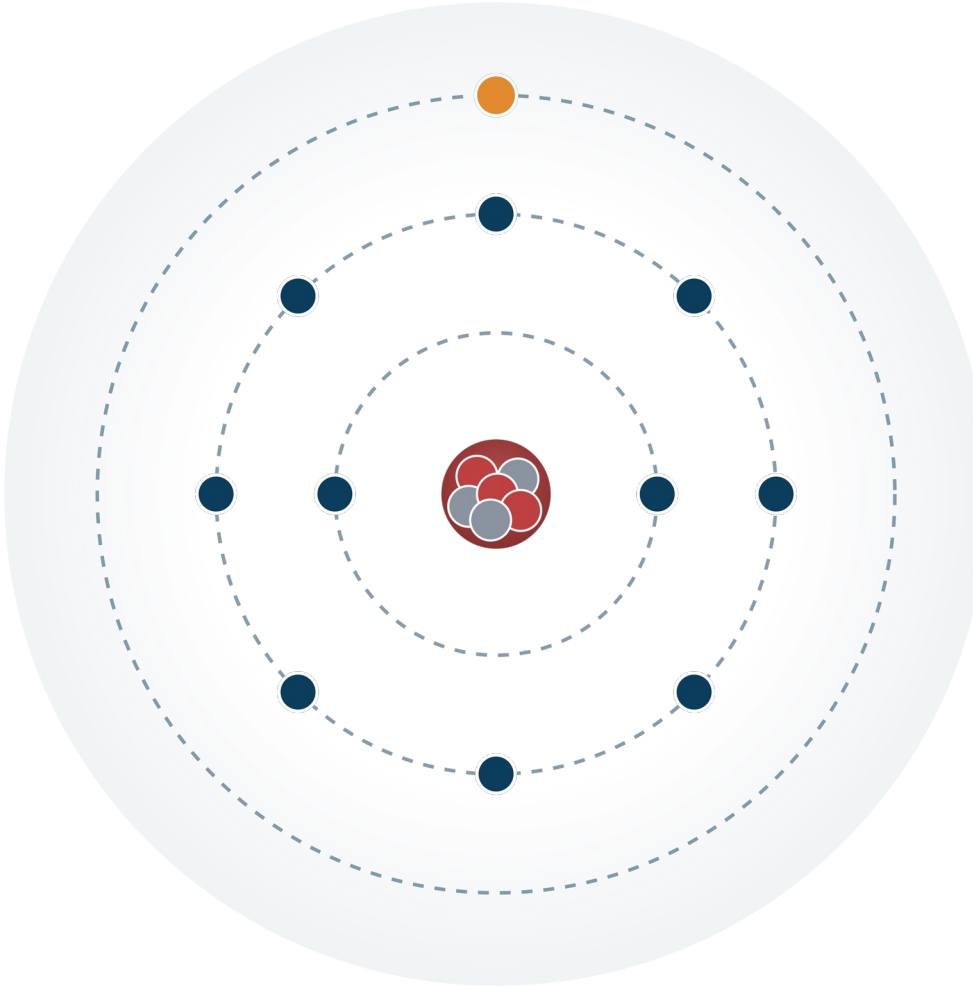
GCSE CHEMISTRY · TEACHING DECK

Atomic Structure

Chunk 1 of 6 — The structure of the atom

AQA 8462 | Edexcel 1CH0 | OCR J248 / J258

Common to all three boards · Foundation & Higher · every student covers this



Where we're going — 6 building blocks

1 The structure of the atom

Particles, nucleus & shells

YOU ARE HERE

2 Atomic & mass number

Protons, neutrons, electrons & ions

3 Size & scale of the atom

Standard form, mostly empty space

4 Isotopes & relative atomic mass

Weighted-mean A_r calculation

5 Electronic structure

Shell-filling & the periodic table

6 Development of the model

Dalton → Thomson → Rutherford → Bohr

This is the foundation session — bonding, the periodic table and quantitative chemistry all lean on it.

STARTER

~1 min

“Everything in this room — the desk, the air, you — is built from the same tiny building blocks. What are they, and what's inside one?”

Give students 60 seconds to jot down the three particles they remember.

1.

2.

3.

Tutor: write students' ideas in the boxes — we'll confirm the three particles next.

What is an atom?

An atom is the smallest part of an element that can exist.

- **Nucleus in the centre**

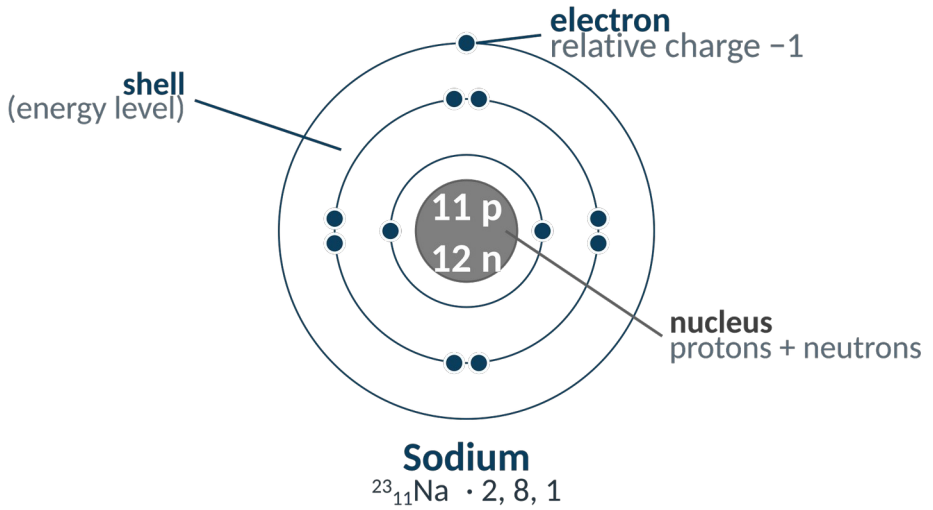
  Holds the protons and neutrons — tiny, but almost all the mass.

- **Electrons in shells**

  Arranged in shells (energy levels) around the nucleus.

- **Neutral overall**

  Number of protons = number of electrons, so the charges cancel.



This diagram is drawn to the standard students are expected to reproduce and label in the exam.

The three sub-atomic particles

Particle	Relative charge	Relative mass	Found in
Proton	+1	1	nucleus
Neutron	0	1	nucleus
Electron	−1	very small (~1/1836)	shells

Atoms are neutral

Equal protons (+) and electrons (−), so the charges cancel exactly.

Almost all the mass is in the nucleus

Electrons weigh almost nothing (~1/1836) — treat their mass as negligible.

BOARD NOTE

Same idea, different words: **Edexcel** gives the electron's relative mass as 1/1835; **OCR** often writes ~0.0005; **AQA** just calls it “very small”. All are accepted — teach “negligible”.

WORKED EXAMPLE

Tutor models the method — answer comes last

A neutral atom has 6 protons. How many electrons does it have, and what is its overall charge?

WORKING

1	**Neutral atom → electrons = protons**	The positive and negative charges must balance.
2	**So electrons = 6**	Equal to the number of protons.
3	**Overall charge = 0**	6 protons (+) and 6 electrons (−) cancel out.

Answer: 6 electrons; overall charge 0.

YOUR TURN

Have a go before we check — answers on the next slide.

1. State the relative charge and relative mass of a proton, a neutron and an electron.

2. Explain, in terms of particles, why an atom has no overall charge.

3. Where in the atom is almost all the mass found, and why?

Answer space is left blank on purpose — students write, tutor annotates.

ANSWERS

Tutor reveal

1

p: +1, mass 1 · n: 0, mass 1 · e: −1, mass negligible (~1/1836).

2

Equal numbers of protons (+) and electrons (−), so the charges cancel exactly.

3

In the nucleus — it holds the protons and neutrons, which carry nearly all the mass.

