STRUCTURE OF THE ATOM AND THE PERIODIC TABLE

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Organizer

(24 Lessons)

Objectives

By the end of this topic, the learner should be able to:

(a) Describe the structure of the atom and write electron configuration.

(b) Define atomic number, mass number, isotopes and relative atomic mass.

(c) Determine relative atomic mass from isotopic composition.

(d) Use electron configuration to determine the position of an element in the periodic table and predict the type of ion it forms.

(e) Define valency and oxidation number of an element.

(f) Use valency to derive chemical formulae of compounds.

(g) Write balanced chemical equations.

STRUCTURE OF THE ATOM AND THE PERIODIC TABLE

The atom is the smallest particle of an element that can take part in a chemical reaction.

1. Structure of the Atom

(a) The sub-atomic particles

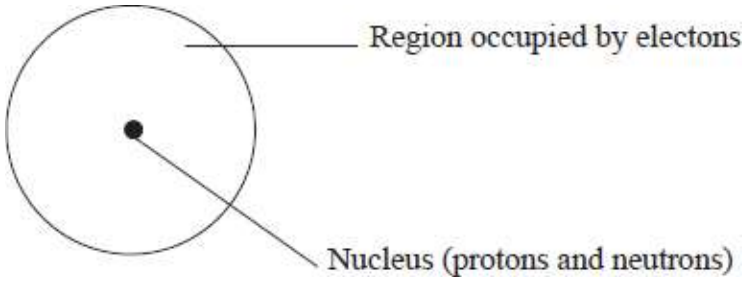
An atom is made up of smaller particles called **sub-atomic particles**.

The sub-atomic particles are; **neutrons, protons and electrons.**

The atom is made up of two regions, a small central part called the **nucleus** and a larger region surrounding the nucleus.

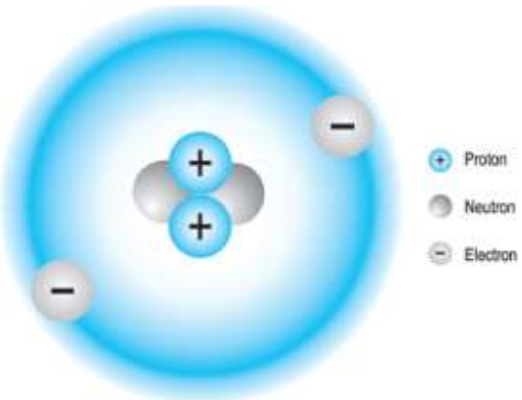
The nucleus consists of protons and neutrons. The protons and neutrons are referred to as **nucleons** because they are found in the nucleus.

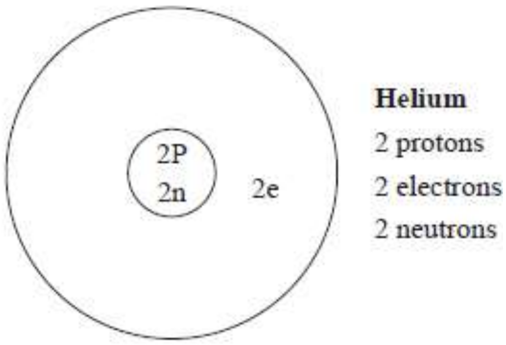
The larger region surrounding the nucleus consists of electrons. The general structure of an atom is as shown below.



The hydrogen atom, which is the simplest in composition has one proton, one electron and has no neutron.

The atom of the next element, helium has two protons, two electrons and two neutrons. The structure of the atom of Helium is shown below.





Characteristics of the sub atomic particles

The proton is positively charged.

The electron is negatively charged.

The neutron has no charge.

Sub atomic particle	Relative mass	Electrical charge
Proton	1	+ 1 (positive)
Neutron	1	0 (neutral)
Electron	$\frac{1}{1840}$	– 1 (negative)

The **number of protons is equal to the number of electrons** for any given atom. This makes the atom to be **electrically neutral.**

For example, a hydrogen atom has one proton and one electron while a helium atom has two protons and two electrons.

The neutrons in the nucleus contribute to the stability of the nucleus.

Atomic Number and Mass Number

Atomic number *is the number of protons in the nucleus of an atom*.

For example, a hydrogen atom has 1 proton in the nucleus; therefore its atomic number is 1.

Likewise, an atom of helium has 2 protons and therefore its atomic number is 2. Sodium has 11 protons in the nucleus therefore it's atomic number is 11.

Mass number *is the sum of the protons and neutrons in an atom of an element*. For example, an atom of hydrogen has 1 proton and no neutrons in it's nucleus; therefore the mass number is 1.

1 proton + 0 neutrons = 1

A helium atom has 2 protons and 2 neutrons. Consequently, the mass number is 4.

2 protons + 2 neutrons = 4

Both mass and atomic number can be written along with the symbol of an element.

The conventional way of representing the mass number is to write the mass number as a **superscript** in front of the chemical symbol e.g. ^{23}Na.

The atomic number is written as a subscript in front of the symbol e.g. $_{11}Na$.

Therefore, the element is represented as $^{23}_{11}Na$.

