

AQA A-Level Chemistry

Atomic structure

Questions only

The newest questions, about an hour. All 53 are in the exam generator.

Questions

18

Total marks

46

Time allowed

1 h

Name

Class or teacher

Date

Instructions

- Answer all questions in the spaces provided.
- Use black ink. Show your working for every calculation.
- You may use a scientific calculator and the AQA Data Sheet.
- Print the separate mark scheme when you are ready to mark your answers.

For marking

Q	Source	Marks	Score
1	2023 A-level P3 Q7	1	
2	2023 AS P1 Q9	1	
3	2023 AS P1 Q1	5	
4	2024 A-level P3 Q7	1	
5	2024 AS P1 Q24	1	
6	2024 AS P1 Q6	6	
7	2024 AS P1 Q22	1	
8	2024 AS P1 Q21	1	
9	2024 AS P1 Q20	1	

Q	Source	Marks	Score
10	2024 A-level P3 Q6	1	
11	2025 AS P1 Q12	1	
12	2025 AS P1 Q14	1	
13	2025 AS P1 Q16	1	
14	2025 AS P1 Q3	13	
15	2025 A-level P1 Q2	8	
16	2025 A-level P3 Q12	1	
17	2025 A-level P3 Q21	1	
18	2025 A-level P3 Q25	1	

Total _____ / 46 Percentage _____ %

Questions from AQA past papers, 2023–2025, reproduced for revision. Practise these topics online, with instant marking:

whiteboardchemistry.com/revision/aqa-a-level-chemistry/exam-questions?topics=atomic-structure&len=0

Questions

Atomic structure · 18 questions · 46 marks · time allowed 1 h

Q1 · June 2023 · Paper 3 · Q7 · [1 mark]

Which row shows the number of each fundamental particle in one $^{25}\text{Mg}^{2+}$ ion? protons neutrons electrons

Tick (✓) one box.

☐ **A** 12 12 10

☐ **B** 14 11 12

☐ **C** 12 13 10

☐ **D** 12 13 12

Q2 · June 2023 · AS Paper 1 · Q9 · [1 mark]

Which atom contains the most neutrons?

Tick (✓) one box.

☐ **A** ^{54}Cr

☐ **B** ^{55}Mn

☐ **C** ^{57}Fe

☐ **D** ^{58}Ni

Q3 · June 2023 · AS Paper 1 · Q1 · [5 marks]

This question is about the elements in Period 3.

(a) Give the full electron configuration of the element in Period 3 with the highest first ionisation energy.

[1 mark]

(b) Give an equation, including state symbols, to represent the process that occurs when the second ionisation energy of sodium is measured.

[1 mark]

(c) The table below shows some successive ionisation energies for an element in Period 3.

Ionisation number	1	2	3	4	5	6	7	8
Ionisation energy / kJ mol ⁻¹	1000	2260	3390	4540	6990	8490	27 100	31 700

Identify the Period 3 element.

Explain your answer.

[3 marks]

Element

Explanation

Q4 • June 2024 • Paper 3 • Q7 • [1 mark]

Which element has the highest third ionisation energy?

Tick (✓) one box.

- ☐ **A** Li
- ☐ **B** Be
- ☐ **C** K
- ☐ **D** Ca

Q5 · June 2024 · AS Paper 1 · Q24 · [1 mark]

Which atom has the greatest number of unpaired electrons?

Tick (✓) one box.

☐ **A** P

☐ **B** V

☐ **C** Fe

☐ **D** Cu

Q6 · June 2024 · AS Paper 1 · Q6 · [6 marks]

This question is about atomic structure and mass spectrometry.

(a) Give the full electron configuration for Br

[1 mark]

A sample of bromine (Br_2) is analysed in a mass spectrometer.