Watch out — and what to remember

COMMON SLIP-UPS

- ✕ **"Electrons have no mass."** They do — it's just negligible (~1/1836), not zero.
- ✕ **"The atom has no charged bits."** It's neutral because + and − balance, not because there's no charge.
- ✕ **Mixing up where mass sits** Nearly all the mass is in the nucleus, not the shells.

IN A NUTSHELL

- Atom = nucleus (protons + neutrons) + electrons in shells.
- Charges: p +1, n 0, e −1 · masses: p 1, n 1, e negligible.
- Neutral overall, and almost all the mass is in the nucleus.

NEXT

→ **Chunk 2 — Atomic number & mass number**

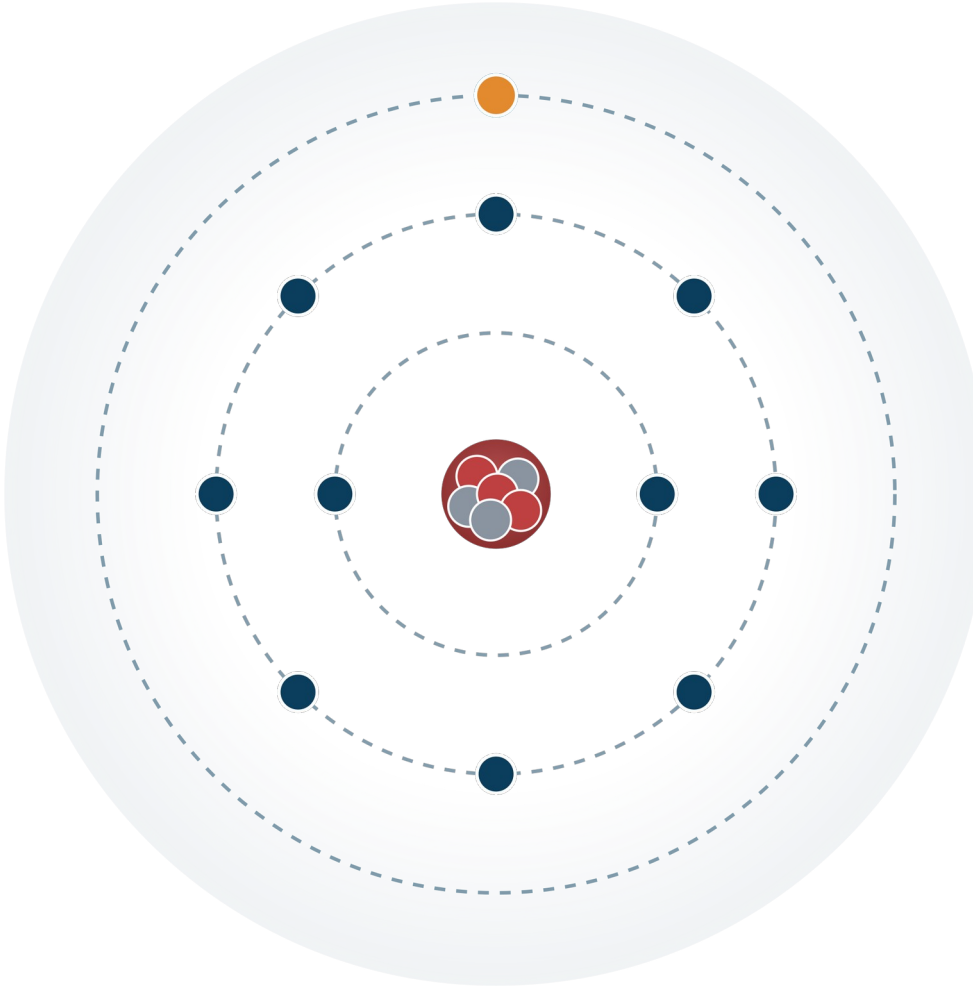
GCSE CHEMISTRY · TEACHING DECK

Atomic Structure

Chunk 2 of 6 — Atomic number & mass number

AQA 8462 | Edexcel 1CH0 | OCR J248 / J258

Ion calculations examinable on every board — teach for all students, all boards



Where we're going — 6 building blocks

1 The structure of the atom

Particles, nucleus & shells

2 Atomic & mass number

Protons, neutrons, electrons & ions

YOU ARE HERE

3 Size & scale of the atom

Standard form, mostly empty space

4 Isotopes & relative atomic mass

Weighted-mean A_r calculation

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Shell-filling & the periodic table

6 Development of the model

Dalton → Thomson → Rutherford → Bohr

Builds directly on Chunk 1 — same particles, now counted from an element's symbol.

STARTER

~1 min

“Two numbers next to an element's symbol tell you almost everything about how many of each particle it has. What are they?”

Give students a moment to recall the two numbers and where each sits next to the symbol.

Top-left number

Bottom-left number

Tutor: write students' ideas in the boxes — we'll confirm both numbers next.

Reading the notation



Atom vs ion — what changes, what doesn't

	Protons	Neutrons	Electrons
Neutral atom	= atomic number	= mass number − atomic number	= protons
Ion	unchanged	unchanged	protons ± charge

Nucleus never changes

Forming an ion only ever adds or removes electrons — protons and neutrons stay exactly the same.

WORKED EXAMPLE

Same atom, then as an ion

Magnesium: mass number 24, atomic number 12. Find its protons, neutrons and electrons.

WORKING

1. **Protons = atomic number = 12**
2. **Neutrons = 24 − 12 = 12**
3. **Electrons = protons (neutral) = 12**

Answer: 12 protons, 12 neutrons, 12 electrons.

Now as Mg^{2+} (same mass & atomic number). Find its protons, neutrons and electrons.

WORKING

1. **Protons = 12, neutrons = 12 — nucleus unchanged**
2. **2+ ion → lost 2 electrons**
3. **Electrons = 12 − 2 = 10**

Answer: 12 protons, 12 neutrons, 10 electrons.

YOUR TURN

Have a go before we check — answers on the next slide.

1. Define atomic number and mass number.

2. An atom has atomic number 17 and mass number 35. Give its protons, neutrons and electrons.

3. An atom has 26 protons and a mass number of 56. How many neutrons does it have?

4. A fluoride ion, F^-, has atomic number 9 and mass number 19. Give its protons, neutrons and electrons.

Answer space is left blank on purpose — students write, tutor annotates.

ANSWERS

Tutor reveal

1

Atomic number = number of protons. Mass number = protons + neutrons.

2

17 protons, 18 neutrons (35 − 17), 17 electrons.

3

56 − 26 = 30 neutrons.

4

9 protons, 10 neutrons (19 − 9), 10 electrons (9 + 1, since a 1− ion has gained one electron).

Watch out — and what to remember

COMMON SLIP-UPS

- ✕ **Muddling the two numbers** Atomic number = protons only; mass number = protons + neutrons. Subtracting the wrong way round is the #1 error.
- ✕ **Ion changes the nucleus** It doesn't. Only electrons move — protons and neutrons stay exactly the same.
- ✕ **Negative ion → subtracting electrons** A 1− ion has GAINED an electron, so add, not subtract.

IN A NUTSHELL

- Protons = atomic number · neutrons = mass − atomic number.
- Neutral atom: electrons = protons.
- Ion: nucleus unchanged; electrons = protons ± charge.