A list of the first Twenty Elements

Element	Symbol	Number of electrons	Number of protons	Number of neutrons	Atomic number	Mass number
Hydrogen	H	1	1	0	1	1
Helium	He	2	2	2	2	4
Lithium	Li	3	3	4	3	7
Beryllium	Be	4	4	4	4	–
Boron	B	–	5	–	–	11
Carbon	C	6	–	–	–	12
Nitrogen	N	–	7	7	–	–
Oxygen	O	–	–	–	8	16
Fluorine	F	–	–	–	9	19
Neon	Ne	10	–	–	–	20
Sodium	Na	–	–	12	11	–
Magnesium	Mg	–	12	12	–	–
Aluminium	Al	13	–	14	–	–
Silicon	Si	–	–	14	–	28
Phosphorus	P	–	15	16	–	–
Sulphur	S	16	–	–	–	32
Chlorine	Cl	17	–	18	–	
Argon	Ar	–	18	–	18	40
Potassium	K	1	–	20	–	–
Calcium	Ca	–	20	20	–	–

Isotopes

Isotopes are atoms of the same element having the same atomic number but different mass numbers.

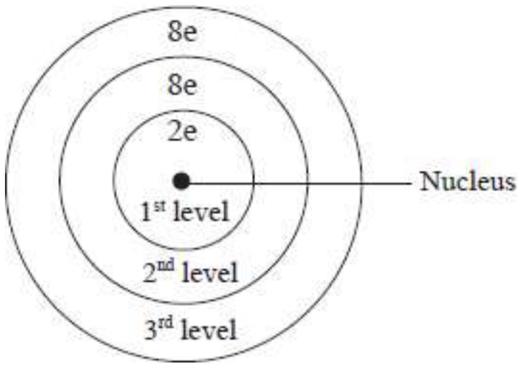
Examples of Isotopes

Element	Isotope	Atomic number	No. of protons	No. of neutrons	Mass number	Isotopic Representation
Hydrogen	Hydrogen –1	1	1	0	1	${}^{1}_{1}H$
	Hydrogen –2 (Deuterium)	1	1	2	2	${}^{2}_{1}H$
	Hydrogen –3 (Tritium)	1	1	2	3	${}^{3}_{1}H$
Carbon	Caron –12	6	6	6	12	${}^{12}_{6}C$
	Carbon –14	6	6	8	14	${}^{14}_{6}C$
Oxygen	Oxygen –16	8	8	8	16	${}^{16}_{8}O$
	Oxygen –17	8	8	9	17	${}^{17}_{8}O$
	Oxygen –18	8	8	10	18	${}^{18}_{8}O$
Chroline	Chlorine –35	17	17	18	35	${}^{35}_{17}CI$
	Chlorine –37	17	17	20	37	${}^{37}_{17}CI$

(b) Energy Levels and Electron Arrangement

Electrons occupy regions around the nucleus known as **energy levels**.

Electrons occupying the same energy level have approximately the same amount of energy. These energy levels are numbered 1, 2, 3, … starting with the one closest to the nucleus.



Each energy level can only accommodate a given maximum number of electrons.

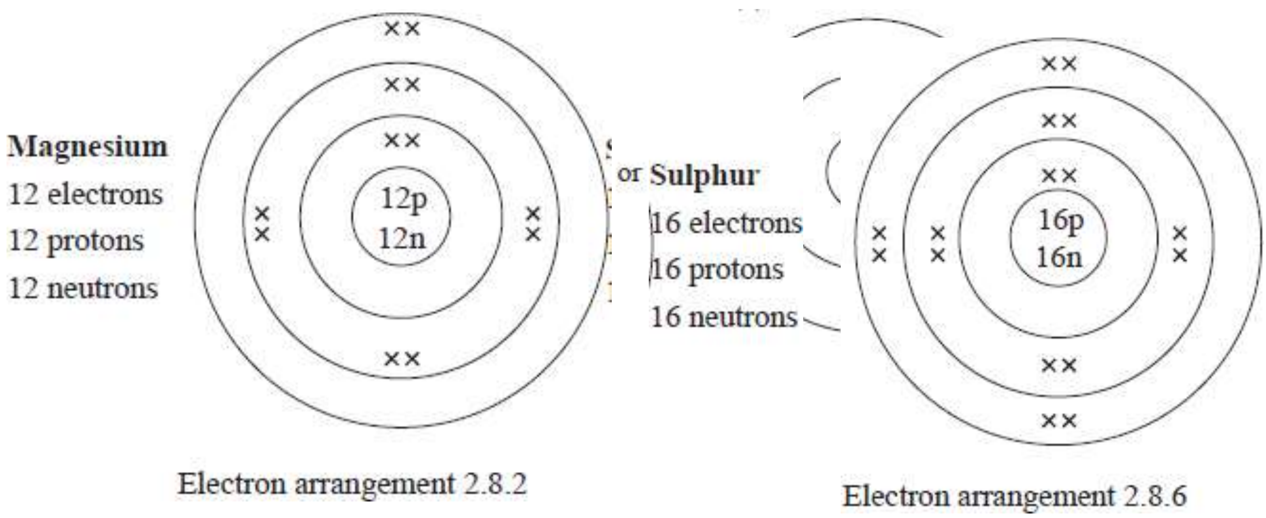
The first energy level can only hold a maximum of two electrons and the second energy level a maximum of eight electrons. For the first twenty elements, the third energy level accommodates a maximum of eight electrons.

