



CrackingCHEM

GCSE | A-LEVEL

UNDERSTAND • APPLY • SUCCEED

OCR A H432

Atomic Structure II

Original exam questions | TEST IT → EXAM STYLE → HARDER MIXED

SPECIFICATION-LED. PROGRESSIVE. EXAM-FOCUSED.

OCR A SPECIFICATION

2.2.1(a)-(d) | Electron structure

TEST IT

8

EXAM STYLE

10

HARDER MIXED

5

STRETCH

1

24 ORIGINAL QUESTIONS

144 TOTAL MARKS

FINAL NOTES-ALIGNED EDITION | OCR A 2.2.1 ELECTRON STRUCTURE

Independent practice material. Every question is original and has been designed from recurring OCR A assessment patterns.

**START HERE****How to use this pack**

A deliberate progression from retrieval to unfamiliar application

- 1 Complete TEST IT without the notes. Correct gaps before moving on.
- 2 In electron configurations, add the superscripts and check the total electron count before you move on.
- 3 Use the notes' decision route: identify the representation, count electrons, apply the filling rules, then check the total and charge.
- 4 Complete HARDER MIXED last. These questions make you select and connect the chemistry for yourself.

✓ **OCR A boundary:** This pack covers OCR A 2.2.1 only. Atoms are required up to $Z = 36$ and ion configurations are limited to ions of s- and p-block elements. Ionisation energies, block classification and transition-metal ion configurations are outside this pack.

Configuration check: Number = principal energy level (shell); letter = sub-shell; superscript = electrons in that sub-shell. An orbital holds a maximum of two electrons with opposite spins.

Count, fill, stop, check: Neutral atoms have Z electrons. Apply ionic charge before filling, use $1s \rightarrow 2s \rightarrow 2p \rightarrow 3s \rightarrow 3p \rightarrow 4s \rightarrow 3d \rightarrow 4p$, then make sure the superscripts total the correct electron count.

Write or type: The pale blue response lines are designed for printing and electronic completion. In Word, click a line and type directly onto it.

Notes alignment: This final edition has been checked directly against the completed CrackingChem OCR A Atomic Structure II notes. Every question maps to OCR A 2.2.1(a)-(d).



SECTION A

TEST IT

Eight direct checks of the finished-notes mastery outcomes

QUESTION 1 | TEST IT

- (a) State the maximum number of electrons in each of the first four principal energy levels (shells).

[4 marks]

- (b) Use $2n^2$ to calculate the maximum number of electrons in the fourth shell.

[1 mark]

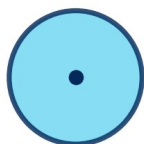
QUESTION 2 | TEST IT

- (a) Define the term atomic orbital.

[2 marks]

One s orbital and three p orbitals (not to scale)

A



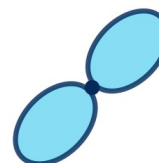
B



C



D



- (b) Identify the type of orbital shown by A and by B-D.

[2 marks]

- (c) Describe the shape and relative arrangement of the three p orbitals.

[2 marks]

**QUESTION 3** | **TEST IT**

Complete the table for the s, p and d sub-shells.

Sub-shell	Number of orbitals	Maximum electrons
s		
p		
d		

[6 marks]**QUESTION 4** | **TEST IT**

(a) Write the order in which sub-shells fill from 1s to 4p.

[2 marks]

(b) Which sub-shell fills immediately before 3d, and which fills immediately after 3d?

[2 marks]

(c) Explain why 4s is filled before 3d.

[1 mark]**QUESTION 5** | **TEST IT**

Complete each electrons-in-box diagram. Show electron spins clearly.

(a) Carbon: complete the $2p^2$ arrangement.

[2 marks]

(b) Fluorine: complete the $2p^5$ arrangement.

[2 marks]

**QUESTION 6** | TEST IT

Write the full electron configuration and check the electron total for each atom.