NEXT

→ **Chunk 3 — Size & scale of the atom**

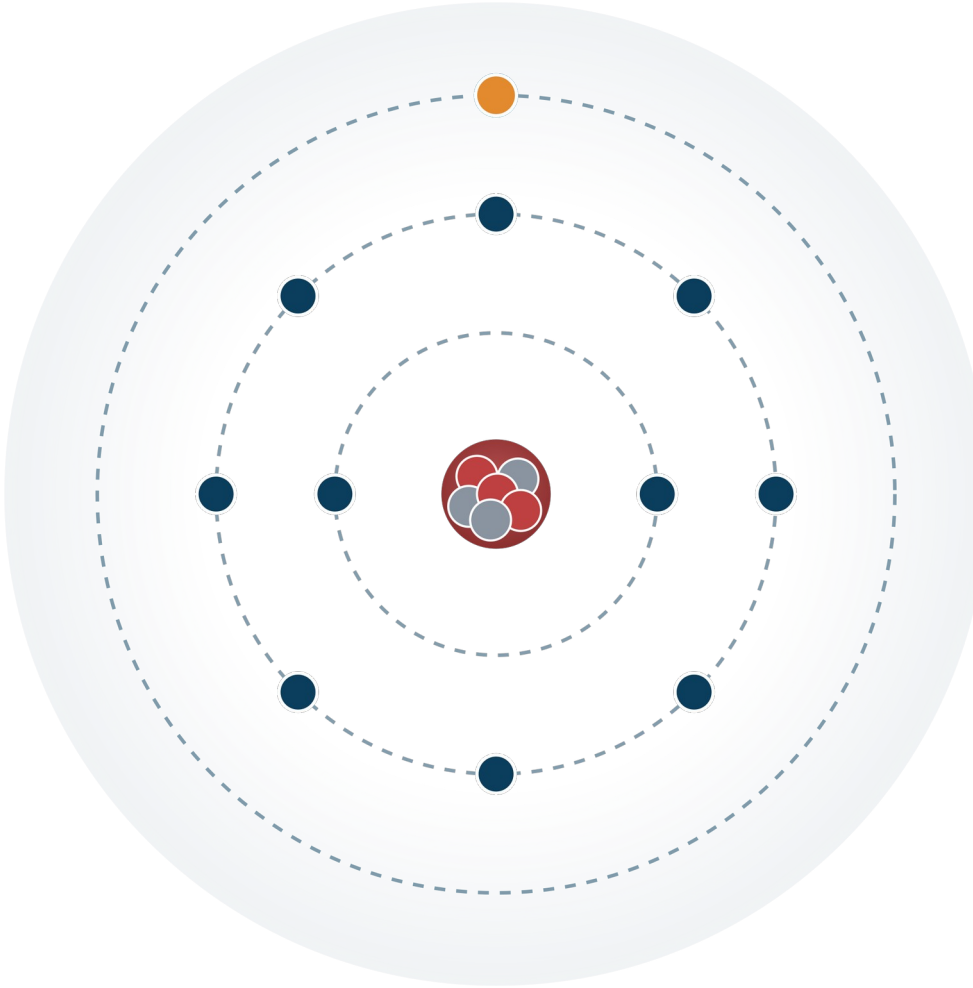
GCSE CHEMISTRY · TEACHING DECK

Atomic Structure

Chunk 3 of 6 — Size & scale of the atom

AQA 8462 | Edexcel 1CH0 | OCR J248 / J258

Small numbers, big exam marks — get the standard form right



Where we're going — 6 building blocks

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Standard form, mostly empty space

YOU ARE HERE

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A short, focused chunk — one big idea about scale, and the standard-form notation to go with it.

STARTER

~1 min

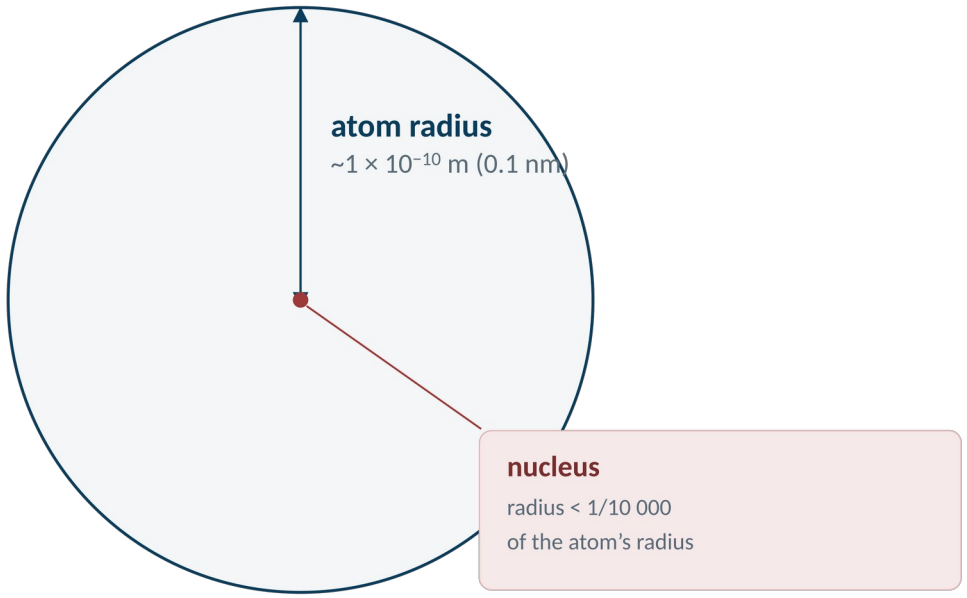
“If an atom were the size of a football stadium, the nucleus would be smaller than a pea in the centre. Roughly how does that ratio show up in the numbers?”

Give students a moment to guess how many times smaller the nucleus is than the atom.

Their guess:

Tutor: any answer in the right ballpark (thousands to tens of thousands) is a good sign — we'll confirm the exact figure next.

The atom is mostly empty space



Almost all the mass is here — in a tiny fraction of the volume

Atoms are tiny

Radius of about 0.1 nm — that's 1×10^{-10} m.

The nucleus is far smaller still

Its radius is less than 1/10 000 of the atom's radius.

Almost all the mass, almost none of the space

The nucleus holds nearly all the mass but only a tiny fraction of the volume — the rest is (mostly empty) space occupied by the electrons.

WORKED EXAMPLE

Tutor models the method — answer comes last

An atom has a radius of 1×10^{-10} m. Estimate the radius of its nucleus.

WORKING

1	**Nucleus radius < 1/10 000 of the atom's radius**	That's the rule to apply.
2	**= $(1 \times 10^{-10}) \div 10\,000$**	Divide the atom's radius by 10 000.
3	**= 1×10^{-14} m (or smaller)**	This is an upper estimate — the true value may be smaller still.

Answer: nucleus radius ≈ 1×10^{-14} m (or smaller).

YOUR TURN

Have a go before we check — answers on the next slide.

1. State the approximate radius of an atom, in standard form.

2. How does the radius of the nucleus compare with the radius of the atom?

3. Where is almost all of an atom's mass concentrated?

Answer space is left blank on purpose — students write, tutor annotates.

ANSWERS

Tutor reveal

1

About 1×10^{-10} m (0.1 nm).

2

The nucleus radius is less than 1/10 000 of the atom's radius.

3

In the nucleus.

Watch out — and what to remember

COMMON SLIP-UPS

- **Losing marks on standard form itself** 1×10^{-10} m is not the same as 10^{-10} m or 1×10^{10} m — the sign and the '1 ×' both matter.
- **Thinking the nucleus is a fixed size** It's a ratio, not a set number — 'less than 1/10 000 of the atom's radius', which changes atom to atom.
- **Forgetting where the mass is** Nearly all the mass is in the nucleus, even though it's a tiny fraction of the volume — small and heavy, not small and light.

IN A NUTSHELL

- Atom radius: about 1×10^{-10} m (0.1 nm).
- Nucleus radius: less than 1/10 000 of that.
- Nearly all the mass, almost none of the volume.

