CHAPTER 2

Chemical Bonding

SYLLABUS – SCOPE OF SYLLABUS – in and after MARCH 2022 – CHEMICAL BONDING – ELECTROVALENT, COVALENT & CO-ORDINATE BONDING, STRUCTURES OF VARIOUS COMPOUNDS, ELECTRON DOT STRUCTURE.

[a] Electrovalent bonding:

- ***Electron dot structure – of Electrovalent compounds – NaCl, $MgCl_2$, CaO.***
- ***Characteristic properties of electrovalent compounds - state of existence, melting & boiling points, conductivity [heat & electricity], dissociation in solution & in molten state to be linked with electrolysis.***

[b] Covalent Bonding:

- ***Electron dot structure – of covalent molecules on the basis of duplet & octet of electrons*** *[example: hydrogen, chlorine, nitrogen, ammonia, carbon tetrachloride, methane].*
- ***Polar Covalent compounds*** *- based on difference in electronegativity: Examples - HCl & H_2O including structures.*
- ***Characteristic properties of Covalent compounds -*** *state of existence, melting & boiling points, conductivity [heat & electricity], ionisation in solution.* Comparison of Electrovalent & Covalent compounds.

[c] Coordinate Bonding:

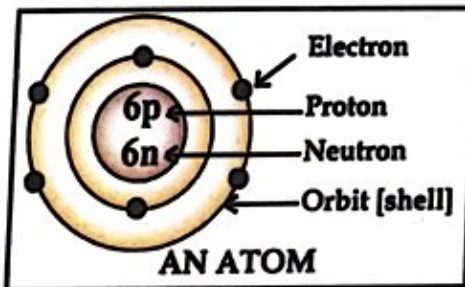
- ***Definition***
- ***The lone pair effect*** *– of the oxygen atom of the water molecule & the nitrogen atom of the ammonia molecule to explain the formation of H_3O^+ & OH ions in water & NH_4^+ ion.*
- ***The meaning of lone pair;*** the formation of *hydronium ion* & *ammonium ion* must be explained with help of electron dot diagrams.

A. INTRODUCTION

Chemical bond is the force which holds two or more atoms together in a stable molecule.

1. AN ATOM

- An atom is the smallest unit of matter taking part in a chemical reaction. It is built up of sub-atomic particles – *protons, neutrons* and *electrons.*
- Two or more atoms [metallic or non-metallic] combine to form a *molecule.*
- The force which holds the atoms together as a stable molecule is the *chemical bond.*



AN ATOM

Sub-atomic particle		Charge	Mass [C-12 standard]
• PROTON	${}^{1}_{+1}p$	+1	1 a.m.u.
• NEUTRON	${}^{1}_{0}n$	0	1 a.m.u.
• ELECTRON	${}^{0}_{-1}e$	-1	negligible

Elements are pure substances made up of one kind of atoms - having the same atomic number.

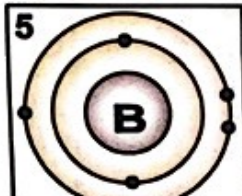
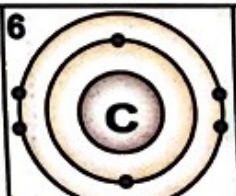
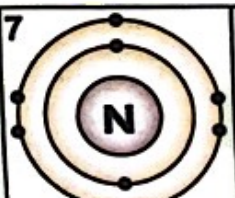
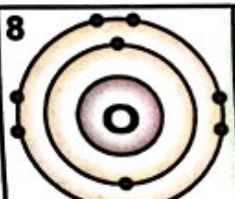
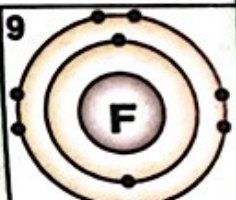
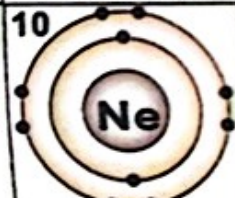
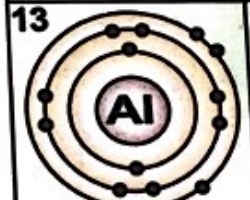
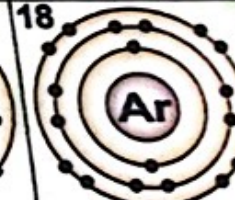
2. TYPES OF ELEMENTS – involved in chemical combination.