(a) Ca, $Z = 20$

[2 marks]

(b) Kr, $Z = 36$

[2 marks]

QUESTION 7 | TEST IT

For each atom, write the simple predicted configuration and the observed configuration using [Ar] shorthand.

(a) Cr, $Z = 24$

[2 marks]

(b) Cu, $Z = 29$

[2 marks]

QUESTION 8 | TEST IT

For each ion, calculate the number of electrons and write its electron configuration using noble-gas shorthand.

(a) Al^{3+}

[2 marks]

(b) S^{2-}

[2 marks]

(c) Br^-

[2 marks]



SECTION B

EXAM STYLE

Ten original structured questions using OCR A electron-structure conventions

✓ **Decision route:** Identify the representation → count the electrons → apply filling order, capacities and singly-before-pairing → check the total and charge.

QUESTION 9 | EXAM STYLE

Nitrogen and oxygen have $2p^3$ and $2p^4$ arrangements respectively.

(a) Draw electrons-in-box diagrams for the $2p$ sub-shell of N and O.

[2 marks]

(b) Use the diagrams to explain the singly-before-pairing rule.

[2 marks]

(c) State the spin requirement for two electrons in the same orbital.

[1 mark]

QUESTION 10 | EXAM STYLE

Selenium has atomic number 34.

(a) State the number of electrons in one Se atom.

[1 mark]

(b) Write its full electron configuration.

[2 marks]

(c) Write the same configuration using [Ar] shorthand.

[1 mark]

(d) Show that the superscripts in your shorthand configuration give the correct electron total.

[1 mark]

**QUESTION 11** | EXAM STYLE

Each student configuration contains one error.

Species	Student configuration
K	[Ar] 3d ¹
Ca	[Ar] 3d ²
Zn	[Ar] 3d ⁸ 4s ⁴
Kr	[Ar] 3d ¹⁰ 4s ² 4p ⁵

(a) Write the correct configuration for each species.

[4 marks]

(b) For each correction, state the filling, capacity or electron-count rule that has been broken.

[4 marks]

QUESTION 12 | EXAM STYLE

Complete the table. Give the electron count and noble-gas configuration for each ion.

Ion	Number of electrons	Configuration
O ²⁻		
Na ⁺		
Ca ²⁺		
Br ⁻		

[8 marks]

QUESTION 13 | EXAM STYLE

Gallium has atomic number 31.

(a) Write the electron configuration of Ga using [Ar] shorthand.

[2 marks]

(b) Calculate the number of electrons in Ga³⁺.

[1 mark]

(c) Write the configuration of Ga³⁺ using [Ar] shorthand.

[1 mark]



- (d) Identify the three electrons removed when Ga^{3+} forms.

[2 marks]

QUESTION 14 | EXAM STYLE

Atom X has electron configuration $[\text{Ar}] 3d^{10} 4s^2 4p^3$.

- (a) Calculate the atomic number of X and identify the element.

[2 marks]

- (b) Write the electron count and configuration of X^{3-} .

[2 marks]

- (c) Draw an electrons-in-box diagram for the $4p^3$ sub-shell of X.

[2 marks]

QUESTION 15 | EXAM STYLE

A student writes the four configurations below. Each contains an error.

Species	Student configuration
Ca	$[\text{Ar}] 3d^2$
Cr	$[\text{Ar}] 3d^4 4s^2$
Cu	$[\text{Ar}] 3d^9 4s^2$
Br^-	$[\text{Ar}] 3d^{10} 4s^2 4p^5$

- (a) Write the correct configuration for each species.

[4 marks]

- (b) State the rule or observed exception responsible for each correction.

[4 marks]

**QUESTION 16** | EXAM STYLE

The diagrams show three proposed $2p^4$ arrangements. Each vertical pair of arrows is in one orbital.