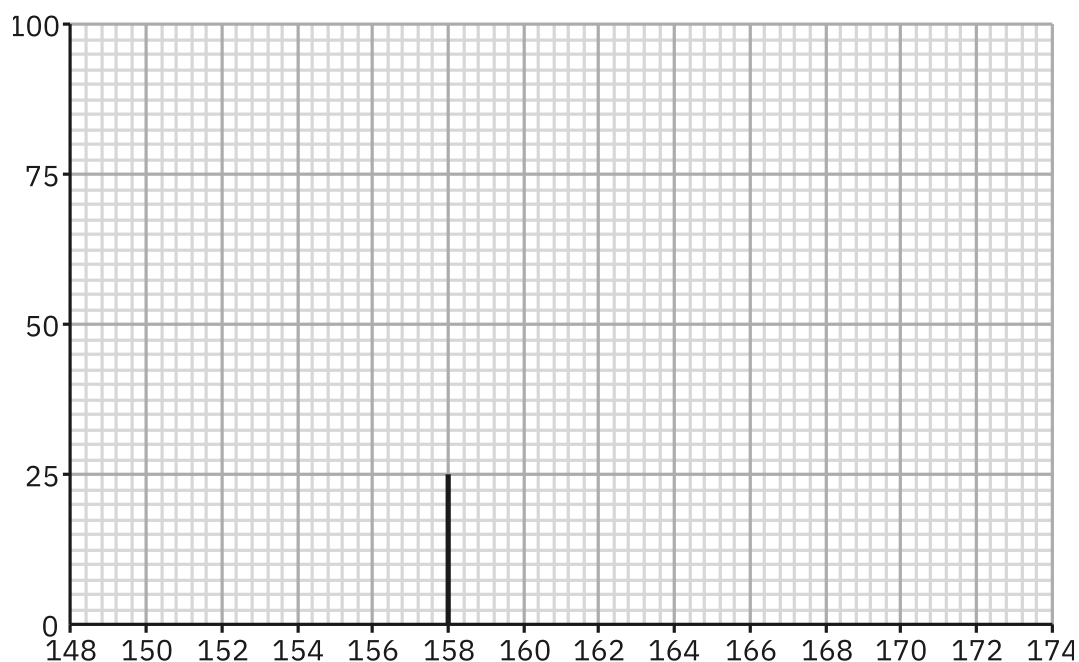
The sample is ionised using electron impact ionisation.

(b) Give an equation, including state symbols, for the process that occurs during the ionisation of bromine.

[1 mark]

(c) Bromine exists as two isotopes, ^{79}Br and ^{81}Br , which exist in equal abundance.

The figure below shows an incomplete mass spectrum for this sample of bromine.



Complete the spectrum by adding a label to each axis, and adding any further peaks you would expect to see.

[3 marks]

Draw your answer on the figure above.

(d) State how the detector enables the relative abundance of each ion to be determined.

[1 mark]

Q7 • June 2024 • AS Paper 1 • Q22 • [1 mark]

Which equation shows the process that occurs during the second ionisation of magnesium?

Tick (✓) one box.

- ☐ **A** $\text{Mg(g)} \rightarrow \text{Mg}^{\text{+}}(\text{g}) + \text{e}^{-}$
- ☐ **B** $\text{Mg(g)} \rightarrow \text{Mg}^{2+}(\text{g}) + 2 \text{e}^{-}$
- ☐ **C** $\text{Mg}^{\text{+}}(\text{g}) \rightarrow \text{Mg}^{2+}(\text{g}) + \text{e}^{-}$
- ☐ **D** $\text{Mg}^{2+}(\text{g}) \rightarrow \text{Mg}^{3+}(\text{g}) + \text{e}^{-}$
-

Q8 • June 2024 • AS Paper 1 • Q21 • [1 mark]

Which isotope has 2 more protons and 3 more neutrons than an atom of ^{112}Cd ?

Tick (✓) one box.

- ☐ **A** $^{115}_{48}\text{Cd}$
- ☐ **B** $^{115}_{50}\text{Sn}$
- ☐ **C** $^{117}_{50}\text{Sn}$
- ☐ **D** $^{117}_{51}\text{Sb}$
-

Q9 • June 2024 • AS Paper 1 • Q20 • [1 mark]

Samples of four different substances are analysed using time of flight mass spectrometry. In each case, the samples are ionised to form ions with a single positive charge. The ions are accelerated to the same kinetic energy. Which sample gives ions with the shortest time of flight?

Tick (✓) one box.

