

1.1 Particles in the atom and atomic radius

Name: _____ Class: _____ Date: _____ Total: 24 marks

KEY WORDS electron 电子 • proton 质子 • neutron 中子 • nucleon 核子 • shell 壳层

Objective

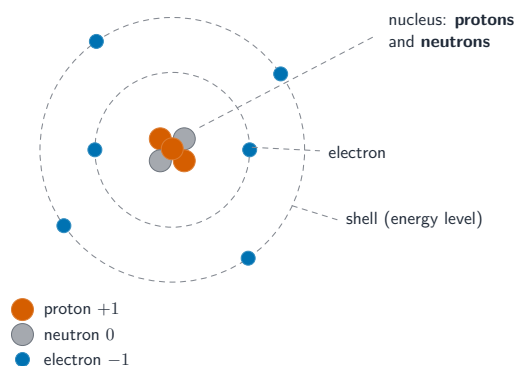
Build the skills to answer exam questions on **particles in the atom and atomic radius** — the **proton** 质子, **neutron** 中子 and **electron** 电子, counting particles in atoms and **ions** 离子, and trends in **atomic radius** 原子半径.

You must be able to:

- describe the relative charge and mass of protons, neutrons and electrons
- count protons, neutrons and electrons in an atom or ion from Z , A and charge
- describe the behaviour of particle beams in an electric field and explain radius trends

1 Worked examples

■ The sub-atomic particles

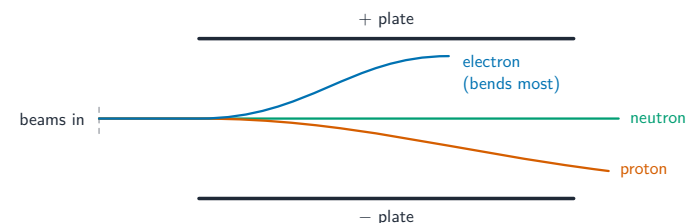


Protons and neutrons sit in the tiny nucleus; electrons move in shells around it

particle	relative charge	relative mass
proton	+1	1
neutron	0	1
electron	-1	$\frac{1}{1836}$ (≈ 0)

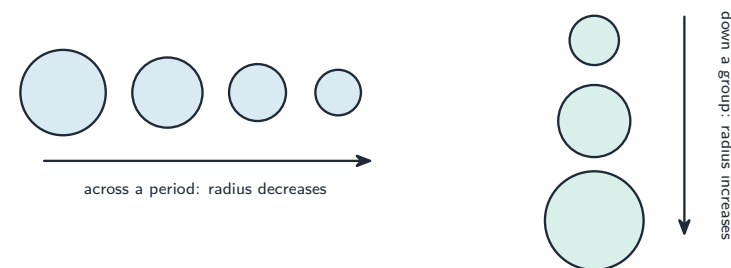
Proton number Z = protons; **nucleon number** A = protons + neutrons; neutrons = $A - Z$. In an ion, electrons = $Z -$ charge. E.g. ${}_{13}^{27}\text{Al}^{3+}$: 13 protons, 14 neutrons, 10 electrons.

■ Beams in an electric field



The proton bends to the - plate; the electron bends the opposite way and far more (it is lighter); the neutron goes straight

■ Atomic and ionic radius



Across a period atoms shrink (stronger nuclear pull, same shell); down a group they grow (each step adds a shell)

A **cation** 阳离子 is smaller than its atom (lost a shell); an **anion** 阴离子 is larger (more electron repulsion). Among ions with the same electrons, more protons $\rightarrow$ smaller.

2 Practice

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 Exam-style questions

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

- | | |
|---|---|
| A | B |
| C | D |
- 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

3.2 Across Period 3, the atomic radius decreases because: [1]

- | | |
|---|---|
| A | B |
| C | D |
- 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

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]

3.4 Explain why the atomic radius increases down Group 2. [2]

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]

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

(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]

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