The distribution of electrons in the energy levels of an atom is referred to as **electron arrangement** (**electron configuration**).

- Hydrogen has one electron in the first energy level. Helium with two electrons, has the two electrons in its first energy level. Helium therefore has one energy level which is filled up.

When an energy level is full, additional electrons occupy the next energy level until it is completely filled up.

- Thus, lithium with three electrons, has two electrons in its first energy level and one electron in its second energy level.
- This can be represented as: 1 for hydrogen, 2 for helium, 2.1 for lithium and 2.8 for neon.
- Electron arrangement may also be represented by a diagram in which electrons are represented by crosses (×) or dots (·) as shown below.



Activity: Draw the electron arrangement of all the first 20 elements in the periodic table.

2. The periodic table

(a) Periods and Groups

- The elements with the same number of occupied energy levels belong to the same **period**.

Hydrogen and helium have one occupied energy level hence they belong to **Period 1.**

Lithium, beryllium, boron, carbon, nitrogen, oxygen, fluorine and neon have two occupied energy levels. These elements belong to **Period 2.**

Similarly, sodium, magnesium, aluminium, silicon, phosphorus, sulphur, chlorine and argon have three occupied energy levels and hence belong to **Period 3.**

- Those elements with the same number of occupied energy levels can be arranged in the same row, starting with the elements with the lowest atomic number.

First row Period 1	Hydrogen and helium.
Second row Period 2	Lithium, beryllium, boron, carbon, nitrogen, oxygen, flourine and neon.
Third row Period 3	Sodium, magnesium, aluminium, silicon, phosphorus, sulphur and argon.
Fourth row Period 4	Potassium and calcium.

- Elements with the same number of electrons in the outermost energy level form a **group**.

Hydrogen, lithium, sodium, potassium have **one** electron in the outermost energy level hence they belong to **group I**.

Similarly, beryllium, magnesium, calcium have **two** electrons in the outermost energy level, therefore they belong to **group II.**

- Elements with the same number of electrons in the outermost energy level can be arranged in the same vertical column. The columns represent members of a group.

Group I 1st Column	**Group II 2nd Column**	**Group III 3rd Column**	**Group IV 4th Column**	**Group V 5th Column**	**Group VI 6th Column**	**Group VII 7th Column**	**Group VIII 8th Column**
Hydrogen	Beryllium	Boron	Carbon	Nitrogen	Oxygen	Fluorine	Helium
Lithium	Magnesium	Aluminium	Silicon	Phosphorous	Sulphur	Chlorine	Neon
Sodium	Calcium						Argon
Potassium							

- There are eight groups numbered in Roman numerals.
  Group 8 is also referred to as **group zero** because these elements have little tendency to lose or gain electrons during reactions.

- This information can be merged into a grid. The resulting figure is the **periodic table of elements**.
- The arrangement of elements in the periodic table is based on increasing atomic number.

	Group I	Group II	Group III	Group IV	Group V	Group VI	Group VII	Group VIII
Period 1	1 Hydrogen 1							2 Helium 2
Period 2	3 Lithium 2.1	4 Beryllium 2.2	5 Boron 2.3	6 Carbon 2.4	7 Nitrogen 2.5	8 Oxygen 2.6	9 Fluorine 2.7	10 Neon 2.8
Period 3	11 Sodium 2.8.1	12 Magnesium 2.8.2	13 Aluminium 2.8.3	14 Silicon 2.8.4	15 Phosphorus 2.8.5	16 Sulphur 2.8.6	17 Chlorine 2.8.7	18 Argon 2.8.8
Period 4	19 Potassium 2.8.8.1	20 Calcium 2.8.8.2						

(b) Relative Atomic Mass and Isotopes

The relative atomic mass (R.A.M) of an element is defined as the average mass of an atom of the element compared with an atom of carbon –12, the mass of which is 12.000 (a.m.u).

$$R.A.M = \frac{\text{Average mass of one atom of an element}}{\frac{1}{2}\text{Mass of an atom of carbon} -12}$$

An instrument called the **Mass spectrometer** is used to accurately determine the relative atomic masses of elements.

It can also be used to obtain the relative abundance of isotopes of a given element. The relative atomic mass of an element can be a fraction because it is an average mass of the isotopes of the element.

The relative atomic mass is **closest in value to the mass of the most abundant isotope of the element.**

Relative atomic mass is a ratio and therefore **has no units.**

Worked Examples

Example 1

Chlorine –35 forms 75% of the total mass of chlorine and chlorine –37 forms 25%. Calculate the relative atomic mass of chlorine.

Solution

Consider a sample containing 100 atoms of chlorine. Therefore 75 atoms will each have a mass of 35.

Therefore, Total Mass = 35 × 75

25 atoms will have a mass of 37

Therefore, Total Mass = 37 × 25

The average mass of a chlorine atom would be;

$$R.A.M = \frac{(\text{Mass of chlorine} - 37 \times \text{Relative abudance})}{100} + R.A.M = \frac{(35 \times 75) + (37 \times 25)}{100}$$

Therefore, RAM of chlorine = 35.5

As can be seen, the relative atomic mass is nearer to the mass number of the most abundant isotope, that is chlorine –35. See mass spectrum of chlorine.

