Exercise walk-through

2.2
Atomic structure and the Periodic Table

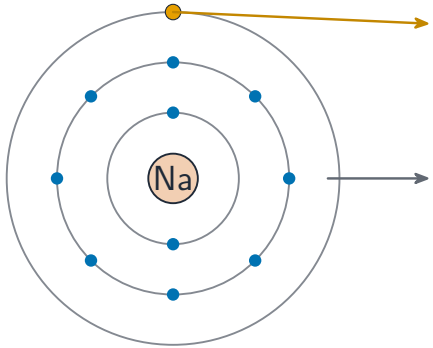
IGCSE Chemistry

Three giant covalent structures

Diamond	Every carbon bonded to four others in a rigid 3D network: extremely hard, so it is used in **cutting tools** , and it does not conduct.
Graphite	Flat layers, three bonds each. The fourth outer electron is delocalised, so graphite conducts and is used as an **electrode** ; weak forces let the layers slide, which makes it a **lubricant** .
Silicon(IV) oxide	**Silicon(IV) oxide** (SiO_2) has a giant covalent structure like diamond – very hard, very high melting point.

> Same element, opposite properties: diamond and graphite differ only in how the bonds are arranged.

Electronic configuration



1 electron in the outer shell
→ **Group I**

3 shells in use
→ **Period 3**

shells fill from the inside:
1st holds 2, then 8, then 8

sodium: **2, 8, 1**

> Sodium's configuration 2,8,1 links to the Periodic Table: one outer electron means Group I, three shells means Period 3

Exam tips

- Number of neutrons = mass number − proton number. The **proton number** is what decides which element an atom is.
- **Isotopes** have the same chemical properties because reactions involve only electrons, and isotopes share the same electron configuration; only the mass differs.
- Match structure to properties: **ionic** = giant lattice (high melting point; conducts only when molten or aqueous); **simple molecular** = weak forces *between* molecules (low melting point; no conduction); **giant covalent** = very hard, very high melting point.
- **Graphite** conducts and is slippery (one free electron per carbon; layers slide); **diamond** does neither (all four electrons bonded, so hard and non-conducting). Metals conduct and bend thanks to the sea of **delocalised electrons**.
- For relative atomic mass, take the weighted average:
  $$A_r = \frac{\sum(\text{isotope mass} \times \text{abundance})}{100}.$$

Exercises 2.1·2.2

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

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

Exercises 2.1·2.2

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

2.1

- a neutron is uncharged
- relative charge 0

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

2.2

- calcium has 20 electrons: fill shells $2, 8, 8, 2$
- $2, 8, 8, 2$

Exercises 2.3·2.4

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]

Exercises 2.3·2.4

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]

2.3

- proton number is 13, so **13 protons**
- neutrons $= 27 - 13 =$ **14**
- 3+ means three electrons lost, so electrons $= 13 - 3 =$ **10**
- fewer electrons than protons because the atom **lost** three electrons

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

2.4

- three outer-shell electrons $\rightarrow$ **Group III**
- three occupied shells $\rightarrow$ **Period 3**

Exercises 2.5·3.1

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

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

Exercises 2.5·3.1

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

2.5

- chemical properties depend on the **arrangement of electrons**
- isotopes have the same proton number, so the **same electrons**

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

3.1 B

- outer shell 7 → **Group VII**; three shells → **Period 3**
- A mixes group and period; C is Period 2; D is Group III

Exercise 3.2 (a)

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

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

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(a)

- protons = **13**
- neutrons = 27 − 13 = **14**
- electrons = **13**

Exercise 3.2 (b)

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

(b) Write its electronic configuration. [1]

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

(b) Write its electronic configuration. [1]

(b)

- 13 electrons fill $2, 8, 3$
- $2, 8, 3$

Exercise 3.3

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

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3.3

- equal numbers of protons (+1) and electrons (−1)
- the charges **cancel**, so the atom is **neutral**

Exercise 3.4 (a)

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]

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

(a)

- **W**: 11 p, 12 n, 11 e
- **X**: 11 p, 13 n, 11 e
- **Y**: 17 p, 18 n, 18 e
- **Z**: 12 p, 12 n, 10 e

Exercise 3.4 (b)

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+

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

Exercise 3.4 (b)

3.4 The table shows information about four particles.

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

(b)

- **W and X**
- same proton number (11) but **different numbers of neutrons**

Exercise 3.4 (c)

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+

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

Exercise 3.4 (c)

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	$2+$

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

(c)

- configuration $2, 8, 1$
- one outer electron $\rightarrow$ **Group I**
- three shells $\rightarrow$ **Period 3**

Exercise 3.4 (d)

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+

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

Exercise 3.4 (d)

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+

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

(d)

- Z is magnesium that has **lost two electrons**
- 12 protons but only 10 electrons → charge 2+

Exercise 3.4 (e)

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+

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

Exercise 3.4 (e)

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+

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

(e)

- chemical properties depend on **outer-shell electrons**
- W and X both have $2, 8, 1$; they differ only in **neutrons**, which do not bond