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S2 New Curriculum chemistry

Theme: The Periodic Table

Chapter 3 – The Periodic Table

Atomic structure

Dalton's atomic theory (1807)

1. Matter is made of tiny, invisible particles atoms.
2. Atoms can neither be created nor destroyed
3. All atoms of the same element are the same and are different from atoms of other elements
4. When atoms combine. They do so in simple whole numbers.

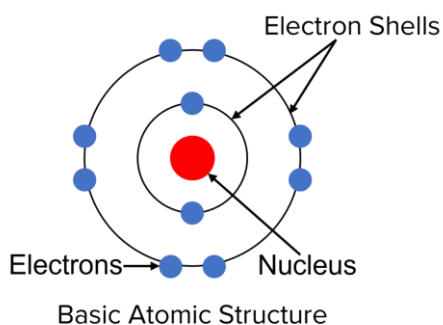
An atom

It is the smallest invisible, electrically neutral particle of an element that can take part in a chemical reaction.

An atom is composed of electrons, protons and neutrons the properties of which are given in the table below:

components	symbol	charge	mass
Proton	p	+1	1
Neutron	n	0	1
Electron	e	-1	$\frac{1}{1840}$

The **protons** and **neutrons** are situated in the **nucleus** whereas the **electrons** rotate around the nucleus in definite **shells** around the nucleus.



Definitions

Atomic number (A) is the number of protons present in the nucleus of an atom. The number of protons are usually equal to the number of electrons.

Atomic mass (Z) is the sum of protons and neutron in an atom

Isotopes are atoms of the same element having the same atomic number but different number of neutron and thus different atomic mass.

For any element X the atomic number, A, and atomic mass, Z, are represented as follows



All atoms of the same element contain the **same number of protons**.

The periodic Table

Metals								8	
Noan-metals		H Hydrogen							He Helium
1	2			3	4	5	6	7	8
Li Lithium	Be Beryllium			B Boron	C Carbon	N Nitrogen	O Oxygen	F Fluorine	Ne Neon
Na Sodium	Mg Magnesium			Al Aluminium	Si Silcon	P Phosphorus	S Suphur	Cl Chlorine	Ar Argon
K Potassium	Ca Calcium							I Iodine	

The periodic table is a tabular arrangement of elements such that the columns contain elements with electronically similar atoms. The rows of the periodic table are called **periods** while the vertical columns are called **groups**. There are 7 periods and 8 groups.

Elements are listed in order of increasing atomic number (i.e. the number of protons in the nucleus). Rows are arranged so that elements with similar properties fall into the same columns (group)

Some special groups

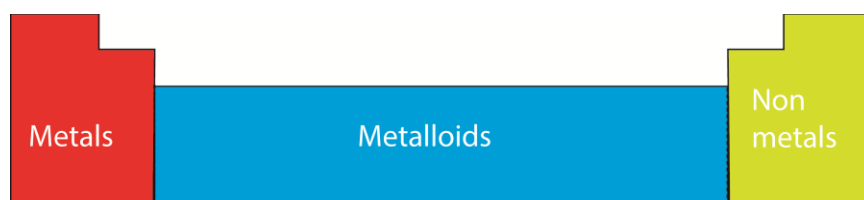
Group I: This consists of the elements, H, Li, Na, K, Rb, Cs, and Fr; except hydrogen, these elements are highly metallic in character and are known as **alkali metals**.

Group 2: This consists of the elements, Be, Mg, Ca, Sr, Ba and Ra. All these elements are metals but their metallic character is less than that of group 1. These elements are known as **alkaline earth metals**.

Group 7: This consists of elements, F, Cl, Br, I and At. All these elements are non-metals and are known as **halogens**.

Group 8: Consists of the elements, He, Ne, Ar, Kr, Xe and Rn. These elements are non-reactive and are known as the **noble elements, inert elements** or **zero elements** and are all gaseous elements at room temperature.

Summary



A simplified Periodic Table to show the variation of properties

The extreme left end of the periodic table consists of metals with exception of hydrogen; the extreme right end consists of non-metals. The middle part of the periodic table consists of semi-metals or metalloids

Metals are good conductors of heat and electricity, lustrous (shiny), ductile (can be stretched or drawn into thin wires without breaking) and malleable (can be **hammered, pressed, or shaped** without breaking or cracking), sonorous (produce sound) and hard.

The metallic characteristics of the elements decrease across the period, i.e., (left - right); but increases down the group

The reactivity of metal increases down the group for example in group 1; Lithium is less reactive than sodium than potassium.

Non-metals are brittle, non-conductors of heat and electricity (insulators), mostly gases at room temperature. Non-metallic character of elements increases across the period i.e. from left to right but decreases down the group

The reactivity of non-metals decreases down the group for example in group 7; fluorine is more reactive than chlorine than iodine.

Electronic Configuration

Electronic configuration shows the arrangement of electrons in the energy levels of an atom. The inner most energy level accommodates a maximum of two electrons. This energy level is filled first. The second energy level can only accommodate eight electrons. This energy level is filled after the first energy level. The third energy level can accommodate maximum of eight electrons

Fill in the relevant information of the first 20 elements in the table below

Name	Symbol	Atomic number	Atomic mass	Number of electrons	Electronic configuration	Formula of atom
Hydrogen	H	1				${}^1_1\text{H}$
Helium		2				
Lithium					2:1	
Beryllium						
Boron		5				
Carbon		6				
Nitrogen	N	7				
Oxygen						
Fluorine						
Neon						
Sodium		11				
Magnesium	Mg		24		2.8.2	
Aluminium			27			
Silicon			28			
Phosphorus			31			
Sulphur		16	32			
Chlorine	Cl		35			
Argon			40			
Potassium	K	39	39		2.8.8.1	
Calcium			40			

Ions

The electronic configuration of noble gases is very stable. This is why noble gases do not take part in any chemical reactions. Atoms combine to attain the noble gas configuration.