Example 2

An element X, consists of three isotopes with mass number of 22, 24 and 25 with percentage abundance of 89.6%, 6.4% and 4.0% respectively. Find the relative atomic mass of element X.

Solution

Consider a sample of 100 atoms of element X:

89.6 atoms of X have a mass of 22

Total mass = 89.6 × 22

6.4 atoms of X have a mass of 24

Total mass = 6.4 × 24

4.0 atoms of X have a mass of 25

Total mass = 4.0 × 25

$$R.A.M = \frac{(\text{Mass of isotope 1} \times \text{Relative abudance})}{100}$$

$$+\frac{(\text{Mass of isotope 2} \times \text{Relative abudance})}{100}$$

$$+\frac{(\text{Mass of isotope 3} \times \text{Relative abudance})}{100}$$

$$R.A.M = \frac{(89.6 \times 22) + (6.4 \times 24) + (4.0 \times 25)}{100}$$

$$\therefore \text{R.A.M of X} = 22.2$$

More Questions

1. An element P has two isotopes with relative abundance of 65% and 35%. If the mass number of the two isotopes is X and 31 respectively, find the mass number represented by X given that the relative atomic mass of element P is 30.
2. Lithium has two isotopes with mass number 6 and 7. If the relative atomic mass of lithium is 6.94, determine the percentage abundance of each isotope.

(c) Ion Formation

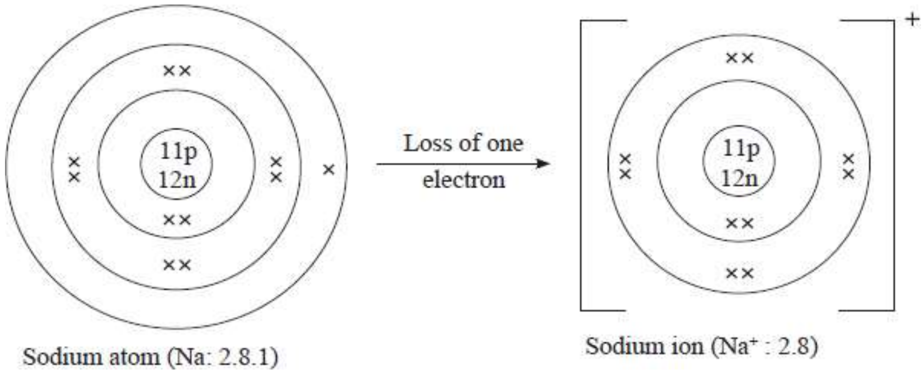
Atoms with an electron configuration of 2, 2. 8 and 2.8.8 are said to be stable. Atoms without this electron configuration tend to attain this stability by either losing or gaining electrons.

- The charged particles formed when atoms gain or lose electrons are called **ions**.
- Positively charged ions are called **cations** and negatively charged ions are called **anions**.
- Metals mostly lose electrons to form positively charged ions while non-metals gain electrons to form negatively charged ions.

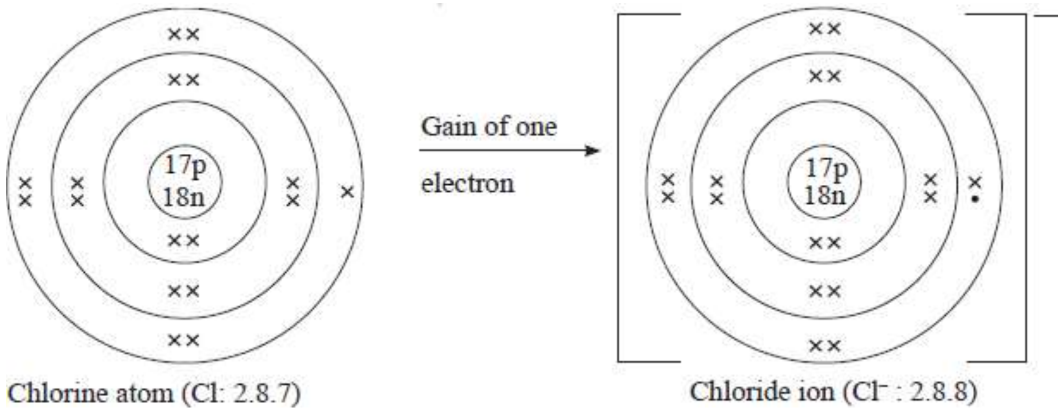
The examples below can be used to explain ion formation.

1. Sodium with atomic number 11 and an electron configuration 2.8.1 can acquire the stable electron configuration of 2.8 by losing one electron or 2.8.8 by gaining seven electrons. Since it requires less energy, it is easier to loose one electron than to gain seven electrons. The resulting sodium particle will have only ten electrons while the nucleus still has 11 protons. Ten negative charges and 11 positive charges give the resulting particles a net positive charge of 1(+1). The particle formed is a sodium ion, written as Na^{+}.