- ☐ **A** A sample of ^{45}Sc that is ionised using electron impact ionisation.
- ☐ **B** A sample of C_3H_8 that is ionised using electrospray ionisation.
- ☐ **C** A sample of $\text{CH}_3\text{CH}_2\text{OH}$ that is ionised using electrospray ionisation.
- ☐ **D** A sample of CO_2 that is ionised using electron impact ionisation.

Q10 • June 2024 • Paper 3 • Q6 • [1 mark]

Which row contains two species with different numbers of electrons?

Tick (✓) one box.

- ☐ **A** NH_3 and HF
- ☐ **B** CO_3^{2-} and NO_3^-
- ☐ **C** H_3O^+ and HF_2^+
- ☐ **D** CH_4 and NH_2^-
-

Q11 • June 2025 • AS Paper 1 • Q12 • [1 mark]

Which row shows the order of discovery?

Earliest Latest

Tick (✓) one box.

- ☐ **A** electron neutron nucleus
- ☐ **B** electron nucleus neutron
- ☐ **C** nucleus electron neutron
- ☐ **D** nucleus neutron electron
-

Q12 • June 2025 • AS Paper 1 • Q14 • [1 mark]

Which Period 3 element has these successive ionisation energies?

1st 2nd 3rd 4th 5th 6th

Ionisation energy / kJ mol^{-1} 786 1580 3230 4360 16 000 20 000

Tick (✓) one box.

- ☐ **A** Al
- ☐ **B** Si
- ☐ **C** P
- ☐ **D** S

Q13 · June 2025 · AS Paper 1 · Q16 · [1 mark]

Which element has atoms that contain only two unpaired electrons?

Tick (✓) one box.

- ☐ **A** cobalt
- ☐ **B** magnesium
- ☐ **C** nickel
- ☐ **D** phosphorus

Q14 · June 2025 · AS Paper 1 · Q3 · [13 marks]

This question is about atomic structure and time of flight (TOF) mass spectrometry.

03.1 Give the full electron configuration of a fluoride ion (F^-).

[1 mark]

03.2 The Q^{2+} ion has electron configuration $1s^2 2s^2 2p^6 3s^2 3p^6 3d^5$

Identify Q.

[1 mark]

03.3 Give the meaning of the term relative atomic mass.

[2 marks]

03.4 A TOF mass spectrometer is used to determine the relative atomic mass of a metal.

Explain why the sample of the metal must be ionised before passing into the flight tube.

Describe how the ion is detected.

Describe how the abundance of each isotope is determined.

[3 marks]

Why sample must be ionised

How ion is detected

How abundance is determined

A sample of metal was analysed using a TOF mass spectrometer.

The mass spectrum showed four peaks.

Table 2 shows data about the four peaks in this spectrum.

Table 2

m/z	Percentage abundance
50	4.3
52	82.8
53	10.5
54	2.4

03.5 State the m/z value of the ion that would be the last to reach the detector.

[1 mark]

03.6 Calculate the relative atomic mass of this sample of metal.

Give your answer to 1 decimal place.

Relative atomic mass

[2 marks]

03.7 These are the data for one of the isotopes in this analysis.

Length of flight tube = 0.850 m

Time of flight = 6.41×10^{-4} s

KE = 7.59×10^{-20} J

The kinetic energy of an ion is given by the equation $KE = (1)/(2) mv^2$

KE = kinetic energy / J

m = mass / kg

v = speed / $m s^{-1}$

Calculate the mass, in g, of one ion of this isotope.

Mass g

[3 marks]

Q15 · June 2025 · Paper 1 · Q2 · [8 marks]

This question is about ionisation energies.

02.1 Explain why beryllium is the element with the highest first ionisation energy in

Group 2.

[2 marks]

02.2 Give an equation, including state symbols, to show the process that occurs when the second ionisation energy of beryllium is measured.