NEXT

Chunk 4 — Isotopes & relative atomic mass

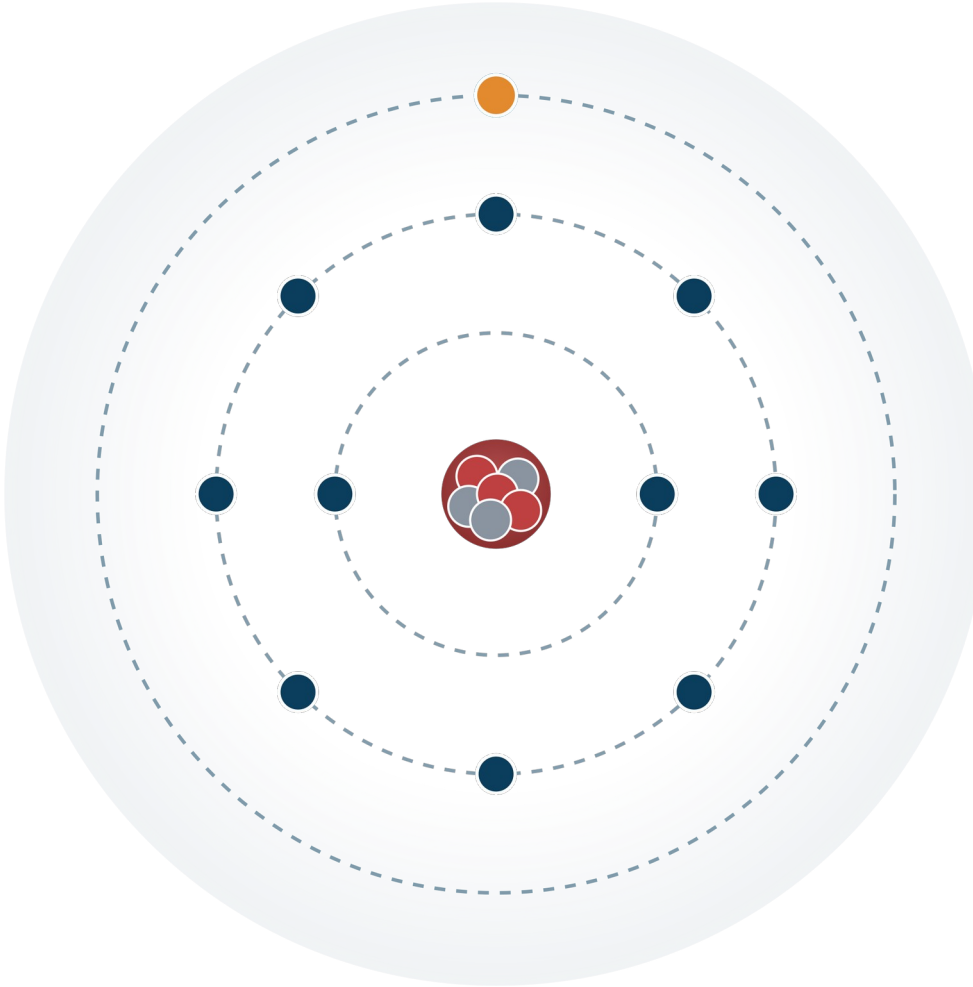
GCSE CHEMISTRY · TEACHING DECK

Atomic Structure

Chunk 4 of 6 — Isotopes & relative atomic mass

AQA 8462 | Edexcel 1CH0 | OCR J248 / J258

The Ar calculation is the key exam skill — practise it hard



Where we're going — 6 building blocks

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Standard form, mostly empty space

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YOU ARE HERE

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Dalton → Thomson → Rutherford → Bohr

The longest chunk in the topic — the weighted-mean calculation needs real practice time.

STARTER

~1 min

“Not every atom of carbon has the same mass. How can that be true, if they're all definitely carbon?”

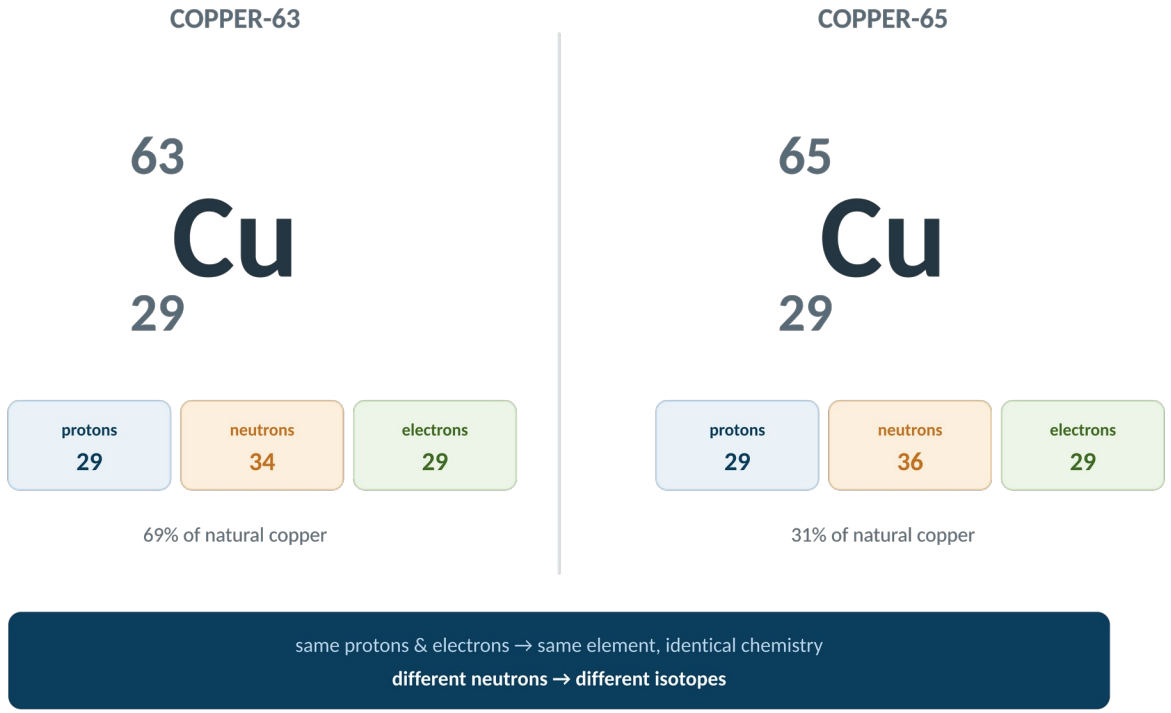
Give students a moment to think — what could differ between two carbon atoms, if not the number of protons?

Their idea:

Tutor: if 'neutrons' comes up, that's the whole answer — confirm it on the next slide.

What is an isotope?

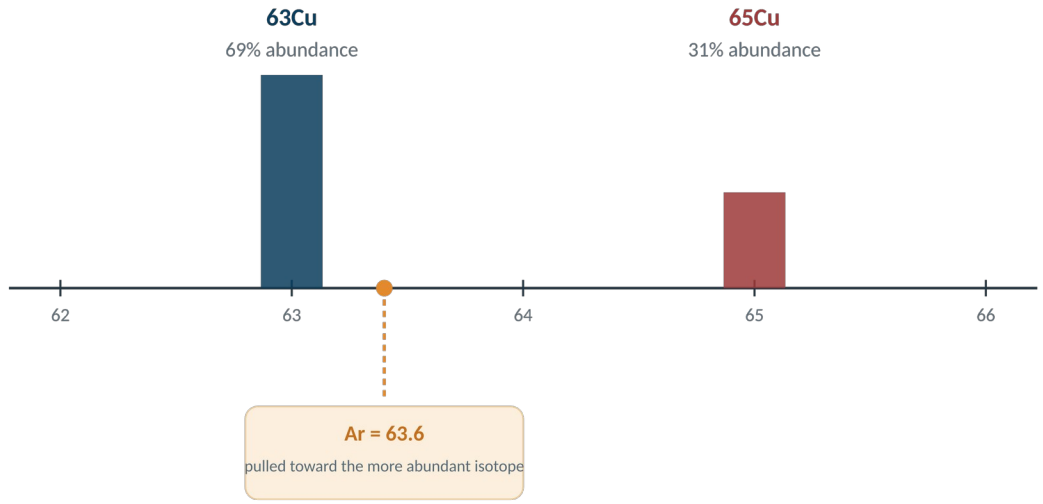
Isotopes are atoms of the same element (same atomic number) with different numbers of neutrons — so they have the same atomic number but different mass numbers.



Relative atomic mass (Ar) — a weighted mean

Ar is the weighted mean mass of an element's atoms, taking the abundance of each isotope into account. This is why Ar values on the periodic table are often not whole numbers.

$$Ar = \Sigma(\text{isotope mass} \times \%\ \text{abundance}) \div 100$$



WORKED EXAMPLE

Tutor models the method — answer comes last

Copper has two isotopes: 63Cu (69% abundance) and 65Cu (31% abundance). Calculate its relative atomic mass.