2. A chlorine ion can also be formed, Cl^-. A chlorine atom with atomic number 17 and

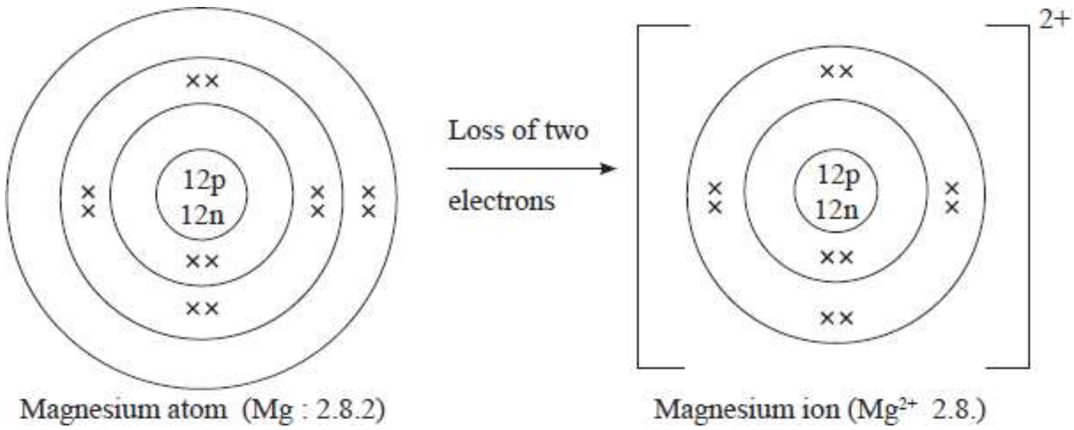


an electron configuration of 2.8.7 can acquire a configuration of 2.8 by losing seven electrons or a configuration of 2.8.8 by gaining one electron. It is easier for the chlorine atom to gain one electron than to lose seven.

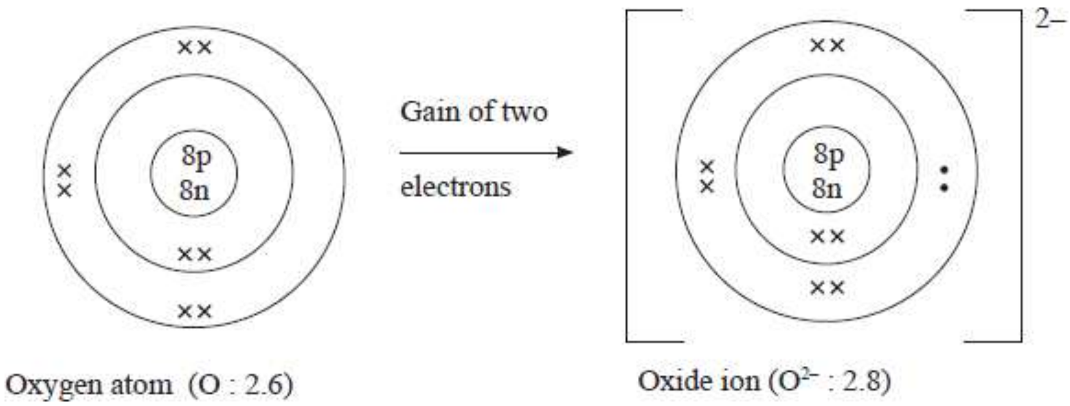


Therefore, a chorine atom with 17 electrons and 7 protons will gain an electron and have 18 electrons. Since it still has 17 protons, a chlorine particle with a net negative charge of 1 is formed i.e a chlorine ion. The ion formed is written as Cl^-It is also refered to as a chloride ion.

3. Magnesium has an atomic number of 12. The electron arrangement is 2.8.2. The magnesium atom can acquire the stable electron configuration of 2.8 by losing the two electrons in the outermost energy level. This means that the resulting particle will have a net positive charge of two. The ion formed is called a magnesium ion, and is written as Mg^{2+}.



4. Oxygen atomic number 8 and electron arrangement of 2.6 can acquire a stable electron configuration of 2.8 by gaining two electrons. The resulting particle will have a net negative charge of two. The ion formed is an oxide ion and is written as O^{2-}.



- Ion formation may be shown in a different format using chemical symbols. For example:

Sodium: Na ⟶ $Na^+ + e^-$

Chlorine: $Cl + e^-$ ⟶ Cl^-

Magnesium: Mg ⟶ $Mg^{2+} + 2e^-$

Oxygen: $O + 2e^-$ ⟶ O^{2-}

- During chemical reactions atoms of metals react by losing electrons from their outermost energy level. On the other hand, non-metals generally gain electrons into their outermost energy level.

For example, a reaction between sodium and chlorine will involve the transfer of one electron from a sodium atom to a chlorine atom. In this reaction, sodium loses one electron. The chlorine atom gains one electron from sodium.

(d) Valency and Oxidation number

The number of electrons an atom loses or gains during a chemical reaction is the **valency** of that atom. Valency is also refered to as the **combining power** of an element.

- All elements in Group I have a valency of one while Group II elements have a valency of two.
- Elements in Group VII have a valency of one, since they require one electron to acquire a stable electron configuration.
- Some elements have variable valencies. For example, iron can have a valency of 2 or 3, copper can have a valency of 1 or 2 while lead can have a valency of 2 or 4.

Electrons in the outer most energy level are called **valence electrons** because they can be used to predict valency. Valence should not be confused with valency.

Radicals

Radicals are groups of atoms with a net charge that exist and react as a unit during chemical reactions.

- The valency of a radical is the same as the value of its charge.

For example, a sulphate ion (SO_4^{2+}) has a valency of 2, a nitrate ion ($NO^-{}_3$) has a valency of 1, an ammonium ion ($NH^+{}_4$) has a valency of 1.