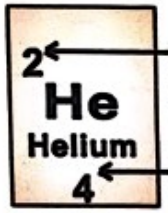
- *Metallic elements* – have *1, 2* or *3 electrons* in valence [outer] shell. They *lose* 1, 2 or 3 electrons and become *positively charged ions* [cations].
- *Non-metallic elements* – have *4, 5, 6* or *7 electrons* in valence [outer] shell. They *gain* (4), 3, 2, or 1 electrons and become *negatively charged ions* [anions].

3. CHEMICAL COMBINATION – Atoms combine to form a molecule by two means–

- *Transfer of valence electrons from* – a metallic atom to a non-metallic atom.
- *Sharing of valence electrons between* – two atoms [generally both non-metallic].

THE ELEMENTS OF THE FIRST THREE PERIODS OF THE PERIODIC TABLE

	GROUP 1 IA	GROUP 2 IIA	GROUP 13 IIIA	GROUP 14 IVA	GROUP 15 VA	GROUP 16 VIA	GROUP 17 VIIA	GROUP 18 0
PERIOD 1	1  HYDROGEN 1 p = 1, n = 0 Elec. conf. 1							2  HELIUM 4 p = 2, n = 2 Elec. conf. 2
2	3  LITHIUM 7 p = 3, n = 4 Elec. conf. 2,1	4  BERYLLIUM 9 p = 4, n = 5 Elec. conf. 2,2	5  BORON 11 p = 5, n = 6 Elec. conf. 2,3	6  CARBON 12 p = 6, n = 6 Elec. conf. 2,4	7  NITROGEN 14 p = 7, n = 7 Elec. conf. 2,5	8  OXYGEN 16 p = 8, n = 8 Elec. conf. 2,6	9  FLUORINE 19 p = 9, n = 10 Elec. conf. 2,7	10  NEON 20 p = 10, n = 10 Elec. conf. 2,8
3	11  SODIUM 23 p = 11, n = 12 Elec. conf. 2,8,1	12  MAGNESIUM 24 p = 12, n = 12 Elec. conf. 2,8,2	13  ALUMINIUM 27 p = 13, n = 14 Elec. conf. 2,8,3	14  SILICON 28 p = 14, n = 14 Elec. conf. 2,8,4	15  PHOSPHORUS 31 p = 15, n = 16 Elec. conf. 2,8,5	16  SULPHUR 32 p = 16, n = 16 Elec. conf. 2,8,6	17  CHLORINE 35.5 p = 17, n = 18 Elec. conf. 2,8,7	18  ARGON 40 p = 18, n = 22 Elec. conf. 2,8,8
4	19  POTASSIUM 39 p = 19, n = 20 Elec. conf. 2,8,8,1	20  CALCIUM 40 p = 20, n = 20 Elec. conf. 2,8,8,2						



Atomic number
[= no. of electrons = no. of protons]

Mass number [relative atomic mass]
[= no. of neutrons + no. of protons]

B. CHEMICAL BONDING

CHEMICAL BOND & TYPES OF BONDING – Electrovalent & Covalent

CHEMICAL BONDING

- *Chemical bond* – The linkage or force which acts between two or more atoms to hold them together as a stable molecule. The concept – **chemical bonding.**

NOBLE GAS	SYMBOL	AT. NO.	ELECTRONIC CONFIGURATION					
			K	L	M	N	O	P
HELIUM	He	2	[2]					
NEON	Ne	10	2	[8]				
ARGON	Ar	18	2	8	[8]			
KRYPTON	Kr	36	2	8	18	[8]		
XENON	Xe	54	2	8	18	18	[8]	
RADON	Rn	86	2	8	18	32	18	[8]

NOBLE GASES

- Have *stable electronic configuration.* i.e. their outermost [valence] shell is **complete.**
- They have **2 electrons** in outermost shell [He] or **8 electrons** in outermost shell.
- They *do not* – lose, gain or share electrons and are *inert* or *unreactive.*

ATOMS OF ELEMENTS – *OTHER THAN NOBLE GASES*

- Have *unstable electronic configuration.* i.e. their outermost shell is **incomplete.**
- They *can* – lose, gain or share electrons and are chemically *reactive.*

REASONS FOR CHEMICAL BONDING BETWEEN ATOMS – *TO FORM A MOLECULE*

- The driving force for atoms to combine is related to the tendency of each atom – *to attain stable electronic configuration of the nearest noble gas.*

