

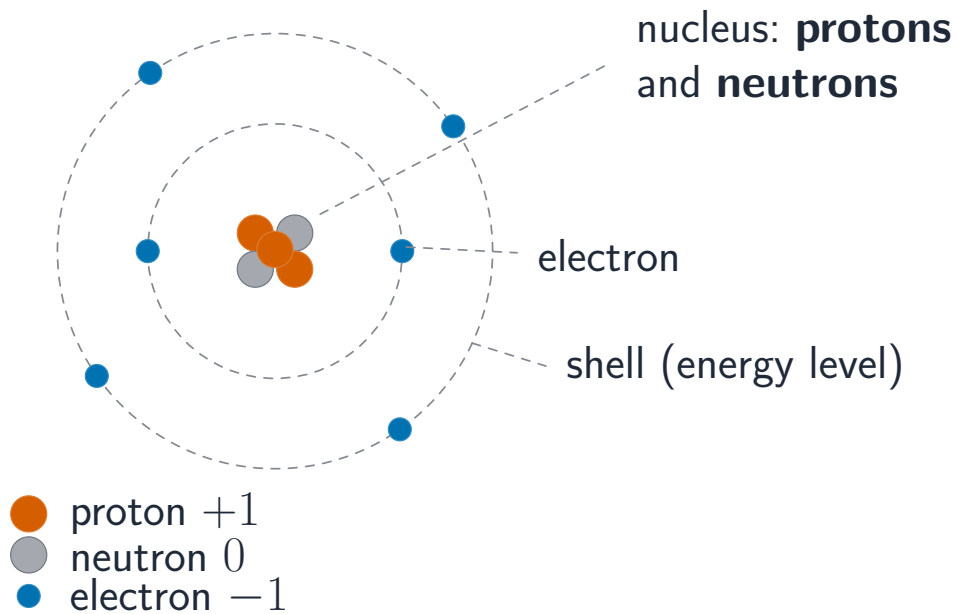
Exercise walk-through

1.1

Particles in the atom and atomic radius

A-Level Chemistry

Inside the atom



A tiny **nucleus** of **protons** (+1) and **neutrons** (0) holds nearly all the mass; **electrons** (-1, ~0 mass) move in **shells**.

Relative charge and relative mass

We compare the three particles using **relative charge** and **relative mass**

.

These are simple numbers, not real units.

Counting particles

proton number

nucleon number

 A neutrons = $A - Z$ **Worked example:** ${}_{13}^{27}\text{Al}^{3+}$ 13 protons; $27 - 13 = 14$ neutrons; $13 - 3 = 10$ electrons (lost 3 to become $3+$)

A positive **ion** (**cation**) has fewer electrons than protons; a negative ion (**anion**) has more.

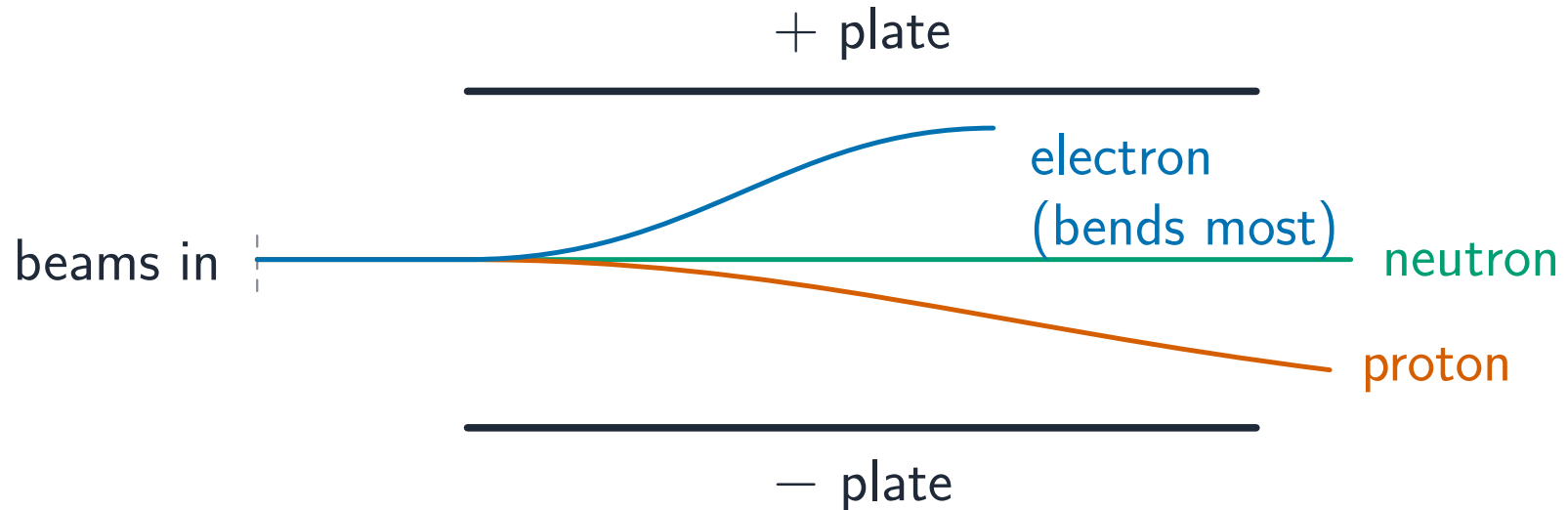
How mass and charge are spread out

Almost all the mass sits in the nucleus, because protons and neutrons are heavy and electrons are very light.

