

Atomic Structure

Mark Scheme



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1. Atomic structure describes the arrangement of the protons, neutrons, and electrons that make up every atom. Circle the letter of the correct answer for each of the following questions.

a. Where is most of the mass that is in an atom found?

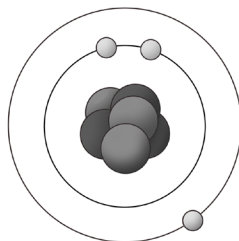
D – is the only correct answer.	(1)
	Total: 1 mark

b. The radius of a helium atom is 0.14 nm.

What is the radius of a helium atom in metres?

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

c. The figure below shows a neutral atom. Using the information in this image, identify this atom.



B – is the only correct answer.	(1)
	Total: 1 mark

d. Which statement about the subatomic particles in an atom is **correct**?

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

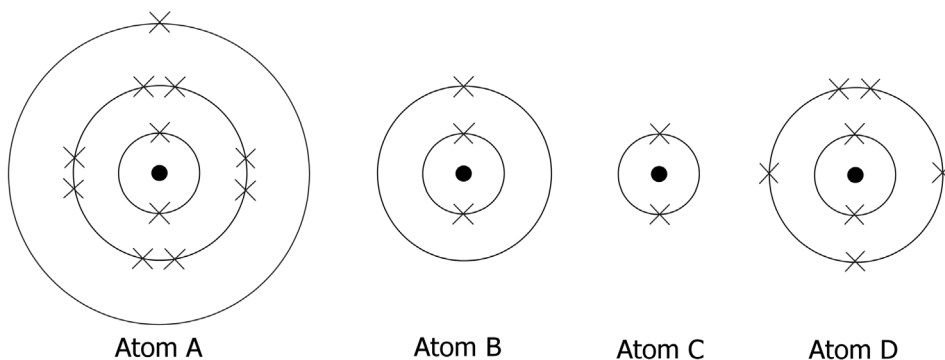
e. Oxygen has three naturally occurring isotopes.

Which statement about isotopes of oxygen is correct?

B – is the only correct answer.	(1)
	Total: 1 mark

(Total for Question 1 is 5 marks)

2. The diagrams show the electronic structure of four different atoms.



a) Name the **two** subatomic particles in the nucleus of an atom.

Protons <u>and</u> neutrons.	(1)
Marking note: both correct particles are required for the mark.	
	Total: 1 mark

b) Why is there no overall electrical charge on each atom?

The number of protons is equal to the number of electrons .	(1)
Accept: The positive charges equal the negative charges.	
	Total: 1 mark

c) Why is atom C unreactive?

It has a full outer shell (of electrons).	(1)
Accept: It has a stable electronic structure. Accept: It is a Noble gas.	
	Total: 1 mark

d) Which two of these atoms have similar chemical properties?
Give a reason for your answer.

Which two atoms: Atom A <u>and</u> Atom B.	(1)
Reason: they both have one electron on their outer shell.	
Accept: they have the same number of electrons on their outer shells.	
	Total: 2 marks

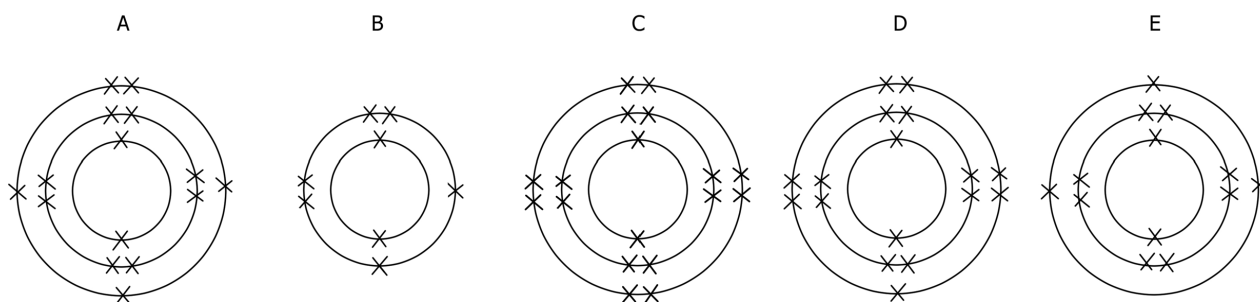
e) Atom B reacts to form an ion.

