Total: 3 marks

- b. The mass of a neutron is 1.6749×10^{-27} kg. The mass of a proton is 1.6726×10^{-27} kg

Calculate the difference in mass between a single neutron and a single proton.
Give your answer in standard form.

Calculation: Difference = 0.0023×10^{-27}	1 mark
Standard form: 2.3×10^{-30}	1 mark
	Total: 2 marks

(Total for Question 5 is 5 marks)

6. A Carbon-12 atom has 6 protons and 6 neutrons in its nucleus.

The mass of a single proton and a single neutron is approximately the same: 1.67×10^{-27} kg.

The radius of a Carbon-12 nucleus is 2.70×10^{-15} m

The volume of a sphere can be calculated using the equation: $V = \frac{4}{3} \pi r^3$

Calculate the density of the Carbon-12 nucleus.

Give your answer in standard form to 3 significant figures.

Total mass: Total particles in the nucleus = 12 Mass = $12 \times (1.67 \times 10^{-27})$ Mass = 2.004×10^{-26} kg	1 mark
Volume substitution: Volume = $\frac{4}{3} \times \pi \times (2.70 \times 10^{-15})^3$	1 mark
Volume calculation: Volume = $8.24(47...) \times 10^{-44} \text{ (m}^3\text{)}$	1 mark
Density substitution: Density = $(2.004 \times 10^{-26}) \div (8.24(47...) \times 10^{-44})$	1 mark
Density: $2.430(5...) \times 10^{17}$	1 mark
Standard form & sig figs: 2.43×10^{17}	1 mark
Total: 6 marks	

(Total for Question 6 is 6 marks)