Diagram	Orbital 1	Orbital 2	Orbital 3
A	$\uparrow \downarrow$	$\uparrow$	$\uparrow$
B	$\uparrow \downarrow$	$\uparrow \downarrow$	empty
C	$\uparrow \uparrow$	$\uparrow$	$\uparrow$

(a) Identify the correct diagram.

[1 mark]

(b) Explain the error in each of the other two diagrams.

[4 marks]

QUESTION 17 | EXAM STYLE

An atom has full configuration $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^4$.

(a) Deduce its atomic number and identify the element.

[1 mark]

(b) Write the configuration using [Ar] shorthand.

[1 mark]

(c) Write the electron count and configuration of its $2-$ ion.

[2 marks]

(d) Draw the neutral atom's 4p electrons-in-box diagram.

[2 marks]

**QUESTION 18** | EXAM STYLE

A 2- ion formed by a p-block element has 18 electrons.

- (a) Calculate the atomic number of the neutral atom and identify it.

[2 marks]

- (b) Write the full electron configuration of the ion.

[2 marks]

- (c) Draw the ion's 3p electrons-in-box diagram.

[2 marks]

SECTION C**HARDER MIXED**

Five unfamiliar applications followed by one stretch challenge

Independent thinking: Count first. Then decide whether the prompt needs a full configuration, shorthand configuration, box diagram or ionic adjustment.

QUESTION 19 | HARDER MIXED

Neutral atom Y contains 29 electrons.

- (a) Write the simple predicted configuration of Y using [Ar] shorthand.

[2 marks]

- (b) Identify Y and write its observed configuration.

[2 marks]

- (c) Represent the 3d and 4s electrons in boxes for the observed atom.

[3 marks]

**QUESTION 20** | HARDER MIXED

A^{2-} , B^- , C and D^+ each contain 18 electrons. A, B, C and D are consecutive elements in increasing atomic number.

(a) Identify A, B, C and D.

[4 marks]

(b) Write the electron configuration shared by all four species.

[1 mark]

QUESTION 21 | HARDER MIXED

Gallium, Ga, has $Z = 31$ and germanium, Ge, has $Z = 32$.

(a) Write the neutral configuration of each atom using [Ar] shorthand.

[2 marks]

(b) Calculate the electron counts of Ga^{3+} and Ge^{4+} .

[2 marks]

(c) Write the configuration of each ion.

[2 marks]

(d) Explain why the two ions have the same configuration.

[1 mark]

QUESTION 22 | HARDER MIXED

An atom contains [Ne], two 3s electrons and four 3p electrons.

(a) Calculate the total number of electrons and identify the atom.

[2 marks]

(b) Write its full electron configuration.

[1 mark]

(c) Write the electron count and configuration of its $2-$ ion.

[2 marks]

(d) Draw the neutral atom's 3p box diagram.



[1 mark]

QUESTION 23 | HARDER MIXED

A student writes selenium as $[\text{Ar}] 3d^{10} 4s^2 4p^4$ and says this proves that 3d fills before 4s.

(a) State the filling sequence immediately after 3p.

[1 mark]

(b) Write the full electron configuration of selenium.

[2 marks]

(c) Explain why the student's written order does not prove the stated filling order.

[2 marks]

(d) Check the selenium electron total from the full configuration.

[1 mark]

QUESTION 24 | STRETCH / SYNOPTIC

Stretch note: This question integrates particle counting from Atomic Structure I with every representation used in the finished Atomic Structure II notes.

Ion X^- contains 35 protons, 44 neutrons and 36 electrons.

(a) Identify the element and write the full nuclide symbol for X^- , including mass number, atomic number and charge.

[2 marks]

(b) Write the full electron configuration of X^- and check its total.

[2 marks]

(c) Write the electron configuration of the neutral atom X using [Ar] shorthand.

[2 marks]

(d) Draw electrons-in-box diagrams for the 4p sub-shell of neutral X and of X^- .