WORKING

1	**Multiply each isotope mass by its % abundance**	(63 × 69) + (65 × 31)
2	**= 4347 + 2015**	Add the two products together.
3	**÷ 100**	Divide by 100 to get the weighted mean.
4	**= 63.6**	Rounded to 1 decimal place.

Answer: Ar = 63.6

YOUR TURN

Have a go before we check — answers on the next slide.

1. Define "isotope" in one sentence.

2. Boron is 20% ^{10}B and 80% ^{11}B. Calculate its relative atomic mass.

3. Explain why isotopes of the same element have identical chemical reactions.

Answer space is left blank on purpose — students write, tutor annotates.

ANSWERS

Tutor reveal

1

Atoms with the same number of protons but different numbers of neutrons.

2

(10×20 + 11×80) ÷ 100 = (200 + 880) ÷ 100 = 10.8.

3

Same electronic structure (same outer electrons) — and chemistry depends on electrons, not neutrons.

Watch out — and what to remember

COMMON SLIP-UPS

- **Dividing by 2, not 100** This turns a weighted mean into a simple average — always divide by 100 (the total % abundance).
- **"Isotope" = different element** Wrong — same element, same protons. Only the neutrons (and so the mass) differ.
- **Assuming isotopes react differently** They don't — same electronic structure means identical chemistry. Only physical properties (like density) can differ slightly.

IN A NUTSHELL

- Isotopes: same protons, different neutrons.
- Same chemistry, can differ slightly in physical properties.
- Ar = Σ(mass × % abundance) ÷ 100.

NEXT

Chunk 5 — Electronic structure

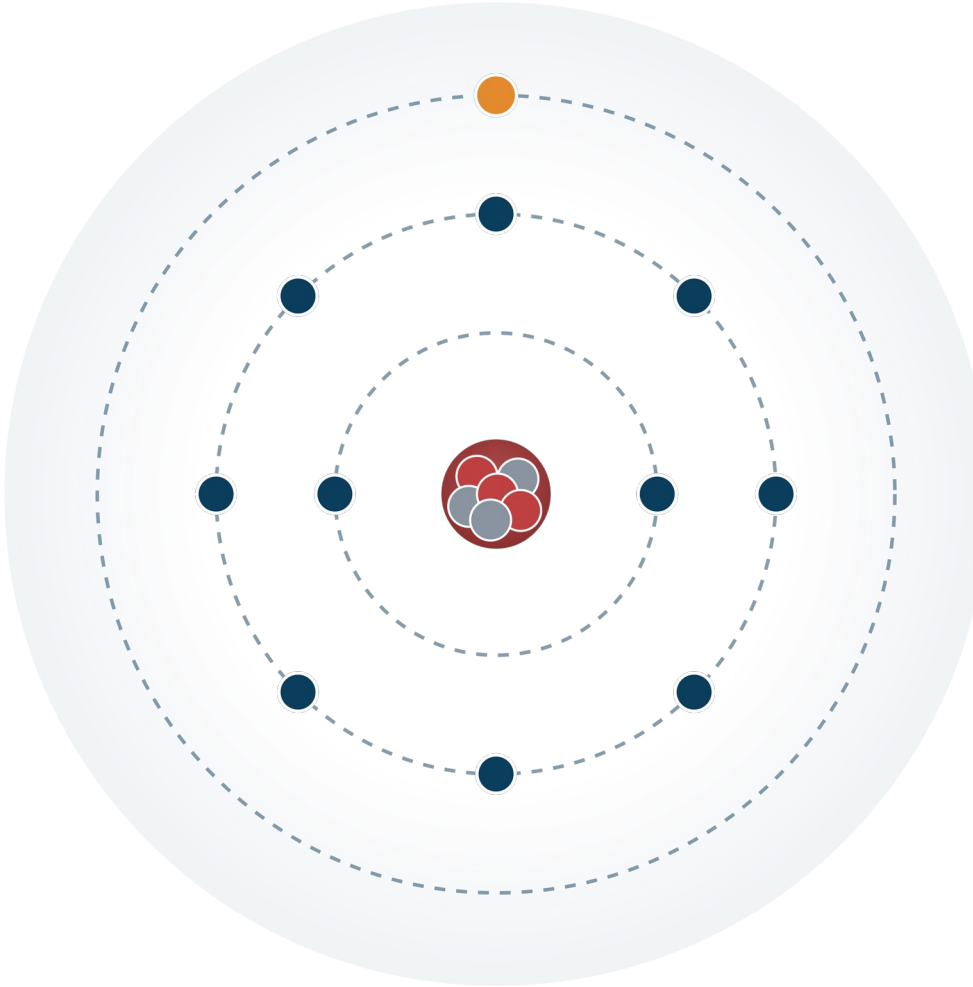
GCSE CHEMISTRY · TEACHING DECK

Atomic Structure

Chunk 5 of 6 — Electronic structure

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Shell-filling rules — the foundation for the whole periodic table



Where we're going — 6 building blocks

1 The structure of the atom

Particles, nucleus & shells

2 Atomic & mass number

Protons, neutrons, electrons & ions

3 Size & scale of the atom

Standard form, mostly empty space

4 Isotopes & relative atomic mass

Weighted-mean A_r calculation

5 Electronic structure

Shell-filling & the periodic table

YOU ARE HERE

6 Development of the model

Dalton → Thomson → Rutherford → Bohr

Sets up the periodic table link — shells and outer electrons explain the whole layout.

STARTER

~1 min

“Electrons don't just float randomly around the nucleus — they fill in a strict order, shell by shell. What's the pattern?”

Give students a moment to recall the maximum number of electrons in each of the first few shells.

Their idea:

Tutor: write students' ideas in the box — we'll confirm the exact numbers next.

Filling the shells

- **Innermost shell fills first**

  Electrons occupy the lowest-energy shell before any higher one.

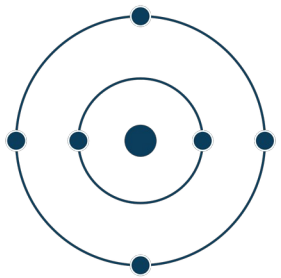
- **Maximum per shell (at GCSE)**

  1st shell = 2 · 2nd shell = 8 · 3rd shell = 8.

- **Each shell fills completely before the next starts**

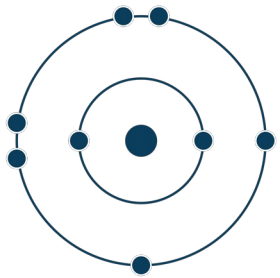
  Write the configuration as numbers separated by commas, e.g. sodium (11) = 2,8,1.

Carbon (6)



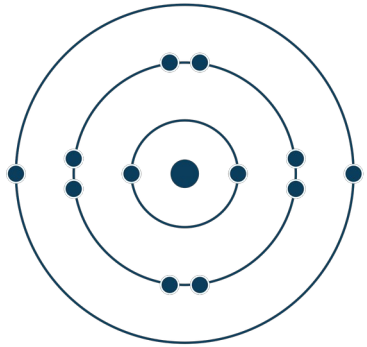
2, 4

Oxygen (8)



2, 6

Magnesium (12)



2, 8, 2

The link to the periodic table

Number of shells = the **period** (row). **Number of outer-shell electrons** = the **group** (column).

