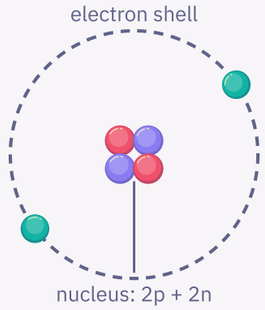
03 Atomic Structure

1 Sub-atomic Particles

1.1 What an atom is made of

An **atom** is the smallest particle of an element that still has the _____ of that element.

Particle	Relative charge	Relative mass	Location
p proton	+1	1	_____
n neutron	_____	1	nucleus
e electron	−1	_____	_____



- Protons and neutrons are together called **nucleons**. They are in the **nucleus** at the centre of the atom.
- Atoms are electrically neutral, so the number of _____ = the number of _____.

1.2 Proton number and nucleon number

$^{12}_{6}C$

12 nucleon (mass) number
6 proton (atomic) number
read as **carbon-12**

DEFINITION **Proton number**: the number of _____ in the nucleus of an atom. It tells us which _____ the atom is from.

DEFINITION **Nucleon number**: the total number of _____ in the nucleus of an atom.

number of neutrons = nucleon number − proton number

WORKED EXAMPLE Tungsten is used to make drill bits. Tungsten-184 is written $^{184}_{74}W$. Deduce the numbers of protons, neutrons and electrons in one atom of tungsten-184.

Protons = proton number = **74**
Neutrons = nucleon number − proton number = 184 − 74 = **110**
Electrons = protons = **74**

1 Sub-atomic Particles (continued)

1.3 Sub-atomic particles in ions

An **ion** is a particle formed when an atom or group of atoms _____. The numbers of protons and neutrons stay the same.

Particle	Protons	Neutrons	Electrons
calcium atom, Ca	20	20	20
calcium ion, Ca^{2+}	20	20	_____
oxygen atom, O	8	8	8
oxide ion, O^{2-}	8	8	_____

Cation (positive ion)
The atom _____ electrons, so it has fewer electrons than protons, e.g. Ca^{2+}.

Anion (negative ion)
The atom _____ electrons, so it has more electrons than protons, e.g. O^{2-}.

2 Isotopes

2.1 Isotopes of an element

DEFINITION **Isotopes** are atoms of the same element with the same _____ but different _____. They have different numbers of _____.



	hydrogen-1	hydrogen-2	hydrogen-3
Notation	$^{1}_{1}H$	$^{2}_{1}H$	$^{3}_{1}H$
Protons	1	1	1
Neutrons	0	_____	_____
Electrons	1	1	1
Nucleon number	1	2	3

Chemical properties
Isotopes have the same number of _____, so they react in the _____ way.

Physical properties
Isotopes have different masses, so they may have different _____, melting points and boiling points.

NOTE Isotopes are named with their nucleon number, e.g. chlorine-35 and chlorine-37.

3 Electrons in Shells

3.1 Electron shells

- Electrons in the shell closest to the nucleus have the **lowest energy**. Electrons fill the lowest energy shells first.
- The first shell holds up to _____ electrons. The second and third shells usually hold up to _____ electrons each.
- The outermost shell is the **valence shell**, and its electrons are **valence electrons**.
- A full valence shell is stable, so atoms of helium and argon are _____. An atom with a valence shell that is not full is reactive.

3.2 Electronic configuration

The **electronic configuration** of an atom shows the number of _____, starting from the innermost shell, e.g. sodium is 2.8.1.

From the periodic table

- The **period** number is the number of _____
- The **group** number gives the number of valence electrons: Groups 1 and 2 have 1 and 2, and Groups 13 to 18 have 3 to 8. Helium has 2.

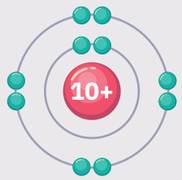
3.3 Shell diagrams



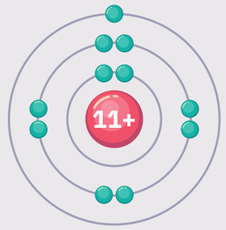
Li 2.1



Be 2.2



Ne 2.8



Na 2.8.1

3 Electrons in Shells (continued)

3.4 Configurations of the first 20 elements

Period	Group 1	2	13	14	15	16	17	18
1	**H** 1							**He** 2
2	**Li** 2.1	**Be** 2.2	**B** 2.3	**C** 2.4	**N** 2.5	**O** 2.6	**F** 2.7	**Ne** 2.8
3	**Na** _____	**Mg** _____	**Al** _____	**Si** _____	**P** _____	**S** _____	**Cl** _____	**Ar** _____
4	**K** _____	**Ca** _____						

WORKED EXAMPLE How are the electrons arranged in an atom of potassium (proton number 19)?

Potassium has 19 protons, so it has **19** electrons.
Fill the first shell with 2, then the second with 8: 2.8. That is 10 electrons.
The remaining 9 electrons: the third shell takes 8, so 1 is left for the fourth shell.
Electronic configuration = **2.8.8.1**

NOTE Electronic configurations are needed only up to calcium (proton number 20).

EXAM TIP Isotopes of an element have the **same** number of electrons, so they have the **same** electronic configuration.

4 Summary

4.1 Atomic structure at a glance

Nucleus

- Contains _____ and _____, together called nucleons.
- Protons: relative charge _____, relative mass 1. The proton number identifies the element.
- Neutrons: relative charge _____, relative mass 1.

Electron shells

- Electrons: relative charge _____, relative mass _____.
- Up to _____ electrons in the first shell and usually _____ in the second and third.
- Electronic configuration, e.g. oxygen is _____.

Isotopes

Atoms of the same element with the same _____ and different _____. They have the same chemical properties and different physical properties.

4.2 Finding the numbers

To find	Use
Protons	the _____
Neutrons	_____
Electrons in an atom	the same number as the _____
Electrons in an ion	protons – charge, e.g. Ca^{2+} has 20 – 2 = _____
Electron shells	the _____ number
Valence electrons	the _____ number (Groups 1 and 2), or 3 to 8 for Groups 13 to 18