[4 marks]

✓ **DONE:** Mark the pack using the answer section. For every lost mark, name the rule that was missing, then redo that question without the worked answer.



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OCR A H432

Atomic Structure II

Fully worked answers | OCR A-style marking guidance

FULLY WORKED. PRECISELY MARKED. BUILT FOR IMPROVEMENT.

OCR A SPECIFICATION

2.2.1(a)-(d) | Electron structure

TEST IT

8

EXAM STYLE

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HARDER MIXED

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STRETCH

1

24 QUESTIONS MARKED

144 MARKS EXPLAINED

FINAL NOTES-ALIGNED EDITION | OCR A 2.2.1 ELECTRON STRUCTURE

Independent practice material. Every question is original and has been designed from recurring OCR A assessment patterns.



OCR A MAP

How this pack matches the finished notes

Every mastery outcome from OCR A 2.2.1(a)-(d), with nothing imported from Periodicity

Specification area	Recurring OCR A demand	Frequent trap	Questions
Shell capacities	Recall 2, 8, 18 and 32 and use $2n^2$ without confusing capacity with filling order.	Filling shell 3 completely before beginning 4s.	1, 4, 11, 23
Orbitals and sub-shells	Define an atomic orbital; recognise one s and all three p orientations; use s, p and d orbital counts and capacities.	Calling a sub-shell an orbital; drawing a p orbital as an orbit.	2-3, 9, 16, 22
Filling and box diagrams	Use the order through 4p; occupy equal-energy orbitals singly before pairing; show opposite spins in one orbital.	Pairing too early or drawing two same-spin electrons in one box.	4-5, 9, 11, 14-17, 19, 22-24
Atoms to $Z = 36$	Construct, translate and check configurations; use [Ar] shorthand; recall the observed Cr and Cu arrangements.	Wrong electron total; treating Cr or Cu as an ordinary filling case.	6-7, 10-11, 14-15, 17, 19, 21-24
s- and p-block ions	Apply charge first, count electrons, then deduce and check ion configurations up to $Z = 36$.	Removing or adding the charge after writing the configuration; practising transition-metal ions.	8, 12-14, 17-18, 20-22, 24

Research basis: The final question design was checked against the completed CrackingChem OCR A Atomic Structure II notes, OCR A Chemistry H432 Version 3.1 and public OCR assessment material. Every question in this pack is original.



SECTION A

TEST IT answers

Direct retrieval with exact OCR A terminology

TEST IT 1

- (a) $n = 1: 2; n = 2: 8; n = 3: 18; n = 4: 32$ electrons. [4]
- (b) $2n^2 = 2 \times 4^2 = 32$ electrons. [1]

Examiner guidance: These are shell capacities. They do not mean that shell 3 is completed before electrons begin to enter 4s.

TEST IT 2

- (a) An atomic orbital is a region around the nucleus that can hold up to two electrons with opposite spins: region around the nucleus [1]; up to two electrons with opposite spins [1]. [2]
- (b) A is an s orbital; B, C and D are the three p orbitals. [2]
- (c) Each p orbital is dumb-bell shaped [1]; the three have the same shape and energy and point at right angles to one another [1]. [2]

TEST IT 3

- s: 1 orbital; maximum 2 electrons. [2]
- p: 3 orbitals; maximum 6 electrons. [2]
- d: 5 orbitals; maximum 10 electrons. [2]

TEST IT 4

- (a) $1s \rightarrow 2s \rightarrow 2p \rightarrow 3s \rightarrow 3p \rightarrow 4s \rightarrow 3d \rightarrow 4p$. [2]
- (b) 4s fills immediately before 3d; 4p fills immediately after 3d. [2]
- (c) The 4s sub-shell is lower in energy than 3d while the atom is being filled. [1]