Table (a) and (b) summaries the valency of some common elements and radicals.

(a) Valencies of common Metals

	Valency 1	Valency 2	Valency 3
Metals	Sodium Potassium	Calcium Barium Magnesium Zinc Iron Lead Copper	Aluminium Iron
Non-metals	Nitrogen Chlorine Fluorine Hydrogen	Nitrogen Oxygen Sulphur	Nitrogen Phosphorus

(b) Valencies of common radicals Radicals

	Valency 1	Valency 2	Valency 3
Radicals	Ammonium (NH^+_4) Hydroxide (OH^-) Nitrate (NO^-_3) Hydrogen Carbonate (HCO^-_3) Hydrogen Sulphate (HSO^-_4)	Carbonate (CO_3^{2-}) Sulphate (SO_4^{2-}) Sulphite (SO_3^{2-})	Phosphate (PO_4^{3-})

Oxidation number

Elements react by either gaining or losing electrons, they are said to acquire a new state known as **oxidation state**.

The oxidation number *of an element shows the number of electrons which have been removed or added to it to get the present state.*

There are positive oxidation numbers and negative oxidation numbers. Since atoms are electrically neutral, they are assigned an oxidation number of zero.

Oxidation Numbers of Some Ions and Atoms

Particle	Oxidation number
Mg2+	+2
Fe2+	+2
Fe+3	+3
H+	+1
Cu+	+1
Cu2+	+2
Cl–	–1
Cu	0
Mg	0
H	0

Oxidation state should not be confused with charge. Oxidation states are written with the positive or negative sign coming before the number, e.g., – 2, + 3.

Charge on the other hand is written as a superscript with the number coming before the positive or negative sign e.g X^{2+} or X^{3+}.

3. Chemical Formulae

***A chemical formula** is a representation of a chemical substance using chemical symbols. It shows the constituent elements and the proportions in which they are combined*.

When elements combine, they form compounds.

For example, Sodium and chlorine react to form sodium chloride. During the reaction, a sodium atom loses an electron to form a sodium ion, Na^+. A chlorine atom then gains the electron lost by the sodium atom to form a chloride ion, Cl^-. The ions then combine to form sodium chloride.

$$Na^+ + Cl^- \longrightarrow NaCl$$

The product of the reaction between sodium and chlorine when represented in chemical symbols is called the chemical formula.

- In order to write a correct chemical formula, it is necessary to know the **symbols** and **valencies** of the elements which form the compounds.
- When writing the formula, always start with the element which is more likely to lose an electron or electrons then follow with the one that gains.

  The chemical formula of a compound can be derived using the valencies of the combining elements.

Worked examples

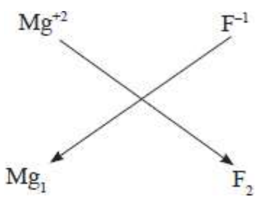
Example 1

Combining atoms	*Mg*	*F*
Combining power (valency)	*2*	*1*

For magnesium to combine with fluorine to form magnesium fluoride, each magnesium atom requires two fluorine atoms. Accordingly the formula for magnesium fluoride is:

Mg F_2.

In the formula the valencies are interchanged and written as subscripts.



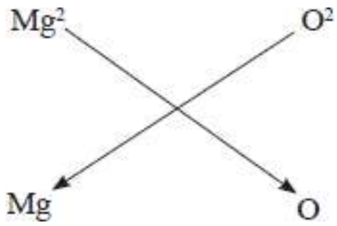
For example

Therefore, the formula is Mg_1F_2

- When the subscript is 1, it is usually not written since the symbol represents 1 atom. Thus the formula of magnesium fluoride is MgF_2.

Example 2

Combining atoms	*Mg*	*O*
Combining power (valency)	*2*	*2*

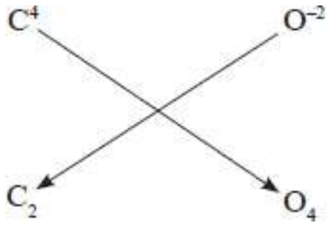


Formula Mg_2O_2

- When the subscripts are the same it indicates that the combining ratio is 1:1 and it is therefore omitted from the formula. Hence, the formula of magnesium oxide is: MgO

Example 3

Combining atoms	*C*	*O*
Combining power (valency)	*4*	*2*

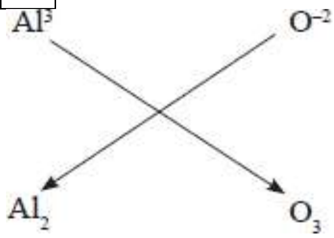


Formula C_2O_4

The combining ratio is 2:4 which is simplified to 1:2 hence the formula for Carbon (IV) oxide is: CO_2

Example 4

Combining atoms	*Al*	*O*
Combining power (valency)	*3*	*2*

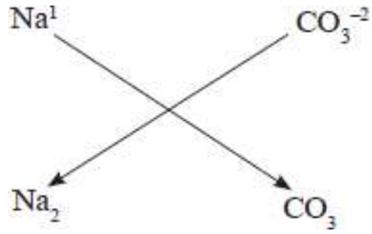


Formula Al_2O_3

Example 5

In deriving formula for compounds involving radicals, the net charge on the radical is taken to be equal to the valency of the radical.

