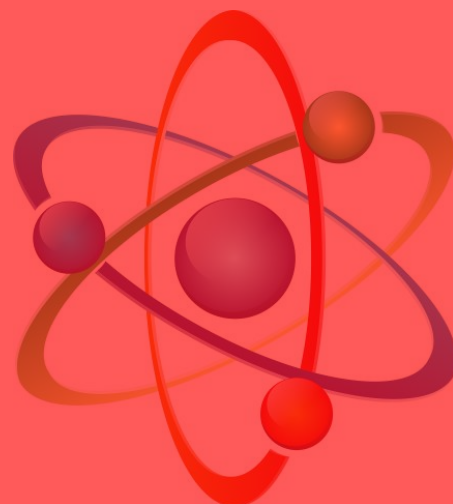


IGCSE CHEMISTRY STUDY NOTES
UNIT 3 ATOMS, ELEMENTS & COMPOUNDS





UNIT 3

ATOMS, ELEMENTS & COMPOUNDS

3.1 Atomic structure and the Periodic Table

- State the relative charges and approximate relative masses of protons, neutrons and electrons
- Define *proton number* (atomic number) as the number of protons in the nucleus of an atom
- Define *nucleon number* (mass number) as the total number of protons and neutrons in the nucleus of an atom
- Use proton number and the simple structure of atoms to explain the basis of the Periodic Table (see section 9), with special reference to the elements of proton number 1 to 20
- Define *isotopes* as atoms of the same element which have the same proton number but a different nucleon number
- State the two types of isotopes as being radioactive and non-radioactive

CORE

C

Understand that isotopes have the same properties because they have the same number of electrons in their outer shell

SUPPLEMENT

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- State one medical and one industrial use of radioactive isotopes
- Describe the build-up of electrons in 'shells' and understand the significance of the noble gas electronic structures and of the outer shell electrons. (The ideas of the distribution of electrons in s and p orbitals and in d block elements are not required.)

CORE

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	Relative charge	Approximate relative mass
Proton, p^+	1+	1
Electron, e^-	1-	$\frac{1}{1860}$ (negligible)
Neutron, n^0	0	1

NOTE:

For all practical calculations, the relative mass of an electron is assumed to be ZERO.

Proton number (atomic number, Z):

The number of protons in the nucleus of an atom

Nucleon number (atomic mass number, A):

The total number of protons and neutrons in the nucleus of an atom

Number of neutrons = Nucleon number – Proton number

In an atom,

Number of protons = number of electrons

Number of positive charges = number of negative charges

An atom is therefore electrically neutral (no net charge).

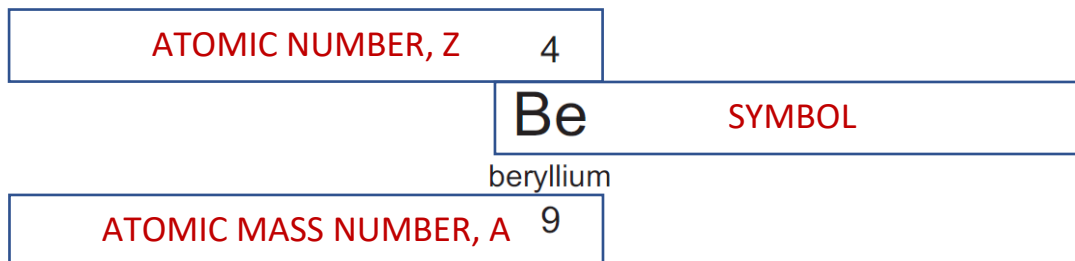
Proton number / Atomic number is the basis of the modern periodic table.

Elements are arranged in order of their increasing atomic number.



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Key for using Periodic Table

**NOTE:**

A different format may be used in some questions.

In any case, the greater number is always the Atomic mass number and the smaller number is the Atomic number.

Exception: ${}^1_1\text{H}$, where $Z = 1$ & $A = 1$

In yet another notation like **U-235**, 235 is the Atomic mass number. Atomic number can be found out from the periodic table.



C



The following are gallium atoms.