All the positive charge is in the nucleus (the protons).

Beams in an electric field

- proton bends to the $-$ plate
- electron bends to the $+$ plate, **far more** (much lighter)
- neutron goes straight (no charge)



Exercises 2.1·3.1

2.1 State the relative charge and relative mass of a neutron. [2]

2.2 Give the number of protons, neutrons and electrons in ${}^{40}_{20}\text{Ca}^{2+}$. [3]

3.1 Which particle is deflected **most** in an electric field, and toward which plate? [1]

- ☐ **A** the proton, toward the positive plate
B the electron, toward the positive plate
C the neutron, toward the negative plate
D the electron, toward the negative plate

Exercises 2.1·3.1

2.1 State the relative charge and relative mass of a neutron. [2]

2.1

- relative charge 0; relative mass 1
-

2.2 Give the number of protons, neutrons and electrons in ${}_{20}^{40}\text{Ca}^{2+}$. [3]

2.2

- protons 20; neutrons $40 - 20 = 20$; electrons $20 - 2 = 18$
-

3.1 Which particle is deflected **most** in an electric field, and toward which plate? [1]

☐

- A the proton, toward the positive plate
- B the electron, toward the positive plate
- C the neutron, toward the negative plate
- D the electron, toward the negative plate

3.1 B

- The electron is lightest, so it deflects most, toward the positive plate

Exercise 3.2

3.2 Across Period 3, the atomic radius decreases because:

[1]

☐

A more shells are added

B the nuclear charge increases while shielding stays about the same

C the electrons repel each other more

D the atoms gain neutrons

Exercise 3.2

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[1]

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3.2 B

- The rising nuclear charge with similar shielding pulls the outer shell in

Exercise 3.3

3.3 (a) Explain why a sodium ion, Na^+ , is smaller than a sodium atom. [2]

(b) The ions Na^+ , Mg^{2+} and Al^{3+} all have 10 electrons. State and explain which is smallest. [2]

Exercise 3.3

3.3 (a) Explain why a sodium ion, Na^+ , is smaller than a sodium atom. [2]

(b) The ions Na^+ , Mg^{2+} and Al^{3+} all have 10 electrons. State and explain which is smallest. [2]

3.3

(a)

- Na^+ has lost its outer (third) shell, so it has one fewer shell; the remaining electrons are pulled in more strongly by the same nucleus

(b)

- Al^{3+} is smallest; it has the most protons (13) for the same 10 electrons, so the strongest pull per electron

Exercise 3.4

3.4 Explain why the atomic radius increases down Group 2.

[2]

Exercise 3.4

3.4 Explain why the atomic radius increases down Group 2.

[2]

3.4

- each step down Group 2 adds a shell, so the outer electrons are further out and more shielded from the nucleus

Exercise 3.5 (a)

3.5 The table gives the particles in four species.

Species	Protons	Neutrons	Electrons
A	12	12	10
B	8	10	10
C	12	14	12
D	17	18	18

(a) Identify each species, giving its symbol with mass number and any charge.

[4]

Exercise 3.5 (a)

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(a)

- **A** $^{24}\text{Mg}^{2+}$, **B** $^{18}\text{O}^{2-}$, **C** ^{26}Mg , **D** $^{35}\text{Cl}^{-}$. Mass number = protons + neutrons; the charge is protons – electrons

Exercise 3.5 (b)

3.5 The table gives the particles in four species.

Species	Protons	Neutrons	Electrons
A	12	12	10
B	8	10	10
C	12	14	12
D	17	18	18

(b) State which two species contain nuclei of the same element, and explain how you can tell.

[2]

Exercise 3.5 (b)

3.5 The table gives the particles in four species.

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(b) State which two species contain nuclei of the same element, and explain how you can tell. [2]

(b)

- **A** and **C** – both have 12 protons, and the proton number is what fixes the element

Exercise 3.5 (c)

3.5 The table gives the particles in four species.

Species	Protons	Neutrons	Electrons
A	12	12	10
B	8	10	10
C	12	14	12
D	17	18	18

(c) Explain, in terms of shells and of the attraction between the nucleus and the outer electrons, why **A** is much smaller than **C**. [3]

Exercise 3.5 (c)

3.5 The table gives the particles in four species.

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(c) Explain, in terms of shells and of the attraction between the nucleus and the outer electrons, why **A** is much smaller than **C**. [3]

(c)

- **A** has lost both 3s electrons, so its outermost occupied shell is now the second, not the third; the same 12 protons now hold only 10 electrons, so the pull per electron is greater; there is also less electron–electron repulsion, so the remaining shells are drawn in

Exercise 3.5 (d)

3.5 The table gives the particles in four species.

Species	Protons	Neutrons	Electrons
A	12	12	10
B	8	10	10
C	12	14	12
D	17	18	18

(d) Predict, with a reason, whether **D** is larger or smaller than a neutral chlorine atom.[2]

Exercise 3.5 (d)

3.5 The table gives the particles in four species.

Species	Protons	Neutrons	Electrons
A	12	12	10
B	8	10	10
C	12	14	12
D	17	18	18

(d) Predict, with a reason, whether **D** is larger or smaller than a neutral chlorine atom.[2]

(d)

- Larger. The extra electron adds repulsion within the same third shell while the nuclear charge is unchanged, so the shell expands