TEST IT 5

- (a) C, $2p^2$: $\uparrow \mid \uparrow \mid$ empty. The electrons occupy separate orbitals [1] with parallel spins [1]. [2]
- (b) F, $2p^5$: $\uparrow \downarrow \mid \uparrow \downarrow \mid \uparrow$. Two orbitals are paired and the third contains one electron; each pair has opposite spins. [2]

TEST IT 6

- (a) Ca: $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2$; the superscripts total 20. [2]
- (b) Kr: $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6$; the superscripts total 36. [2]

TEST IT 7

- (a) Cr simple prediction: $[\text{Ar}] 3d^4 4s^2$; observed: $[\text{Ar}] 3d^5 4s^1$. [2]
- (b) Cu simple prediction: $[\text{Ar}] 3d^9 4s^2$; observed: $[\text{Ar}] 3d^{10} 4s^1$. [2]

Required recall: OCR A requires the observed atomic configurations of chromium and copper. These are atoms, not transition-metal ions.

TEST IT 8

- (a) Al^{3+} : $13 - 3 = 10$ electrons; $[\text{Ne}]$. [2]
- (b) S^{2-} : $16 + 2 = 18$ electrons; $[\text{Ar}]$. [2]
- (c) Br^- : $35 + 1 = 36$ electrons; $[\text{Kr}]$. [2]



SECTION B

EXAM STYLE answers

Apply the decision route and show the check

EXAM STYLE 9

- (a) N, $2p^3$: $\uparrow \mid \uparrow \mid \uparrow$. O, $2p^4$: $\uparrow \downarrow \mid \uparrow \mid \uparrow$. [2]
- (b) Equal-energy p orbitals are occupied singly before pairing begins: N has one electron in each; O pairs only after all three are occupied. [2]
- (c) Two electrons in one orbital must have opposite spins. [1]

EXAM STYLE 10

- (a) A selenium atom has 34 electrons. [1]
- (b) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^4$. [2]
- (c) [Ar] $3d^{10} 4s^2 4p^4$. [1]
- (d) $18 + 10 + 2 + 4 = 34$. [1]

EXAM STYLE 11

- K: [Ar] $4s^1$ [1]. 4s fills before 3d [1]. [2]
- Ca: [Ar] $4s^2$ [1]. 4s fills before 3d [1]. [2]
- Zn: [Ar] $3d^{10} 4s^2$ [1]. An s sub-shell holds at most two electrons [1]. [2]
- Kr: [Ar] $3d^{10} 4s^2 4p^6$ [1]. Neutral Kr must contain 36 electrons [1]. [2]

EXAM STYLE 12

- O^{2-} : 10 electrons; [Ne]. [2]
- Na^+ : 10 electrons; [Ne]. [2]
- Ca^{2+} : 18 electrons; [Ar]. [2]
- Br^- : 36 electrons; [Kr]. [2]

EXAM STYLE 13

- (a) Ga: [Ar] $3d^{10} 4s^2 4p^1$. [2]
- (b) Ga^{3+} has $31 - 3 = 28$ electrons. [1]
- (c) Ga^{3+} : [Ar] $3d^{10}$. [1]
- (d) The $4p^1$ electron is removed [1], followed by the two 4s electrons [1]. [2]

EXAM STYLE 14

- (a) $18 + 10 + 2 + 3 = 33$, so X is arsenic, As. [2]
- (b) X^{3-} has 36 electrons and configuration [Kr]. [2]
- (c) $4p^3$: $\uparrow \mid \uparrow \mid \uparrow$. One electron occupies each p orbital before any pairing. [2]

EXAM STYLE 15

- Ca: [Ar] $4s^2$. The 4s sub-shell fills before 3d. [2]
- Cr: [Ar] $3d^5 4s^1$. This is the observed chromium exception. [2]
- Cu: [Ar] $3d^{10} 4s^1$. This is the observed copper exception. [2]
- Br^- : [Ar] $3d^{10} 4s^2 4p^6$. The student has not added the electron associated with the 1- charge. [2]

