8 The Periodic Table

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Learning outcomes

Candidates should be able to:

8.1 Periodic trends

(a) describe the Periodic Table as an arrangement of the elements in the order of increasing proton (atomic) number

(b) describe how the position of an element in the Periodic Table is related to proton number and electronic configuration

(c) describe the relationship between group number and the ionic charge of an element

(d) explain the similarities between the elements in the same group of the Periodic Table in terms of their electronic configuration

(e) describe the change from metallic to non-metallic character from left to right across a period of the Periodic Table

(f) describe the relationship between group number, number of valency electrons and metallic/non-metallic character

(g) predict the properties of elements in Group I, VII and the transition elements using the Periodic Table

8.2 Group properties

(a) describe lithium, sodium and potassium in Group I (the alkali metals) as a collection of relatively soft, low-density metals showing a trend in melting point and in their reaction with water

(b) describe chlorine, bromine and iodine in Group VII (the halogens) as a collection of diatomic non-metals showing a trend in colour, state and their displacement reactions with solutions of other halide ions

(c) describe the elements in Group VIII (the noble gases, also known as Group 0) as a collection of monatomic elements that are chemically unreactive and hence important in providing an inert atmosphere, e.g. argon and neon in light bulbs; helium in balloons; argon in the manufacture of steel

(d) describe the lack of reactivity of the noble gases in terms of their electronic structures

8.3 Transition elements

(a) describe the central block of elements (transition metals) as metals having high melting points, high density, variable oxidation state and forming coloured compounds

(b) state the use of these elements and/or their compounds as catalysts, e.g. iron in the Haber process; vanadium(V) oxide in the contact process; nickel in the hydrogenation of alkenes, and how catalysts are used in industry to lower energy demands and hence are economically advantageous and help conserve energy sources

(101)

Periodic table

Periodic table is an arrangement of elements according to the increasing order of their proton number.

Important Characteristics of the periodic table

Groups of the periodic table

Vertical columns in the periodic table are called groups of the periodic table.

⇒ There are 8 groups in the periodic table.

Relationship between group number and valence electrons

Group number represents the number of valence electrons.

Groups are numbered by Roman numerals.

Group number	I	II	III	IV	V	VI	VII	VIII
valence electrons	1	2	3	4	5	6	7	8

Periods in the periodic table

Horizontal rows in the periodic table are called periods of the periods of the periodic table.

There are seven periods in the periodic table.

Relationship between period number and number of shells

Period number represents the number of shells that elements have in that period.

Period Number	Elements	Electronic configuration
1	$_1H$	1 (one shell)
2	$_3Li$	2, 1 (two shells)
3	$_{11}Na$	2, 8, 1 (3 shells)
4	$_{19}K$	2, 8, 8, 1 (4 shells)

Valency

Number of electrons lost or gained by an element is called its valency.
Metals loose electrons while non metals gain electrons.

Relationship between group number and valency

Group number represents the number of valence electrons.
Valency of metals is equal to their valence electrons
Valency of non metals is equal to $8 -$ group number
(Minus)

Group Number	I	II	III	IV	V	VI	VII	VIII
Valence electrons	1	2	3	4	5	6	7	8
Valency	+1	+2	+3	±4	−3	−2	−1	0

Position of metals and non metals in the periodic table

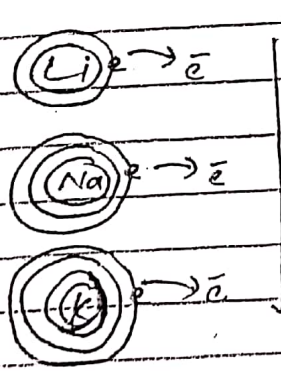
Metals:- Metals are the elements which loose electrons and form positive ion are called metals.
In the periodic table metals are present from group I to III of the periodic table

Non metals:- Non metals are the elements which gain electron and form negative ion.
Non metals are present from group IV to VIII of the periodic table.

Trends in the properties of elements in the periodic table

Metallic Character
Ability of metals to loose electrons is called metallic character.