  For an atom to achieve stable electronic configuration it must have –
  - *Two electrons* – in outermost shell [nearest noble gas – He] – **Duplet rule**
  - *Eight electrons* – in outermost shell [all noble gases other than – He] – **Octet rule**

METHODS FOR ACHIEVING CHEMICAL BONDING

- A stable electronic configuration in two combining atoms – resulting in chemical bonding between them is achieved by:

  Electron transfer – of valence electrons from one atom to another –
  - leading to *electrovalent bonding* & formation of an *electrovalent or ionic compound.*

  Electron sharing – of pairs of electrons between two reacting atoms –
  - leading to *covalent bonding* and formation of a *covalent compound.*

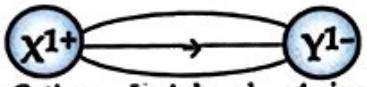
PERIODIC PROPERTIES WHICH AFFECT CHEMICAL BOND FORMATION

FOR FORMATION OF – *IONIC COMPOUND*	
Ionisation potential –	*Lower* – the value of I.P. of a metallic atom. greater the ease of formation of the – *cation.*
Electronaffinity –	*Higher* – the value of E.A. of a non-metallic atom. greater the ease of formation of the – *anion.*
Electronegativity –	*Larger* – the electronegativity difference between combining atoms, electron transfer takes place easily.
FOR FORMATION OF – *COVALENT COMPOUND*	
Ionisation potential, electronaffinity & electronegativity – *High* - between both atoms or elements.	
Electronegativity difference – *Should be negligible* – between the two combining atoms.	

C. ELECTROVALENT BONDING – Electrovalent compounds

FORMATION OF – Electrovalent compounds

- *Formation of electrovalent compounds – involves transfer of valence electrons – from one atom* – generally metallic *to another atom* – generally non-metallic .
  - Metallic atom – *loses* electrons to attain stable electronic configuration and becomes a – ***cation***
    Metallic atom X [elec. config. 2,8,1] $X - 1e^- \rightarrow X^{1+}$ *Cation* [positive ion 2,8]
  - Non-metallic atom – *gains* electrons to attain stable electronic configuration and becomes an – ***anion***
    Non-metallic atom Y [elec. config. 2,8,7] $Y + 1e^- \rightarrow Y^{1-}$ *Anion* [negative ion 2,8,8]
  - Ions – ***cations and anions*** – are oppositely charged particles, which attract one another to form an – *electrovalent bond* leading to formation of an –*electrovalent compound.*
    Bond formation is due to – Electrostatic force of attraction between two oppositely charged ions.



Cation Ionic bond Anion → $X^{1+}\ Y^{1-} \rightarrow XY$
Electrovalent or Ionic Compound

- ***Electrovalent or ionic bond***
  The chemical bond formed between two atoms by transfer of one or more electrons from the – atom of a *metallic* - electropositive element to an – atom of a *non-metallic* - electronegative element.
- ***Electrovalent or ionic compound***
  The chemical compound formed as a result of transfer of one or more electrons from the – atom of a *metallic* - electropositive element to an – atom of a *non-metallic* - electronegative element.
- ***Electrovalency***
  The number of electrons donated or accepted by the valence shell of an atom of an element – so as to achieve stable electronic configuration is called – *electrovalency.*
  [Mg (2,8,2) loses 2 electrons - valency +2]; [O (2,6) gains 2 electrons - valency –2]