Period / Group	1	2											3	4	5	6	7	0
1	1 H hydrogen 1																	4 He helium 2
2	7 Li lithium 3	9 Be beryllium 4											11 B boron 5	12 C carbon 6	14 N nitrogen 7	16 O oxygen 8	19 F fluorine 9	20 Ne neon 10
3	23 Na sodium 11	24 Mg magnesium 12											27 Al aluminium 13	28 Si silicon 14	31 P phosphorus 15	32 S sulfur 16	36 Cl chlorine 17	40 Ar argon 18
4	39 K potassium 19	40 Ca calcium 20	45 Sc scandium 21	48 Ti titanium 22	51 V vanadium 23	52 Cr chromium 24	55 Mn manganese 25	56 Fe iron 26	59 Co cobalt 27	59 Ni nickel 28	64 Cu copper 29	65 Zn zinc 30	70 Ga gallium 31	73 Ge germanium 32	75 As arsenic 33	79 Se selenium 34	80 Br bromine 35	84 Kr krypton 36
5	86 Rb rubidium 37	88 Sr strontium 38	89 Y yttrium 39	91 Zr zirconium 40	93 Nb niobium 41	96 Mo molybdenum 42	[98] Tc technetium 43	101 Ru ruthenium 44	103 Rh rhodium 45	106 Pd palladium 46	108 Ag silver 47	112 Cd cadmium 48	115 In indium 49	119 Sn tin 50	122 Sb antimony 51	128 Te tellurium 52	127 I iodine 53	131 Xe xenon 54
6	133 Cs caesium 55	137 Ba barium 56	139 La lanthanum 57	178 Hf hafnium 72	181 Ta tantalum 73	184 W tungsten 74	186 Re rhenium 75	190 Os osmium 76	192 Ir iridium 77	195 Pt platinum 78	197 Au gold 79	201 Hg mercury 80	204 Tl thallium 81	207 Pb lead 82	209 Bi bismuth 83	[209] Po polonium 84	[210] At astatine 85	[222] Rn radon 86
7	[223] Fr francium 87	[226] Ra radium 88	[227] Ac actinium 89	[267] Rf rutherford. 104	[268] Db dubnium 105	[271] Sg seaborgium 106	[272] Bh bohrium 107	[270] Hs hassium 108	[276] Mt meitnerium 109	[281] Ds darmstadti. 110	[280] Rg roentgenium 111	[285] Cn copernicium 112	[286] Nh nihonium 113	[289] Fl flerovium 114	[290] Mc moscovium 115	[293] Lv livermorium 116	[294] Ts tennessine 117	[294] Og oganesson 118

Carbon, oxygen and magnesium highlighted — same three elements from the shell diagrams.

WORKED EXAMPLE

Tutor models the method — answer comes last

Give the electronic structure of chlorine (17) and use it to find its group and period.

WORKING

1	**Fill shells: 2, then 8, then remainder**	17 electrons total → 2 + 8 = 10, leaving 7 for the third shell.
2	**Electronic structure = 2, 8, 7**	Three shells used in total.
3	**3 shells → period 3**	Number of shells = period.
4	**7 outer electrons → group 7**	Number of outer electrons = group.

Answer: 2,8,7 — period 3, group 7.

YOUR TURN

Have a go before we check — answers on the next slide.

1. State the maximum number of electrons in the first, second and third shells.

2. Write the electronic structures of: nitrogen (7), oxygen (8), aluminium (13), argon (18).

3. An atom has electronic structure 2,8,8,2. What are its period and group?

Answer space is left blank on purpose — students write, tutor annotates.

ANSWERS

Tutor reveal

1

2, 8, 8.

2

N: 2,5 · O: 2,6 · Al: 2,8,3 · Ar: 2,8,8.

3

Period 4 (4 shells); group 2 (2 outer electrons).

Watch out — and what to remember

COMMON SLIP-UPS

- **Filling shells out of order** The innermost shell must fill completely (to its maximum) before the next shell gets any electrons.
- **Forgetting the shell maximums** 1st = 2, 2nd = 8, 3rd = 8 — these caps are fixed at GCSE, not guesses.
- **Mixing up period and group** Shells → period (row). Outer electrons → group (column). Easy to say backwards under pressure.

IN A NUTSHELL

- Shells fill innermost first: 2, 8, 8.
- Each shell fills fully before the next starts.
- Shells = period; outer electrons = group.

NEXT

→ **Chunk 6 — Development of the atomic model**

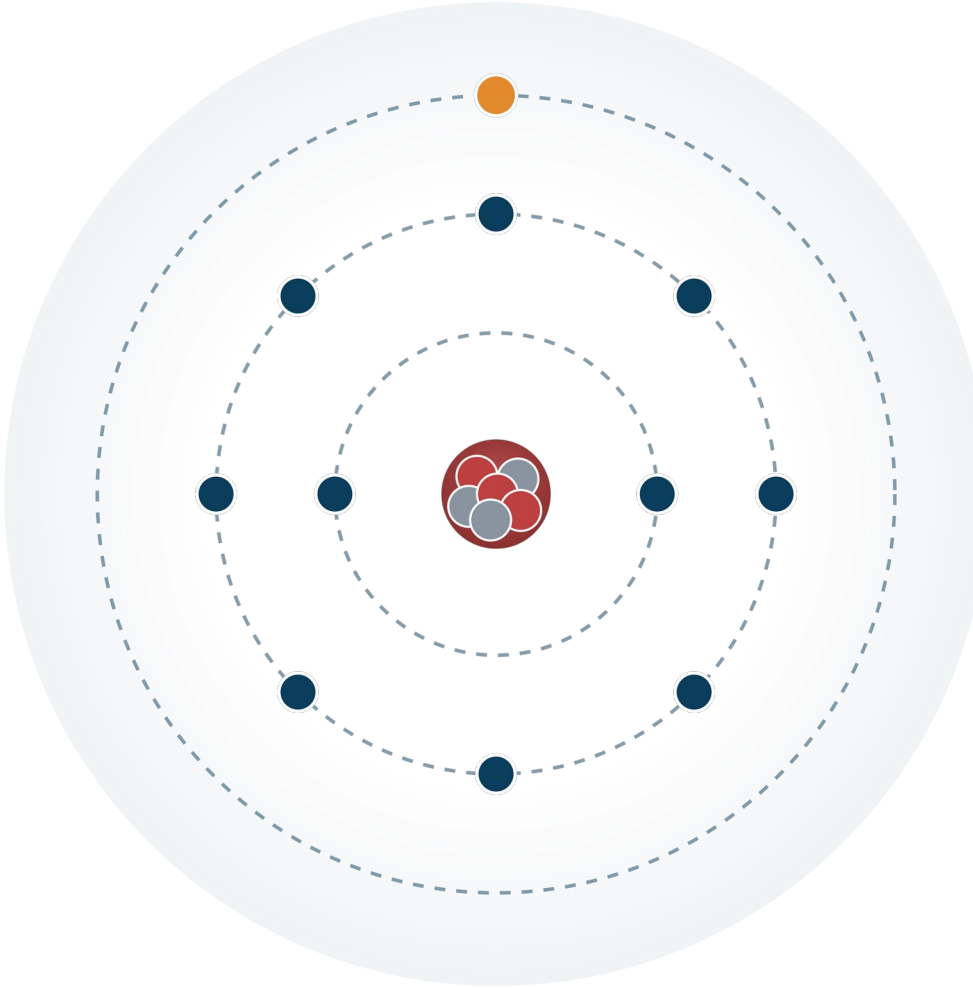
GCSE CHEMISTRY · TEACHING DECK

Atomic Structure

Chunk 6 of 6 — Development of the atomic model

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Models change as new evidence arrives — the classic 'how science works' chunk



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Dalton → Thomson → Rutherford → Bohr

YOU ARE HERE

The final chunk — then a whole-topic review pulling everything together.