Metallic character along the groups

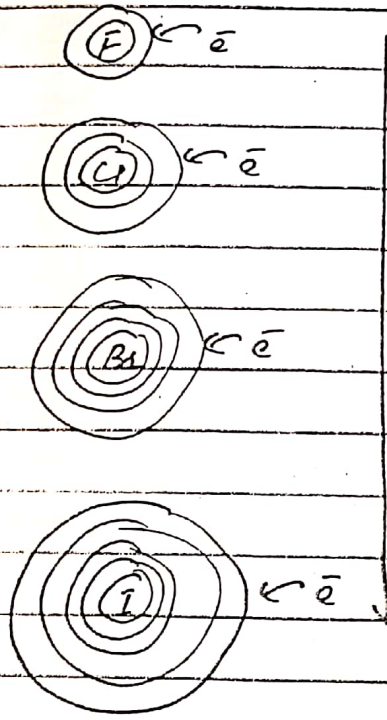


Metallic character increases from top to bottom due to the increase in atomic size and decrease in attraction between nucleus and valence electrons.

Non metallic character

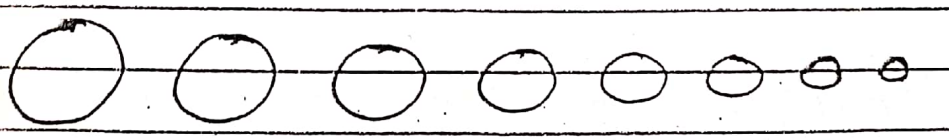
Ability of non metals to gain electron and get negative charge is called non metallic character.

Non metallic character along the group



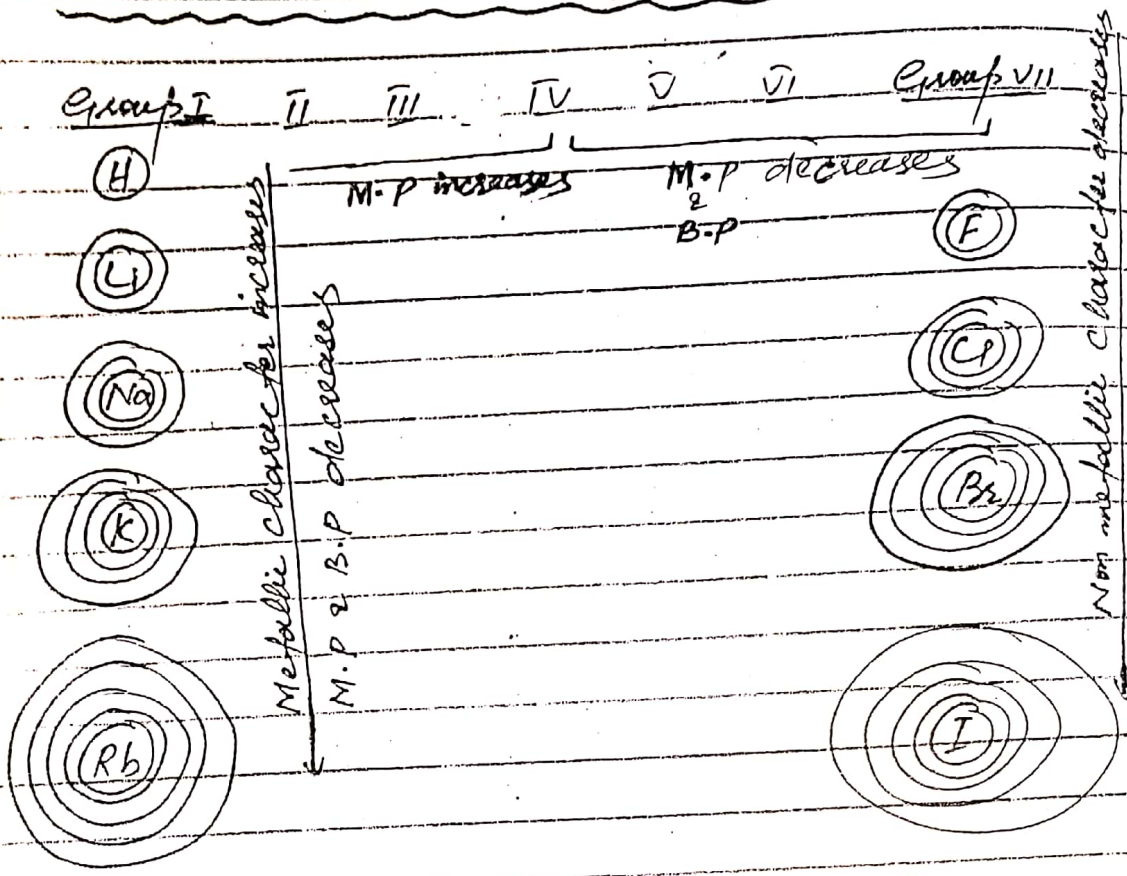
Non metallic character decreases from top to bottom due to the increase in atomic size and decrease in attraction between nucleus and valance shell.