[1 mark]

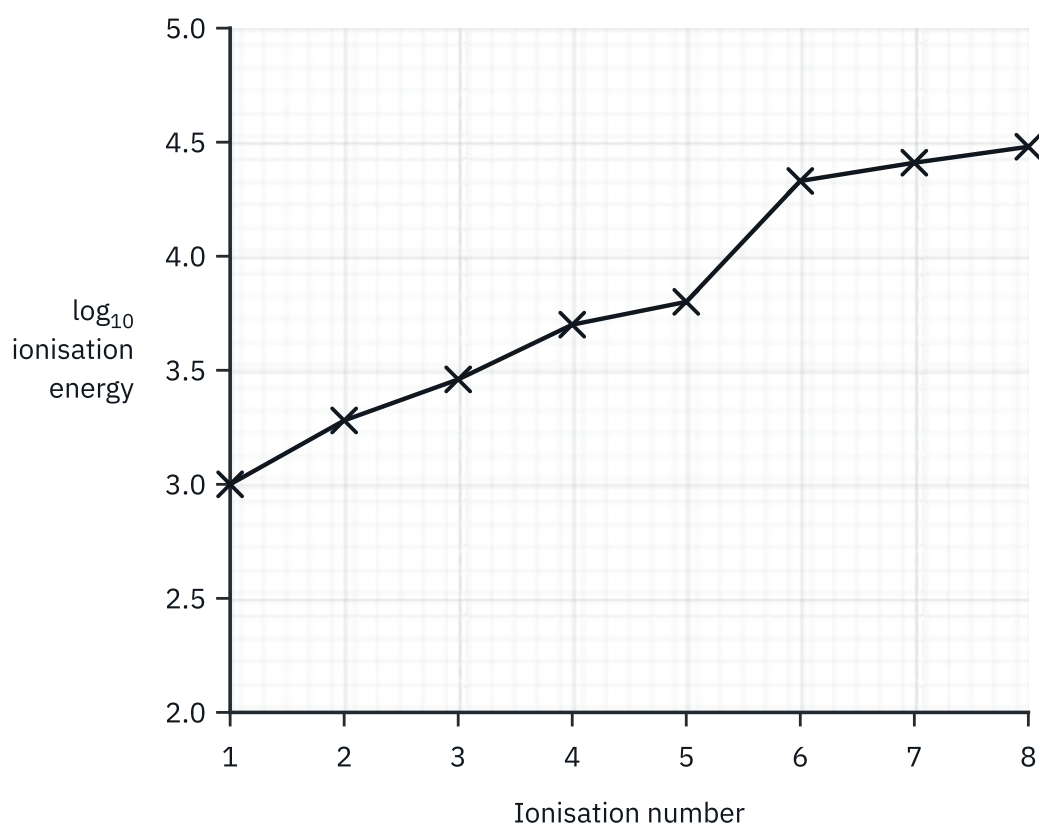
02.3 Predict which element in Period 3 has the lowest second ionisation energy.

[1 mark]

02.4 Figure 1 shows a plot of $\log_{10}(\text{ionisation energy})$ for a Period 3 element.

The ionisation energies are measured in kJ mol^{-1}

Figure 1



Deduce the identity of this element.

Explain your answer.

[3 marks]

Element

Explanation

Q2.5 Use Figure 1 to determine the third ionisation energy, in kJ mol^{-1} , of this element.

kJ mol^{-1}

[1 mark]

Q16 • June 2025 • Paper 3 • Q12 • [1 mark]

A sample of UF_6 consists of molecules containing ^{19}F and either ^{235}U or ^{238}U atoms.

The relative molecular mass of the sample is 351.43

What is the percentage abundance of $^{235}\text{UF}_6$ in the sample?

Tick (✓) one box.

☐ **A** 19

☐ **B** 33

☐ **C** 50

☐ **D** 81

Q17 • June 2025 • Paper 3 • Q21 • [1 mark]

This question also needs Redox.

Which electron configuration represents an element that can have a maximum oxidation state of +5 in its compounds?

Tick (✓) one box.

☐ **A** $1s^2 2s^2 2p^1$

☐ **B** $1s^2 2s^2 2p^6 3s^2 3p^5$

☐ **C** $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^3$

☐ **D** $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^5$

Q18 · June 2025 · Paper 3 · Q25 · [1 mark]

This question also needs Periodicity.

Which element is in the p block in the Periodic Table?

Tick (✓) one box.

- ☐ **A** Radium
- ☐ **B** Radon
- ☐ **C** Rhenium
- ☐ **D** Roentgenium

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Mark scheme:

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