What is the charge on this ion? Explain your answer in terms of electrons.

Charge: + or 1+	(1)
Explanation: it losses one electron from it's outside shell. Accept any correct version of this.	
	Total: 2 marks

(Total for Question 2 is 7 marks)

3. The electronic structures of five atoms, A, B, C, D and E, are shown.



a) The following questions refer to the structures labelled A, B, C, D and E in the figure above.

- An atom of a metallic element. **E**
- An atom with a proton number of 13. **E**
- An atom of phosphorus. **A**
- An atom with only two shells of electrons. **B**
- An atom which forms a stable ion with a single negative charge. **D**

Award 1 mark for each correct response.	
	Total: 5 marks

b) There are a number of isotopes of sulfur and many of these can be found in seawater.

- Explain, in terms of subatomic particles, what is meant by the term isotopes.

Atoms with the same number of protons	(1)
but different numbers of neutrons.	(1)
	Total: 2 marks

- The figure below shows three different isotopes of sulfur, draw a line from each isotope of sulfur to its correct description.

Isotope	Description
16 S 32	This isotope contains 17 neutrons. This isotope has a full outer shell of electrons. This isotope has more protons than neutrons. This isotope has the highest mass number. This isotope has the same number of neutrons and protons.
16 S 33	
16 S 34	

Award 1 mark for each correct response.	(1)
	Total: 3 marks

- c) A sample of seawater containing these isotopes contains the following abundances of these sulfur isotopes:

Sulfur 32: 95.0%

Sulfur 33: 1.0%

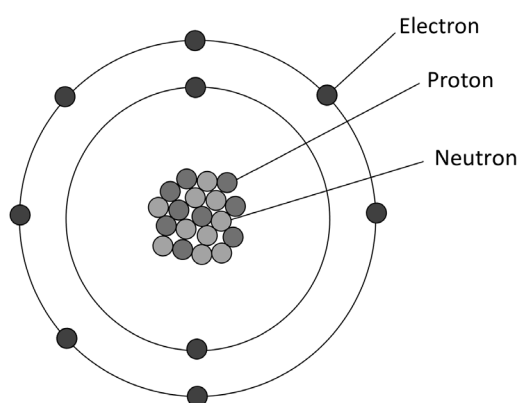
Sulfur 34: 4.0%

Calculate the relative atomic mass (A_r) of this sample of sulfur.

Give your answer to **two** decimal places.

$((32 \times 95.0) + (33 \times 1.0) + (34 \times 4.0)) \div 100$	(1)
$3209 \div 100$	(1)
32.09	(1)
	Total: 3 marks

- d) The figure below shows an atom of an element.



- i. Identify this atom based on the information in the figure.

Fluorine.	(1)
	Total: 3 marks

- ii. State the electronic configuration of this atom.

2, 7	(1)
	Total: 3 marks

- iii. Explain why this atom has no overall electrical charge.
Use information from the figure in your answer.

An explanation to include:	
There are 9 protons and 9 electrons.	(1)
The positive charge of the protons cancels out the negative charge of the electrons.	(1)
	Total: 2 marks

(Total for Question 3 is 13 marks)

4. The table below deals with atomic structure.

a) Atoms are made up of subatomic particles, these are protons, neutrons and electrons.

Complete the following table.

Particle	Relative charge	Relative mass
Proton	+1	1
Neutron	0	1
Electron	– or – 1	See marking section

Award 1 mark for each correct answer.			
For the mass of an electron it's different for different exam boards.			
For AQA it's: $\frac{1}{2000}$ or null.	For Edexcel it's: $\frac{1}{1835}$	For OCR it's: $\frac{1}{2000}$	
			Total: 3 marks

b) An atom of silicon can be shown as:



What can be deduced from this information about the structure of an atom of silicon and the position of silicon in the periodic table?