Elements attain this noble configuration by either losing or acquiring electrons.

An atom, which has either acquired or lost electron(s) is called an **ion**

Metals (group 1 – 3) lose their valence electron(s) to attain a positive charge equal to their group number while **non-metal (group 4 – 7)** gain electron(s) and attain a negative charge equal 8 minus the group number in order to attain a noble gas configuration.

Examples

Element	electron configuration	ion formed
Na	2:8:1	Na ⁺ (2:8)
O	2:6	O ²⁻ (2:8)
Cl	.....	.....
Mg	.....	.....
F	.....	.....
A	.....	.....
Li	.....	.....
Ca	.....	.....
K	.....	.....

Definitions

Cations are positively charged ions. Cations are formed when an atom loses electron(s) and therefore, cations have fewer electron(s) than Parent atoms.

Anions are negatively charged ions. An anion is formed when an atom gains electron(s) and therefore, anions have more electron(s) than the parent atoms.

Relationship between electronic configuration and valence

Valence: Is the combining power of an element or a radical. OR the number of electrons an element loses or acquires to be stable.

- An atom is said to be stable when it contains eight electrons in its outer most energy level (or two electrons in case an atom has only one energy level.) For example, neon has 10 electrons. The configuration of neon is 2:8 which makes it a stable element.
- The valence of an element can be determined from the electronic structure of its atoms. Elements with atoms that have **1-3** electrons in their outer most energy level / shell have valences equivalent to the number of outer most energy level electrons lost by an atom to obtain a stable configuration. For example, the electronic configuration of sodium is 2, 8,1, therefore, the valence of sodium is 1 because it attains a stable configuration by losing 1 electron.
- Elements with atoms that have **4,5,6,7** electrons in their outer most energy level have their valences equivalent to the number of electrons required to obtain a stable

configuration. For example, the electronic configuration of chlorine atom is 2:8:7. The valence of chlorine is 1 because it requires one electron to obtain stable configuration.

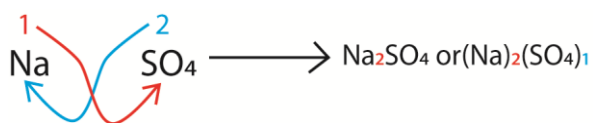
Table below shows elements, radical and their valences.

	Valency I	Valency II	Valency III
Metals	K Na Ag	Ca Mg Zn Pb Cu	Al Fe
Non metals	H Cl	O S	N P
Radicals	OH ⁻ Cl ⁻ NO ₃ ⁻ HCO ₃ ⁻	CO ₃ ²⁻ SO ₄ ²⁻	PO ₄ ³⁻

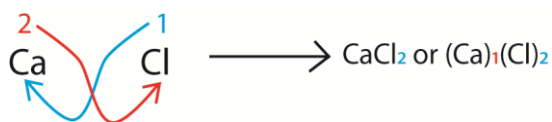
Uses of valences

Valence can help us to write a compound or a molecule e.g

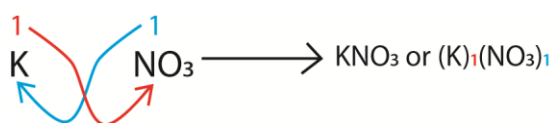
- (i) **Sodium sulphate:** sodium has a valence of 1 and sulphate has a valence of 2 , therefore,



- (ii) **Calcium chloride:** calcium has valence 2 and chlorine has valence of 1



- (iii) **Potassium nitrate:** Potassium has valence of 1 and nitrate radical has a valence of 1



Revision exercise

- Predict the symbols of the following molecules
 - Aluminium Oxide
 - Copper nitrate
 - Sodium carbonate
 - Copper hydroxide
 - Sodium oxide
 - Magnesium hydrogen sulphate
 - Copper (II) oxide
 - Iron (III)oxide
 - Iron(III)chloride
- Some elements denoted by letters A to F, (which are not chemical symbols) and their atomic numbers are: A 3, B 8, C 12, D 16, E 18 & F 20. State, with reason(s) which if any, of these elements:-

Groups	1	2	3	4	5	6	7	8
Valences	1	2	3	4	3	2	1	Zero
	A	C				B		E
		F				D		L

- Is a noble gas?
 - is a halogen?
 - is an alkali metal
 - Are in the same group of the periodic table?
 - Reacts readily with cold water?
 - Has a valence of 3 or 4?
 - Forms no common compounds
- The table below contains some elements (denoted by letter which are not chemical symbol). State, with your reason(s) which if any of these element(s):-

Groups	1	2	3	4	5	6	7	8
Valences	1	2	3	4	3	2	1	0
Periods 1								
Periods 2	B			G		H	A	
Periods 3			I					
Periods 4	M					J		L
5							K	N

- conducts electricity?
- is the most reactive metal?
- is the most reactive non-metal?

- (d) is unlikely to react with any other element in the table.
- (e) forms compounds of the formula of the form
- (i) X_2Y_3
 - (ii) XY_4
 - (iii) XY , where X and Y represent any element in the table
4. An atom X has atomic mass 27 and 14 neutrons, identify the group of the Periodic Table in which it occurs.
5. Give four properties of metals and three properties of non-metals.

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Thanks

Dr. Bbosa Science