

1.1 Particles in the atom and atomic radius

Name: _____ Class: _____ Date: _____

Total: 13 marks

KEY WORDS electron 电子 • proton 质子 • neutron 中子 • shell 壳层 • atomic radius 原子半径

Objective

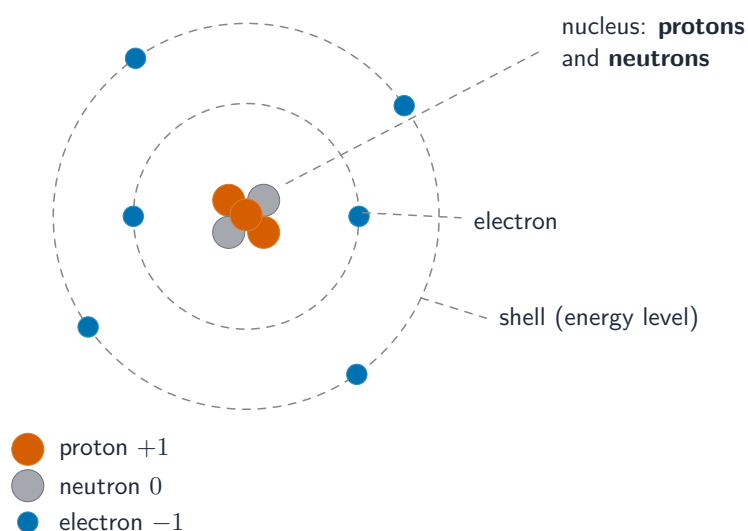
Build the skills to answer exam questions on **particles in the atom and atomic radius** — the **proton** 质子, **neutron** 中子 and **electron** 电子, counting particles in atoms and **ions** 离子, and trends in **atomic radius** 原子半径.

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

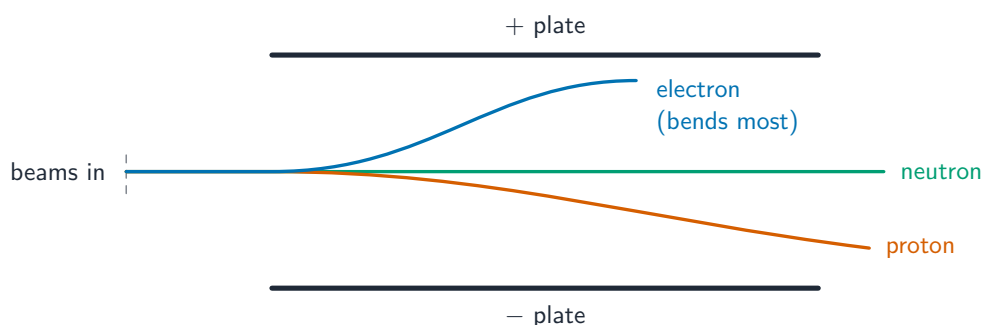


Protons and neutrons sit in the tiny nucleus; electrons move in shells around it

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

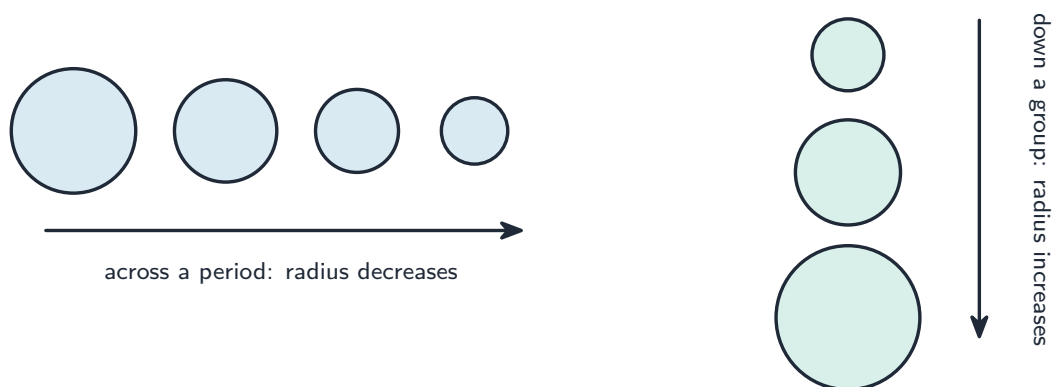
Proton number Z = protons; **nucleon number** A = protons + neutrons; neutrons = $A - Z$. In an ion, electrons = $Z - \text{charge}$. E.g. ${}^{27}_{13}\text{Al}^{3+}$: 13 protons, 14 neutrons, 10 electrons.

■ 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** 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** 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]

Solutions

2.1 relative charge 0; relative mass 1.

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

3.1 B. The electron is lightest, so it deflects most, toward the positive plate.

3.2 B. The rising nuclear charge with similar shielding pulls the outer shell in.

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.

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