Complete the following table.

	number of protons	number of neutrons	number of electrons
${}_{31}^{69}\text{Ga}$			
${}_{31}^{71}\text{Ga}$			

Solution:

	number of protons	number of neutrons	number of electrons
${}_{31}^{69}\text{Ga}$	31	38	31
${}_{31}^{71}\text{Ga}$	31	40	31



Atomic number = 31

Number of protons = 31

Number of electrons = 31

Nucleon number = 69

Number of neutrons

= Nucleon number – number of protons

= 69 – 31 = 38



Atomic number = 31

Number of protons = 31

Number of electrons = 31

Nucleon number = 71

Number of neutrons = 71 – 31 = 40



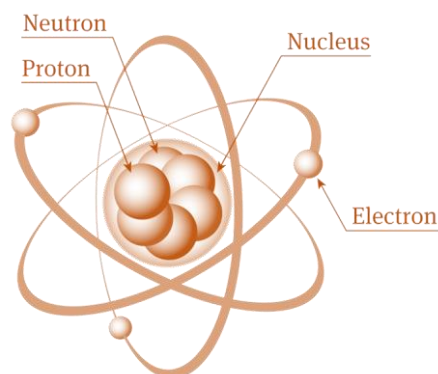
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Atomic structure

An atom is the smallest particle of an element that retains the chemical properties of that element.

An atom is composed of sub-atomic particles:

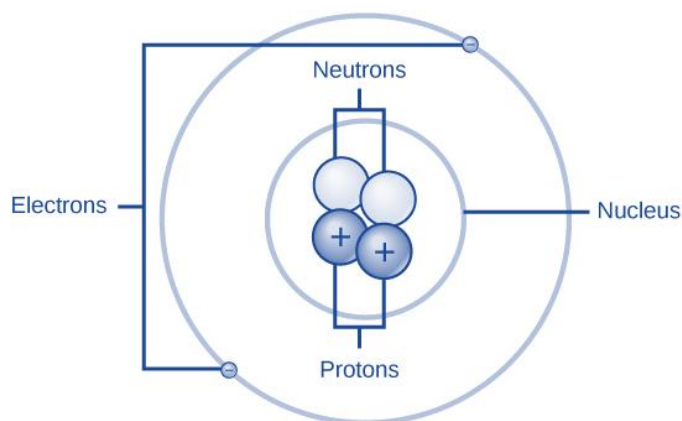
- Proton
- Electron
- Neutron



Protons and Neutrons are present in the nucleus, the core of an atom. The nucleus is therefore positively charged (protons +).

Electrons are present in the extra-nuclear region (outside the nucleus). They constantly move around the nucleus along certain paths called orbits.

Diagram of Atomic Structure of Helium (He – 4 isotope)



**FREQUENTLY ASSESSED CONTENT****C****Isotopes**

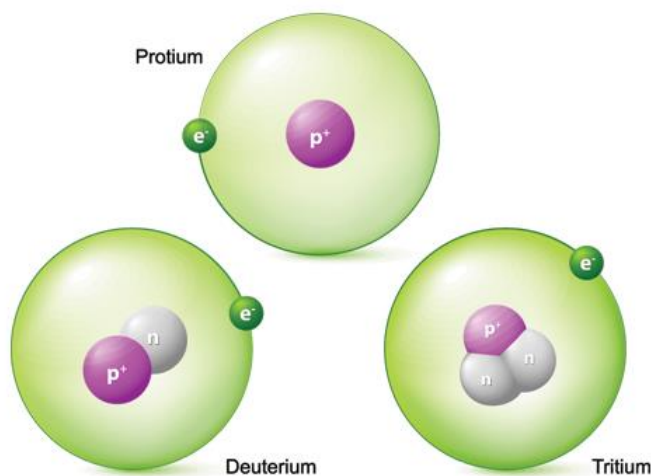
Atoms of the same element which have the same proton number but a different nucleon number; they have a different number of neutrons.

S

The chemical properties of an element largely depend upon the number of electrons in the outer shell.

Isotopes have the same number of electrons, hence identical electronic configurations.

They have the same number of electrons in their outer shell, hence similar chemical properties.

ISOTOPES OF HYDROGEN

same number of protons and electrons, different number of neutrons



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Isotopes

Isotopes are of two types:

- **radioactive (unstable)**
- **non-radioactive (stable)**

The isotopes which are unstable, as a result of the extra neutrons in their nuclei, are radioactive and are called radioisotopes.

Radioisotopes emit radiations and are in much lower abundance than the non-radioactive ones.

MEDICAL USES OF RADIOISOTOPES:

- Co-60 isotope is used in the treatment of cancer.
- Used as tracers in medicine to detect blockages in arteries or to study physiology of certain organs
for example, I-131 is used as a tracer to detect abnormalities of the thyroid gland

INDUSTRIAL USES OF RADIOISOTOPES:

- Uranium-235 is used as a source of power in nuclear reactors.
- Radioisotopes are used as tracers to detect gas leaks in underground water pipes
- to detect water level in overhead water tanks



ASSESSMENT 3.1: ISOTOPES





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Electronic configuration: arrangement of electrons in electron shells

Electrons are present outside the nucleus in electron shells or energy levels. The first electron shell or first energy level is closest to the nucleus and can accommodate a maximum of **2** electrons.

The second electron shell can accommodate a maximum of **8** electrons.