Marking guidance		
Level	Marks	Descriptor
Level 1	1 - 2	Points are identified and stated simply, but their relevance is not clear and there is no attempt at logical linking. The student states simple facts (e.g., "It has 14 protons" or "It is in Group 4") without calculation or explanation.
Level 2	3 - 4	Relevant points (reasons/causes) are identified, and there are attempts at logical linking. The student correctly calculates the subatomic particles but makes errors linking to the periodic table, OR explains the periodic table position well but misses calculations for protons/neutrons.
Level 3	5 - 6	Relevant points (reasons/causes) are identified, given in detail and logically linked to form a clear account. The student deduces the numbers of all three subatomic particles correctly (p, n, e) AND links the electronic structure to both the Group and Period correctly.

Indicative content:	
<u>Structure of the atom:</u> The atomic number is 14, so the atom has 14 protons. The mass number is 28, so the atom has 14 neutrons (28 – 14). Atoms are neutral, so the atom has 14 electrons. The electronic configuration is 2, 8, 4. <u>Position in the periodic table:</u> The atom is in Group 4 . Reason: It has 4 electrons in its outer shell. The atom is in Period 3 . Reason: It has 3 shells (energy levels) containing electrons.	
	Total: 6 marks

(Total for Question 4 is 9 marks)

5. An atom of potassium can be shown as:

a) Complete the table to show the number of protons, neutrons and electrons in this potassium atom.

Number of		
Protons	Electrons	Neutrons
19	19	20

Award 1 mark for each correct answer.	
	Total: 3 marks

b) Describe the positions of these particles in the potassium atom.

Protons and Neutrons: In the nucleus.	(1)
Electrons: In shells or orbits or energy levels (orbiting the nucleus).	(1)
	Total: 2 marks

c) State the electronic configuration of this potassium atom.

2, 8, 8, 1	(1)
	Total: 1 mark

d) The charge on an electron is -1.6×10^{-19} C.
What is the charge on a proton?

1.6×10^{-19} C.	(1)
	Total: 1 mark

e) Magnesium (Mg) has three naturally occurring isotopes.

$((24 \times 79.0) + (25 \times 10.0) + (26 \times 11.0)) \div 100$	(1)
$2432 \div 100$	(1)
24.32	(1)
	Total: 3 marks

(Total for Question 5 is 10 marks)

6. Look at the information below about three different atoms of neon.

The atomic number of neon is 10.

- a) What is meant by atomic number?

The number of protons in the nucleus.	(1)
	Total: 1 mark

These three atoms of neon are isotopes.

- b) Explain, in terms of subatomic particles, what is meant by the term isotopes.

An explanation to include:	
Atoms with the same number of protons	(1)
but different number of neutrons.	(1)
	Total: 2 marks

- c) The table below gives information about other atoms and ions.
Complete the missing values in the table.

Particle	Atomic number	Mass number	Number of protons	Number of neutrons	Number of electrons	Electronic structure
C	6	12	6	6	6	2, 4
Al	13	27	13	14	13	2, 8, 3
Cl ⁻	17	37	17	20	18	2, 8, 8
Ca ²⁺	20	40	20	20	18	2, 8, 8

Award 1 mark for each correct row.	
	Total: 4 marks

The relative atomic mass (A_r) of neon is 20.2. In a sample of neon, the abundance of the neon 21 isotope is so small it can be considered to not be part of the sample.

- d) Calculate the percentage abundances of neon 20 and neon 22 in the sample.

Let the abundance of Neon-20 be x	
Therefore, the abundance of Neon-22 is: $(100 - x)$	
Equation: $(20x + 22(100 - x)) \div 100 = 20.2$	(1)
Working: $20x + 2200 - 22x = 2020$ $-2x = -180$ $x = 90$	(1)
Neon-20 = 90% Neon-22 = 10%	(1)
	Total: 3 marks

(Total for Question 6 is 10 marks)