IGCSE CHEMISTRY • EXERCISE SHEET

2.2 Atomic structure and the Periodic Table

Name: _____ Class: _____ Date: _____ **Total: 30 marks**

KEY WORDS electron 电子 • proton 质子 • neutron 中子 • charge 电荷 • electronic configuration 电子排布

Objective

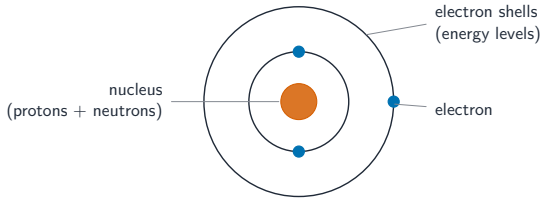
Build the skills to answer exam questions on **atomic structure and the Periodic Table** 原子结构与周期表 — sub-atomic particles, **proton/mass number** 质子数/质量数, and **electronic configuration** 电子排布.

You must be able to:

- give the relative mass and charge of protons, neutrons, electrons
- find protons, neutrons and electrons from proton and mass numbers
- write electronic configurations and link them to Group and Period

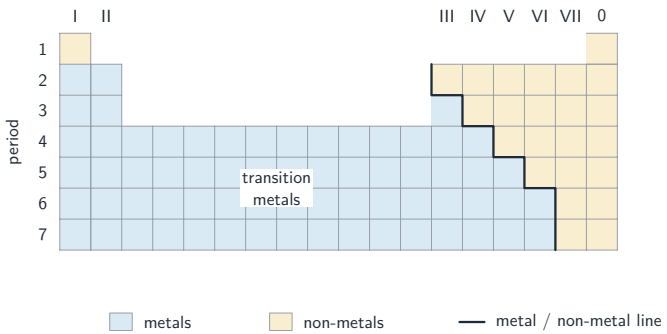
1 Worked examples

Configuration and the Periodic Table



lithium, Li: 3 protons, 4 neutrons
electron configuration 2,1

Electrons fill shells from the inside: 2, then 8, then 8 (first 20 elements)



Electron arrangement explains an element place in the Periodic Table

- **proton +1, neutron 0, electron −1**; neutrons = mass number − proton number.
- **Group** = outer-shell electrons; **Period** = number of shells.
- e.g. sodium $2, 8, 1 \rightarrow$ Group I, Period 3.

Reading an atom, and reading the Periodic Table from it

Particle	Relative mass	Relative charge	Where
proton 质子	1	+1	nucleus
neutron 中子	1	0	nucleus
electron 电子	$\frac{1}{1840}$ (negligible)	−1	shells around the nucleus

Proton number (atomic number) is the number of protons and defines the element. **Nucleon number** (mass number) is protons + neutrons, so **neutrons = nucleon number − proton number**. In a neutral atom, electrons = protons; in an **ion**, subtract the charge: an Al^{3+} ion has 13 protons but 10 electrons.

Filling the shells (first 20 elements): 2, then 8, then 8. Calcium, proton number 20, is $2, 8, 8, 2$.

The configuration tells you the position, and that is the marked step:

- **Group number = number of outer-shell electrons.** $2, 8, 7$ has 7 outer electrons $\rightarrow$ **Group VII**.
- **Period number = number of occupied shells.** $2, 8, 7$ has 3 shells $\rightarrow$ **Period 3**.

So $2, 8, 7$ is chlorine. Reading it the other way is equally examinable: an element in Group II, Period 4 has 2 outer electrons and 4 shells, so $2, 8, 8, 2$ — calcium.

Isotopes 同位素 are atoms of the same element with the **same proton number but different numbers of neutrons**. They have identical chemical properties, because

chemistry depends on the electrons and isotopes have the same electron arrangement; only physical properties that depend on mass, such as density, differ.

Worked example. An atom is written $^{37}_{17}\mathrm{Cl}$. Give its numbers of protons, neutrons and electrons, its electronic configuration, and its group and period.

1. Protons = 17 (the lower number); electrons = 17 (neutral atom).
2. Neutrons = $37 - 17 = 20$.
3. Configuration: $2, 8, 7$.
4. Seven outer electrons → Group VII; three shells → Period 3.

2 Practice

2.1 State the relative charge of a neutron. [1]

2.2 Write the electronic configuration of calcium (proton number 20). [1]

2.3 An ion is $^{27}_{13}\mathrm{Al}^{3+}$. State its numbers of protons, neutrons and electrons, and explain why the last two numbers are not equal. [4]

2.4 Deduce the group and period of an element with configuration $2, 8, 3$. [2]

2.5 Explain why two isotopes of the same element have identical chemical properties. [2]

3 Exam-style questions

3.1 An atom has the configuration $2, 8, 7$. It is in: [1]

- **A** Group II, Period 7
- **B** Group VII, Period 3
- **C** Group VII, Period 2
- **D** Group III, Period 7

3.2 An atom of aluminium has proton number 13 and mass number 27.

(a) State the number of protons, neutrons and electrons. [3]

(b) Write its electronic configuration. [1]

3.3 Explain why an atom has no overall electric charge. [2]

3.4 The table shows information about four particles.

Particle	Proton number	Nucleon number	Charge
W	11	23	0
X	11	24	0
Y	17	35	1−
Z	12	24	2+

(a) Complete a table of the number of protons, neutrons and electrons in each particle. [4]

(b) State which two particles are isotopes of each other, and explain your answer. [2]

(c) Give the electronic configuration of particle W, and deduce its group and period. [3]

(d) Explain why particle Z has a charge of 2+. [2]

(e) Explain why W and X have identical chemical properties despite their different masses. [2]

Solutions

2.1 0 (neutral).

2.2 $2, 8, 8, 2$.

2.3 13 protons — the proton number never changes; $27 - 13 = 14$ neutrons; $13 - 3 = 10$ electrons; the 3+ charge means the atom has **lost** three electrons, so it now has three fewer electrons than protons.

2.4 Three outer-shell electrons → Group III; three occupied shells → Period 3.

2.5 Chemical properties depend on the arrangement of electrons; isotopes have the same proton number and therefore the same number and arrangement of electrons.

3.1 B. Outer shell 7 → Group VII; three shells → Period 3.

3.2 (a) protons = 13; neutrons = $27 - 13 = 14$; electrons = 13.
(b) $2, 8, 3$.

3.3 it has equal numbers of protons (+1) and electrons (−1); so the positive and negative charges cancel.

3.4 (a) W: 11 protons, 12 neutrons, 11 electrons. X: 11 protons, 13 neutrons, 11 electrons. Y: 17 protons, 18 neutrons, 18 electrons. Z: 12 protons, 12 neutrons, 10 electrons.
(b) W and X; they have the same proton number, 11, but different nucleon numbers and so different numbers of neutrons.
(c) $2, 8, 1$; one outer-shell electron → Group I; three occupied shells → Period 3.
(d) Z is a magnesium atom that has lost two electrons; it now has 12 protons but only 10 electrons, so there are two more positive charges than negative.
(e) Chemical properties are determined by the outer-shell electrons; W and X have the same electronic configuration, $2, 8, 1$, and differ only in neutrons, which take no part in bonding.