Combining particles	Na^+	CO_3^{2-}
Combining power (valency)	1	2

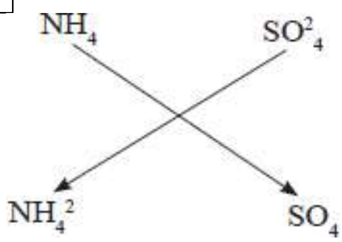


Formula Na_2CO_3

Example 6

Where the formula of a compound contains more than one radical of the same type, the symbol of the radical is put in brackets and the number of radicals indicated as a subscript to the right outside the brackets.

Combining radicals	NH_4^+	SO_4^{2-}
Combining power	1	2



Formula $(NH_4)_2SO_4$

When an element shows variable valency in its compounds, the valency exhibited is indicated in Roman numbers in brackets when naming its compounds as shown below

Examples

Formula of compound	***Conventional name***
CuO	Copper (II) oxide
Cu2O	Copper (I) oxide
FeSO4	Iron (II) Sulphate
FeCl2	Iron (II) Chloride
FeCl3	Iron (III) chloride
SO2	Sulphur (IV) oxide
SO3	Sulphur (IV) oxide

4. Chemical Equations

A chemical equation represents a chemical change by use of **symbols and formula.**

The formulae of the **reactants are put on the left hand side and those of the products on the right hand side.**

To write a correct chemical equation one must write correct formula of the reactants and the products.

For example, copper metal reacts with oxygen to form copper (II) oxide. The chemical reaction is represented by a word equation as follows:

$$\text{Copper metal + oxygen} \longrightarrow \text{copper (II) oxide}$$

The equation which represents the reaction can be written in form of symbols as follows:

$$2Cu + O_2 \longrightarrow 2CuO$$

Balancing chemical equations

This is the process of making the number of each kind of atom on both sides of the equation equal.

A chemical equation is correct if it is balanced. *An equation is balanced when the number of atoms of each type of reactants is equal to that on the products side*. This is because atoms are neither created nor destroyed during a chemical reaction.

The following guidelines should be observed when balancing chemical equations:

(i) Write the chemical reaction in words.

$$\text{Copper metal + Oxygen gas} \longrightarrow \text{copper (II) oxide}$$

(ii) Write the correct chemical formulae for both reactants and products.

$$Cu + O_2 \longrightarrow CuO \text{ (unbalanced)}$$

(iii) Check whether the number of atoms of each element on the reactants side is equal to that on the products side.

(iv) If the number is not equal, multiply the chemical formula containing the unbalanced atoms with the lowest common multiple. In this case multiply the products side by two.

$$2Cu + O_2 \longrightarrow 2CuO \text{ (balanced)}$$

(v) Check again to ensure that all the atoms are balanced.

The chemical formula of the reactants and products should never change during balancing of the equations.

(vi) A chemical equation is correct and complete if the physical state of the reactants and products are indicated. The following symbols represent the physical states which are written in brackets after each reactant or product as solid (a), liquid (l), in solution/aqueous (aq), gas (g).

Thus

$$2Cu(s) + O_2(g) \longrightarrow 2\ CuO\ (s)$$

showing that copper is a solid, oxygen is a gas and the product copper oxide is a solid.

Example

Zinc granules react with dilute hydrochloric acid liberating hydrogen gas and a solution of zinc chloride is formed.

The word equation for the reaction is:

Zinc + Hydrochloric acid ⟶ Zinc chloride + Hydrogen gas

The unbalanced chemical equation for the reaction is:

$$Zn + HCl \longrightarrow ZnCl_2 + H_2$$

There are two atoms of chlorine and two atoms of hydrogen on the products side while there is one atom of chlorine and one atom of hydrogen on the reactants' side of the equation. The number of each of the atoms on both sides of the equation should be equal.

To balance the equation, two molecules of hydrochloric acid are used i.e. the number two is written before the formula of hydrochloric acid.

The balanced equation is:

$$Zn + 2HCl \longrightarrow ZnCl_2 + H_2$$

The equation is not yet complete as the state symbols are not in place. Thus to complete the equation these have to be placed.

$$Zn(s) + 2HCl(aq) \longrightarrow ZnCl_2(aq) + H_2(g)$$

Review Questions

Complete the following word equations. Write balanced chemical equations for the reactions listed below.

(a) Sodium hydroxide + dilute hydrochloric acid
(b) Zinc oxide + dilute sulphuric acid
(c) Zinc metal + dilute nitric acid
(d) Calcium carbonate + dilute sulphuric acid
(e) Calcium hydrogen + carbon (IV) oxide
(f) Sodium + water

1. 2006 Q 12 P1
The table below shows the relative atomic masses and the percentage abundance of the isotopes L_1 of element L_2.

	Relative atomic mass	**% abundance**
L_1	62.93	69.09
L_2	64.93	30.91

Calculate the relative atomic mass of element L. (3 marks)

2. 2007 Q 26 P1
The table below shows the number of valence electrons of the element P, Q and R.