ATOMS – 'X' or 'Y'	IONS – X^{1+} or Y^{1-}
• Electrically – *neutral* particles • *May or may not exist* – independently. • Outermost shell – *may or may not have* duplet or octet.	• Electrically – *charged* particles [cations, anions] • *Exist* – independently in solution. • Outermost shell – *have* complete duplet or octet.
OXIDATION - a process when –	**REDUCTION - a process when –**
• An atom or ion – *loses* electrons • $X - 1e^- \rightarrow X^{1+}$ or $A^{2+} - 1e^- \rightarrow A^{3+}$ [i.e. $X \rightarrow X^{1+} + 1e^-$ or $A^{2+} \rightarrow A^{3+} + 1e^-$] $Na - 1e^- \rightarrow Na^{1+}$ $Zn - 2e^- \rightarrow Zn^{2+}$ $Fe^{2+} - 1e^- \rightarrow Fe^{3+}$ $S^{2-} - 2e^- \rightarrow S$	• An atom or ion – *gains* electrons • $Y + 1e^- \rightarrow Y^{1-}$ or $A^{3+} + 1e^- \rightarrow A^{2+}$ $Cl_2 + 2e^- \rightarrow 2Cl^{1-}$ $Cu^{2+} + 2e^- \rightarrow Cu$ $Fe^{3+} + 1e^- \rightarrow Fe^{2+}$ $S + 2e^- \rightarrow S^{2-}$
Oxidation – Reduction i.e. Redox reactions $2FeCl_2 + Cl_2 \rightarrow 2FeCl_3$ $2Fe^{2+} + Cl_2 \rightarrow 2Fe^{3+} + 2Cl^-$ $2Fe^{2+} \rightarrow 2Fe^{3+}$ [oxidation] [$-2e^-$] $Cl_2 \rightarrow 2Cl^-$ [reduction] [$+2e^-$]	$Zn + CuSO_4 \rightarrow ZnSO_4 + Cu$ $Zn + Cu^{2+} \rightarrow Zn^{2+} + Cu$ $Zn \rightarrow Zn^{2+}$ [oxidation] [$-2e^-$] $Cu^{2+} \rightarrow Cu$ [reduction] [$+2e^-$]

D. STRUCTURE – Of Electrovalent compound – *Sodium chloride*

I. SODIUM CHLORIDE - Formation

- *SODIUM CHLORIDE* – is formed as a result of – *transfer of one valence electron*
  - From metallic sodium atom $^{23}_{11}Na$ [at. no.] - electronic configuration - 2, 8, 1
  - To non-metallic chlorine atom $^{35}_{17}Cl$ - electronic configuration - 2, 8, 7

ATTAINMENT OF – Stable Electronic Configuration

- *SODIUM ATOM* – attains stable electronic configuration of the nearest noble gas – Neon.
  - by losing one electron from its valence shell and becomes a positively charged *sodium ion [cation]* – Na^{1+}.
- *CHLORINE ATOM* – attains stable electronic configuration of the nearest noble gas – Argon.
  - by accepting one electron in its valence shell and becomes a negatively charged *chloride ion [anion]* – Cl^{1-}.
- *THE TWO OPPOSITELY CHARGED IONS* – attract each other resulting in formation of the
  - *electrovalent compound* i.e. sodium chloride – with an *ionic bond.*

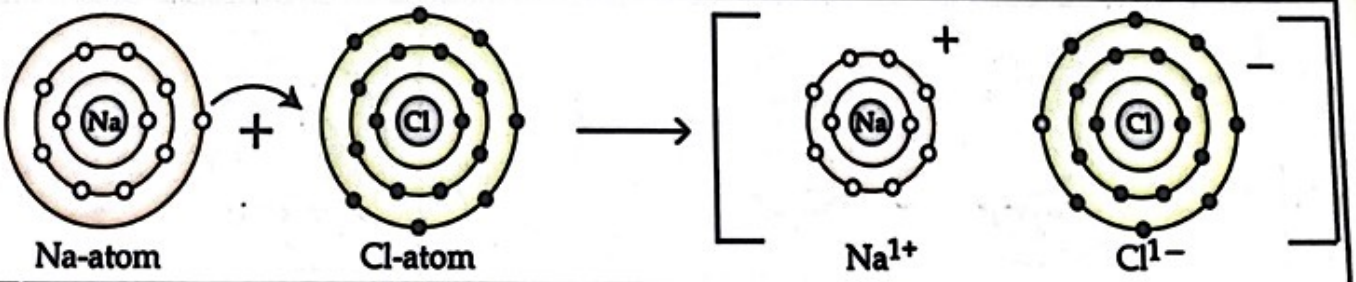
Atom	*Electronic configuration*	*Nearest noble gas*	*To attain stable electronic configuration of nearest noble gas*
SODIUM [metallic]	$^{23}_{11}Na$ [2,8,1]	Neon [2,8]	Atom loses one electron from its valence shell.
CHLORINE [non-metallic]	$^{35}_{17}Cl$ [2,8,7]	Argon [2,8,8]	Atom gains one electron in its valence shell.