Metallic and non metallic character along the period



Metallic character decreases
Non metallic character increases
Due to the decrease in atomic size

Trends in the M.P and B.P



Families in the periodic table

Group I	Alkali metals
Group II	Alkaline earth metals
Group VII	Halogens
Group VIII	Noble gases

Physical properties of Alkali metals

⇒ Alkali metals are soft like rubber and they can be cut with knife
⇒ Have low M.P & B.P
⇒ Good conductors of heat and electricity
⇒ Are greyish white in colour
⇒ Are less denser than water, float over water.

Chemical properties of alkali metals

Alkali metals are very reactive that they are stored in Kerosene oil.

(i) Reaction with oxygen

Alkali metals when exposed to open air reacts with oxygen to form their oxides.

$$Na + O_2 \longrightarrow Na_2O$$

$$K + O_2 \longrightarrow K_2O$$

$$Rb + O_2 \longrightarrow Rb_2O$$

(ii) Reaction with water

Alkali metal + water $\longrightarrow$ Metal hydroxide + H_2

$$Li + H_2O \longrightarrow LiOH + H_2$$

$$Na + H_2O \longrightarrow NaOH + H_2$$

$$K + H_2O \longrightarrow KOH + H_2$$

$$Rb + H_2O \longrightarrow RbOH + H_2$$

Observation

When alkali metals reacts with water, it is seen that

⇒ Metal turns to silvery ball
⇒ Metal darts over water or floats over water
⇒ Bubbles are seen
⇒ Sparks are seen
⇒ Fizzy sound is produced.

(iii) Reaction with halogens (Group VII)

Alkali metal + Halogen → Salt

$Li + F_2 \longrightarrow LiF$

$Na + Cl_2 \longrightarrow NaCl$

$K + Br_2 \longrightarrow KBr$

Halogens

Elements in group VII are called halogens, they are called halogens because they react with metals to form salt.

Physical properties of halogens

⇒ Halogens exist as diatomic molecules
F_2, Cl_2, Br_2, I_2, At_2

⇒ Halogens are coloured elements and their colour darkens down the groups

F_2	Pale yellow	Gas
Cl_2	yellowish green	Gas
Br_2	Reddish Brown	Liquid
I_2	Black	Solid
At_2	Black	solid

⇒ Their M.P & B.P increases down the groups

⇒ Halogens are soluble in water

Chemical properties of halogens

(i) Salt formation

Halogens react with metals to form salt.

$Mg + Cl_2 \longrightarrow MgCl_2$

$Ca + Br_2 \longrightarrow CaBr_2$

$Al + I_2 \longrightarrow AlI_3$

Displacement reaction of halogens

A halogen above in the group can displace another halogen from the aqueous solution of its compound.

$Cl_{2(aq)} + KBr_{(aq)} \longrightarrow KCl_{(aq)} + Br_{2(aq)}$

colourless colourless colourless Brown

$Cl_{2(aq)} + KI_{(aq)} \longrightarrow KCl_{(aq)} + I_{2(aq)}$

colourless colourless colourless dark Brown

$Br_{2(aq)} + KI_{(aq)} \longrightarrow KBr_{(aq)} + I_{2(aq)}$

light Brown colourless colourless dark Brown

$I_{2(aq)} + KCl_{(aq)} \longrightarrow$ No reaction

Transition metals

Elements present in between group II and group III of the periodic table are called transition metals except Zinc.

Less typical properties of Transition metals

Properties which are common to transition metals only are called less typical properties.
Few properties are given below

(i) Transition metals have variable valencies
e.g; copper has +1 and +2 valencies
Iron has +2 and +3 valencies

(ii) Transition metals form coloured compounds
copper(II) (Cu^{+2}) compounds are Blue
Iron(II) (Fe^{+2}) compounds are Green
Iron(III) (Fe^{+3}) compounds are Reddish Brown

(iii) Transition metals and their compound act as catalyst in different industrial process

(iv) Transition metals form complex compounds.

Noble gases

⇒ Elements present in group VIII or zero group are called noble gases.

⇒ They are called noble gases because they do not react with other elements to form compounds due to the complete valence shell by electrons.

Uses of Noble gases

Gas	Use
He	In filling weather baloon
Ne	In advertising lights (Neon signs)
Ar	In light bulbs