STARTER

~1 min

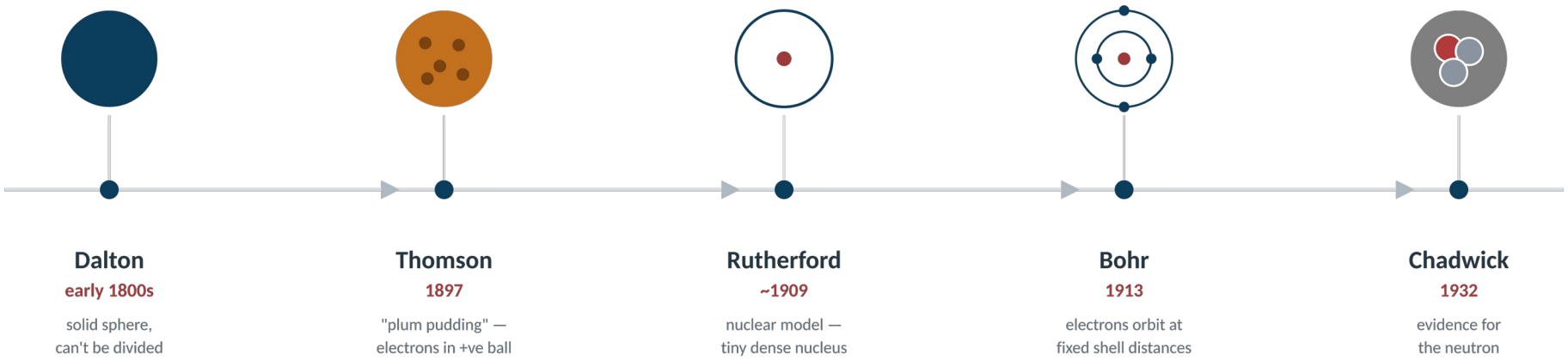
“Scientists once thought the atom was a solid, indivisible ball, then a 'plum pudding'. What changed their minds — twice?”

Give students a moment to think — what kind of thing would make a scientist abandon a model completely?

Their idea:

Tutor: the answer both times is new experimental evidence — that's the theme of this whole chunk.

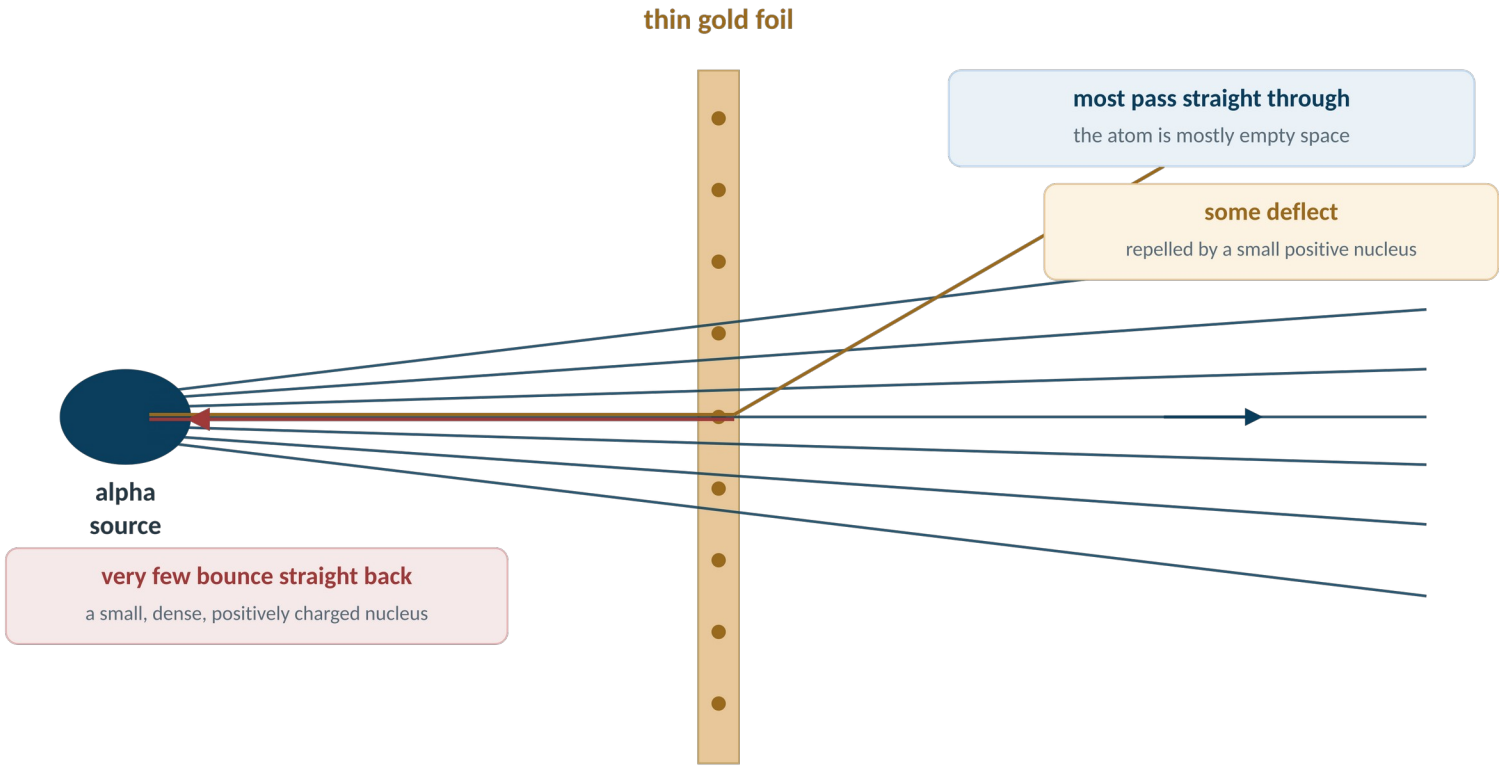
Five scientists, five models



- **Dalton (early 1800s)** Atoms are tiny solid spheres that can't be divided.
- **Thomson (1897)** Discovered the electron — led to the "plum pudding" model: a ball of positive charge with negative electrons embedded in it.

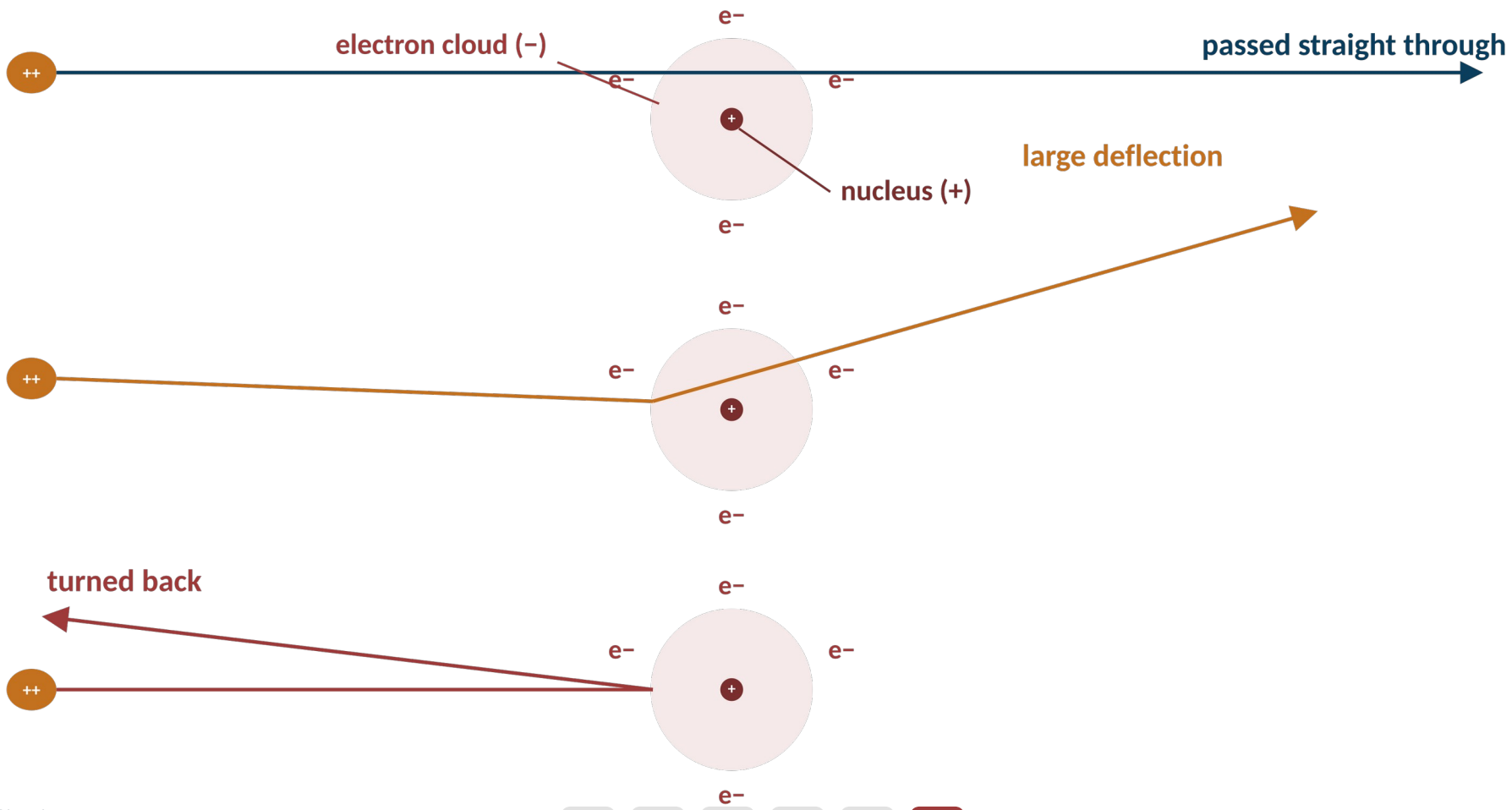
Rutherford's alpha-scattering experiment