Element	P	Q	R
Number of valence electrons	3	5	2

(a) Explain why P and R would not be expected to form a compound. (1 mark)
(b) Write an equation to show the effect of heat on the carbonate of R. (1 mark)
(c) Write the formula for the most stable ion or Q. (1 mark)

3. 2008 Q 7 P1

(a) What are isotopes? (1 mark)

(b) Determine the number of neutrons in $^{18}_{8}O$ (2 marks)

4. 2009 Q6 P1

An isotope of element E has 34 neutrons and its mass number is 64. E forms a cation with 28 electrons. Write the formula of the cation indicating the mass and atomic numbers.

(1 mark)

5. 2010 Q2 P1

(a) What is meant by the terms: (2 marks)

(i) Element;

(ii) Atomic number.

(b) The formula for a chloride of titanium is $TiCl_3$. What is the formula of its sulphate? (1 mark)

6. 2011 Q 5a, b (i-iii) PP2

(a) Other than their location in the atom, name two other differences between an electron and a proton. (2 marks)

(b) The table below gives the number of electrons, protons and neutrons in particles A, B, C, D, E, F and G

Particle	Protons	Electrons	Neutrons
A	6	6	6
B	10	10	12
C	12	10	12
D	6	6	8
E	13	10	14
F	17	17	18
G	8	10	8

(i) Which particle is likely to be a halogen? (1 mark)

(ii) What is the mass number of E? (1 mark)

(iii) Write the formula of the compound formed when E combines with G? (1mark)

7. 2011 Q 24

The table below gives the number of electrons, protons and neutrons in Substances X, Y and Z.

Substance	Electrons	Protons	Neutrons
X	10	10	10
Y	10	8	10
Z	8	8	8

(a) Which letter represents an ion? (1 mark)

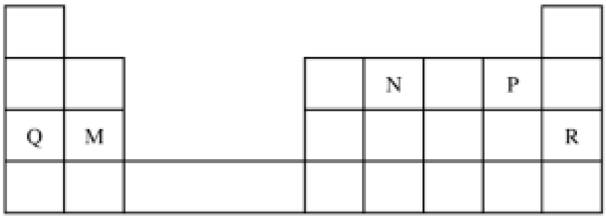
(b) Which of the substances are isotopes? Give a reason. (2 marks)

8. 2013 Q29 P1

A sample of hydrogen gas was found to be a mixture of two isotopes 12 H and H. Determine the relative molecular masses of the molecules 11 formed, when each of these isotopes is burnt in oxygen. (O =16.0) (2 marks)

9. 2014 Q18 P1

Use the part of the periodic table given below to answer the questions that follow (Letters are not the actual symbols of the elements



(a) Identify the element that forms giant covalent structures. (1 mark)
(b) Identify one element that does not form compounds. (1 mark)
(c) Write the formula for the nitride of M. (1 mark)

10. 2014 Q29 P1
(a) What is meant by the term radical?
(b) The table below contains atoms that form common radicals. Complete the table to show radicals formed from various atoms. (2 marks)

Element	N	S
H	NH_4^+	
O		

11. 2015 Q10 P1
The atomic number of an element, T is 15.
(a) Write the electronic configuration of the ion T (1 mark)
(b) Write the formula of an oxide of T. (1 mark)

12. 2015 Q14 P1
The table below shows behaviour of metals R, X, Y and Z. Study it and answer the questions that follow:

Metal	**Appearance on exposure to air**	**Reaction in water**	**Reaction with dilute hydrochloric acid**
R	slowly tarnishes	Slow	Vigorous
X	Slowly turns white	Vigorous	Violent
Y	No change	Does not react	Does not react
Z	No change	No reaction	Reacts moderately

(a) Arrange the metals in the order of reactivity starting with the most reactive (2 marks)
(b) Name a metal which is likely to be (1 mark)
(i) X (ii) Y

13. 2015 Q7a P2
Naturally occurring magnesium consists of three isotopes. 78.6% ^{24}Mg; 10% ^{25}Mg and ^{26}Mg.
Calculate to one decimal place, the relative atomic mass of magnesium. (2 marks)

14. 2017 Q11 P1
An oxide of element K has the formula K_2O_5.
(a) Determine the oxidation number of K. (1 mark)
(b) To which group of the periodic table does K belong? (1 mark)

15. 2018 P1 Q17.
Figure 5 represents a grid that is part of the periodic table. Study it and answer the questions that follow. The letters are not the actual symbols of the elements.

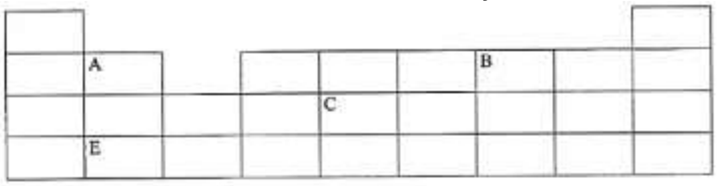


Figure 5

(a) Write the electron arrangement of element **C**. (1 mark)
(b) On the grid provided, show with a tick (✓) the position of element **D** whose atomic number is 18.
(1 mark)
(c) Element **E** is more reactive than **A**. Explain. (1 mark)

16. 2019 Q1 P1
An atom of element A has mass number 39 and 19 protons.
(a) Write the electron arrangements of the atom. (1 mark)
(b) State the period and group to which element A belongs
Group .... (½ mark)
Period .... (½ mark)
(c) State whether the element is a metal or a non-metal. (1 mark)