EXAM STYLE 16

- (a) A is correct. [1]
- (b) B pairs electrons in two orbitals while the third is empty, so it breaks the singly-before-pairing rule. [2]
- C places two same-spin electrons in one orbital; electrons sharing an orbital must have opposite spins. [2]

EXAM STYLE 17

- (a) The superscripts total 34, so the element is selenium, Se. [1]
- (b) [Ar] $3d^{10} 4s^2 4p^4$. [1]
- (c) Se^{2-} has 36 electrons and configuration [Kr]. [2]
- (d) Neutral Se, $4p^4$: $\uparrow \downarrow \mid \uparrow \mid \uparrow$. [2]

**EXAM STYLE 18**

- (a) The neutral atom has $18 - 2 = 16$ electrons, so it is sulfur, S. [2]
- (b) S^{2-} : $1s^2 2s^2 2p^6 3s^2 3p^6$. [2]
- (c) $3p^6$: $\uparrow\downarrow \mid \uparrow\downarrow \mid \uparrow\downarrow$. Every orbital is full and each pair has opposite spins. [2]

SECTION C**HARDER MIXED answers**

Translate unfamiliar information into a count, configuration and check

HARDER MIXED 19

- (a) Simple prediction: $[Ar] 3d^9 4s^2$. [2]
- (b) Y is copper, Cu; observed configuration $[Ar] 3d^{10} 4s^1$. [2]
- (c) $3d$: $\uparrow\downarrow \mid \uparrow\downarrow \mid \uparrow\downarrow \mid \uparrow\downarrow \mid \uparrow\downarrow$ [2]; $4s$: $\uparrow$ [1]. [3]

HARDER MIXED 20

- (a) A is S, B is Cl, C is Ar and D is K. [4]
- (b) Each species has configuration $[Ar]$. [1]

HARDER MIXED 21

- (a) Ga: $[Ar] 3d^{10} 4s^2 4p^1$; Ge: $[Ar] 3d^{10} 4s^2 4p^2$. [2]
- (b) Ga^{3+} : $31 - 3 = 28$; Ge^{4+} : $32 - 4 = 28$ electrons. [2]
- (c) Both ions are $[Ar] 3d^{10}$. [2]
- (d) The ions have the same electron count, so filling the same sub-shells gives the same configuration. [1]

HARDER MIXED 22

- (a) $10 + 2 + 4 = 16$ electrons, so the atom is sulfur, S. [2]
- (b) $1s^2 2s^2 2p^6 3s^2 3p^4$. [1]
- (c) S^{2-} has 18 electrons and configuration $[Ar]$. [2]
- (d) $3p^4$: $\uparrow\downarrow \mid \uparrow \mid \uparrow$; this demonstrates singly-before-pairing. [1]

HARDER MIXED 23

- (a) After 3p, the filling sequence is $4s \rightarrow 3d \rightarrow 4p$. [1]
- (b) Se: $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^4$. [2]
- (c) A configuration may conventionally be written with 3d before 4s [1]; the written order does not change the fact that 4s fills first [1]. [2]
- (d) $2 + 2 + 6 + 2 + 6 + 2 + 10 + 4 = 34$ electrons. [1]

STRETCH / SYNOPTIC 24

- (a) Atomic number 35 identifies bromine. Mass number = $35 + 44 = 79$, so the ion is $^{79}_{35}Br^-$. [2]
- (b) X^- : $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6$; the superscripts total 36. [2]
- (c) Neutral X: $[Ar] 3d^{10} 4s^2 4p^5$. [2]
- (d) Neutral X, $4p^5$: $\uparrow\downarrow \mid \uparrow\downarrow \mid \uparrow$ [2]. X^- , $4p^6$: $\uparrow\downarrow \mid \uparrow\downarrow \mid \uparrow\downarrow$ [2]. [4]

Final check: Every answer follows the notes' count, fill, stop, check route. If a total or charge is wrong, correct that before revisiting the filling rules.