Rutherford, with Geiger & Marsden (~1909): fired alpha particles at thin gold foil.



Zooming in — why each outcome happens

Same experiment, atom by atom: the outcome depends entirely on how close each particle passes to a nucleus.



Bohr's shells, and Chadwick's neutron

Bohr

Proposed that electrons orbit at fixed distances in shells (energy levels) — this matched experimental observations and explained why atoms don't collapse.

Chadwick (1932)

Provided the evidence for the existence of neutrons within the nucleus.

BOARD NOTE — affects what you need to teach

AQA explicitly states Chadwick's experimental work is **not required** — just the fact and the date (1932). Don't teach the method itself.
Edexcel frames this whole chunk as spec point 1.1: "describe how the Dalton model changed over time" — teach it as a sequence.
AQA (4.1) also uses this as the example of how scientific models develop as new evidence emerges — good prep for a "why did the model change?" extended-writing question.

WORKED EXAMPLE

Tutor models the method — answer comes last

Explain how the alpha-scattering results provided evidence against the plum-pudding model.

WORKING

1	**Most particles passed straight through**	So the atom must be mostly empty space — impossible for a solid ball of charge.
2	**A few deflected or bounced straight back**	Something small and dense must have repelled them.
3	**Only a positive nucleus explains repulsion**	A uniform positive "pudding" could never repel a fast alpha particle this strongly.

Answer: mostly empty space + a small dense +ve nucleus — impossible under plum pudding.

YOUR TURN

Have a go before we check — answers on the next slide.

1. Put the models in order: Bohr, Dalton, nuclear (Rutherford), plum pudding (Thomson).

2. Which particle's discovery led to the plum-pudding model, and how did that model have to change afterwards?

3. Describe the alpha-scattering experiment and its two key observations.

4. Who is credited with discovering the neutron, and in what year?

Answer space is left blank on purpose — students write, tutor annotates.

ANSWERS

Tutor reveal

1

Dalton → Thomson (plum pudding) → Rutherford (nuclear) → Bohr.

2

The electron; the atom could no longer be an indivisible sphere — it contained smaller negative particles.

3

Alpha particles fired at thin gold foil: most passed through (mostly empty space); a few deflected or bounced back (small, dense, positive nucleus).

4

James Chadwick, 1932.

Common mistakes — across all 6 chunks

✕ Muddling atomic number and mass number

Chunk 2

Atomic number = protons only; mass number = protons + neutrons. Students often subtract the wrong way round when finding neutrons.

✕ Saying isotopes are "different elements"

Chunk 4

They're the same element (same protons) with different neutrons — swapping this loses the definition mark.

✕ Forgetting electron shells must fill in order

Chunk 5

A shell can't start filling until the one before it is full — students sometimes split electrons unevenly across shells.

✕ Describing plum pudding as having a nucleus

Chunk 6

It doesn't — that's the whole point of the model, and exactly what Rutherford's experiment later disproved.

EXIT QUESTIONS

Pulls together Chunks 1–5 — answers on the next slide.

1 An atom has atomic number 9 and mass number 19. Give its protons, neutrons and electrons, and its electronic structure.

2 Chlorine is 75% ^{35}Cl and 25% ^{37}Cl. Calculate its relative atomic mass.

3 Describe the alpha-scattering experiment and explain what it showed about the structure of the atom.

4 A sodium ion, Na^+, has atomic number 11 and mass number 23. Give its protons, neutrons and electrons.

ANSWERS

Tutor reveal

1

9 protons, 10 neutrons (19−9), 9 electrons; electronic structure 2,7.

2

(35×75 + 37×25) ÷ 100 = (2625+925) ÷ 100 = 35.5.

3

Alpha particles fired at thin gold foil: most passed straight through (atom mostly empty space); a few deflected or bounced back (small, dense, positive nucleus) — this disproved plum pudding and led to the nuclear model.

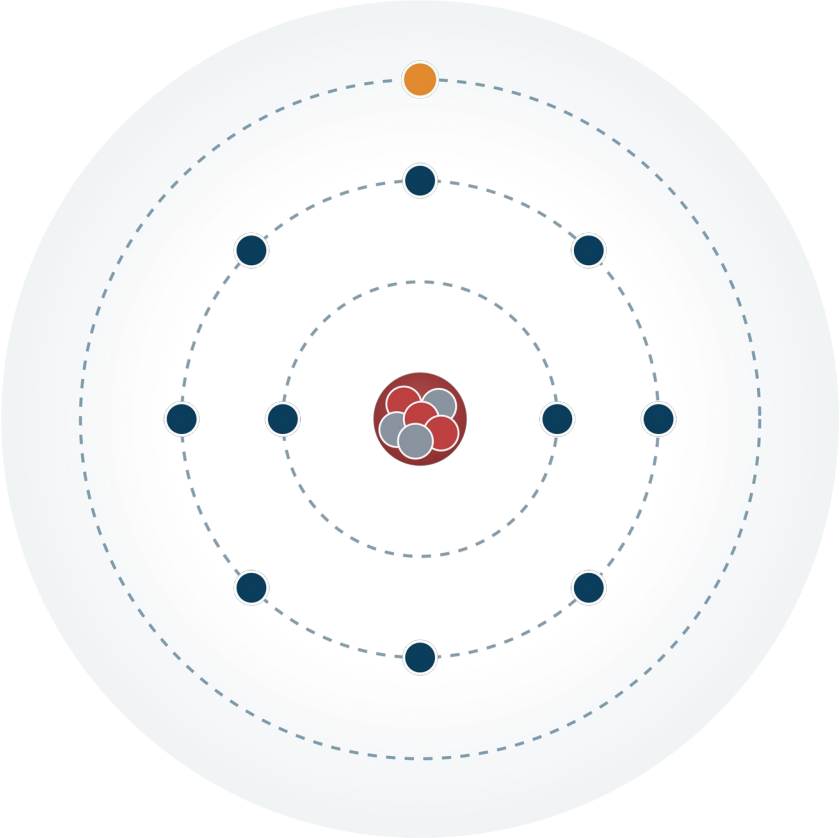
4

11 protons, 12 neutrons (23−11), 10 electrons (11−1, since a 1+ ion has lost one electron).

TOPIC COMPLETE

Atomic Structure

All 6 chunks done — nucleus to periodic table to the history of the model.



- 1. The structure of the atom
- 2. Atomic & mass number
- 3. Size & scale of the atom
- 4. Isotopes & relative atomic mass
- 5. Electronic structure
- 6. Development of the atomic model

This topic underpins bonding, the periodic table, and quantitative chemistry — worth revisiting before those.