NOTE:

For IGCSE exam purpose, it is safe to assume that the third electron shell also accommodates 8 electrons although it can actually accommodate a maximum of 18 electrons.

Electronic configuration of first 20 elements

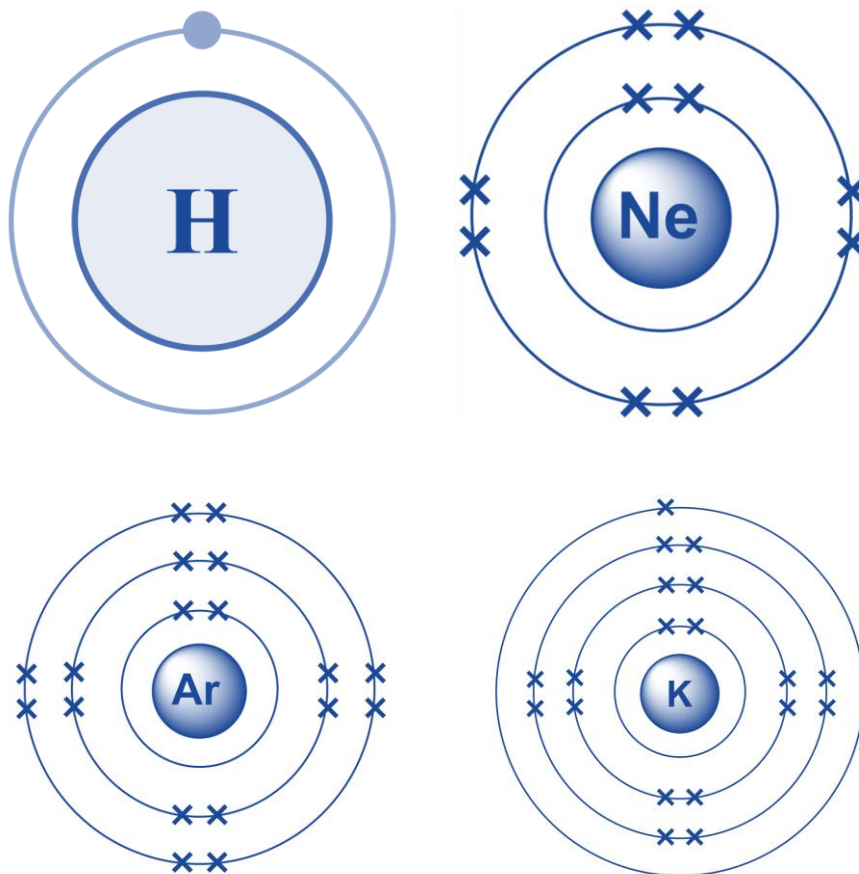
Element Z - SYMBOL	Electronic configuration	Element Z - SYMBOL	Electronic configuration
1 – H	1	11 – Na	2.8.1
2 – He	2	12 – Mg	2.8.2
3 – Li	2.1	13 – Al	2.8.3
4 – Be	2.2	14 – Si	2.8.4
5 – B	2.3	15 – P	2.8.5
6 – C	2.4	16 – S	2.8.6
7 – N	2.5	17 – Cl	2.8.7
8 – O	2.6	18 – Ar	2.8.8
9 – F	2.7	19 – K*	2.8.8.1
10 – Ne	2.8	20 – Ca*	2.8.8.2

*Important to know



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Electron distribution diagrams

**OCTET RULE:**

Noble gases (Group VIII / 0 elements) have eight electrons in their outer electron shell and are chemically inert.

Exception: Helium has a complete outer shell with 2 electrons.

Other elements try to attain the electronic configuration of the nearest noble gas by gain / loss / sharing of electrons.

Valency is the number of electrons that an element needs to lose / gain / share in order to attain the electron configuration of the nearest noble gas.

NOTE:

Valence electrons are the number of electrons in the outer shell.



Ions are electrically charged particles.

When an atom gains electron/s, it forms a negative ion.

When an atom loses electron/s, it forms a positive ion.

Determining the valency of an element

Element: electronic configuration	Nearest Noble gas: electronic configuration	Valency	Ion formed
Fluorine: 2.7	Neon: 2.8	1	F ¹⁻
		A Fluorine atom needs to gain 1 electron to attain a noble gas electronic structure.	
Aluminium: 2.8.3	Neon: 2.8	3	Al ³⁺
		An Aluminium atom needs to lose 3 electrons to attain a noble gas electronic structure.	
Sulfur: 2.8.6	Argon: 2.8.8	2	S ¹⁻
		A Sulfur atom needs to gain 2 electrons to attain a noble gas electronic structure.	



ASSESSMENT 3.1: ATOMIC STRUCTURE