$^{39}_{19}K$ & $^{35}_{17}Cl$ form KCl and $^{23}_{11}Na$ & $^{32}_{16}S$ form Na_2S - both of which are electrovalent compounds – with an *electrovalent or ionic bond.*

FORMATION OF SODIUM CHLORIDE – Represented by electron dot structure :

Ionic equation	*ELECTRON DOT STRUCTURE*
Na [atom] [2,8,1] $- 1e^- \rightarrow$ Na^{1+} [cation] [2,8] [oxidation]	$Na^{\bullet} + :\ddot{Cl}: \rightarrow [Na]^{1+} + [:\ddot{Cl}:]^{1-} \rightarrow NaCl$
Cl [atom] [2,8,7] $+ 1e^- \rightarrow$ Cl^{1-} [anion] [2,8,8] [reduction]	[2,8,1] [2,8,7]
$Na + Cl \rightarrow Na^{1+}Cl^{1-} \rightarrow NaCl$	Sodium atom; Chlorine atom; Sodium chloride

REFERENCE – Orbit structure [Recap of std. IX]



Na-atom Cl-atom Na^{1+} Cl^{1-}

Before combination		After combination [NaCl compound]	
Sodium atom [Na] 2,8,1	*Chlorine atom* [Cl] 2,8,7	*Sodium ion* [Na^{1+}] 2,8	*Chloride ion* [Cl^{1-}] 2,8,8

II. CALCIUM OXIDE - Formation

- *CALCIUM OXIDE* – is formed as a result of – *transfer of two valence electrons*
  - From metallic calcium atom $^{40}_{20}Ca$ [at. no.] - electronic configuration - 2, 8, 8, 2
  - To non-metallic oxygen atom $^{16}_{8}O$ - electronic configuration - 2, 6.

ATTAINMENT OF – Stable Electronic Configuration

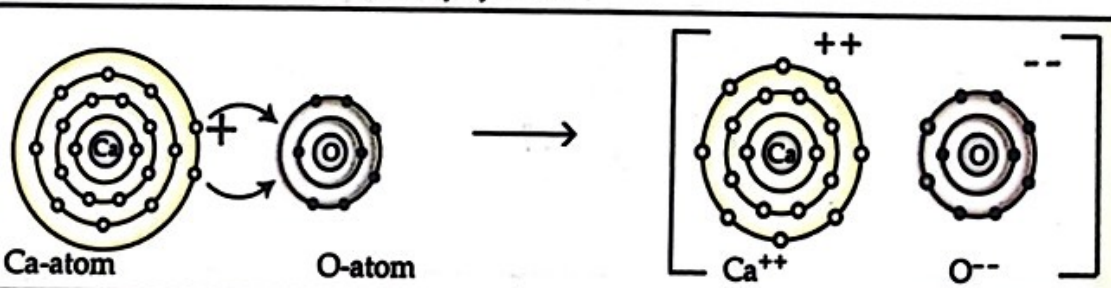
- *CALCIUM ATOM* – attains stable electronic configuration of the nearest noble gas – Argon.
  - by losing two electrons from its valence shell and becomes a positively charged *calcium ion [cation]* – Ca^{2+}.
- *OXYGEN ATOM* – attains stable electronic configuration of the nearest noble gas – Neon.
  - by accepting two electrons in its valence shell and becomes a negatively charged *oxide ion [anion]* – O^{2-}.
- *THE TWO OPPOSITELY CHARGED IONS* – attract each other resulting in formation of the
  - *electrovalent compound* i.e. calcium oxide with an *ionic bond.*

Atom	*Electronic configuration*	*Nearest noble gas*	*To attain stable electronic configuration of nearest noble gas*
CALCIUM [metallic]	$^{40}_{20}Ca$ [2,8,8,2]	Argon [2,8,8]	Atom loses two electrons from its valence shell.
OXYGEN [non-metallic]	$^{16}_{8}O$ [2,6]	Neon [2,8]	Atom gains two electrons in its valence shell.

FORMATION OF CALCIUM OXIDE – Represented by electron dot structure :

Ionic equation	*ELECTRON DOT STRUCTURE*
$Ca - 2e^- \rightarrow Ca^{2+}$ [oxidation] [atom] [cation] [2,8,8,2] [2,8,8]	$Ca: + \cdot\ddot{O}\cdot \rightarrow [Ca]^{2+} + [:\ddot{O}:]^{2-} \rightarrow CaO$
$O + 2e^- \rightarrow O^{2-}$ [reduction] [atom] [anion] [2,6] [2,8]	[2,8,8,2] [2,6] Calcium atom Oxygen atom Calcium oxide
$Ca + O \rightarrow Ca^{2+}O^{2-} \rightarrow CaO$	

REFERENCE – Orbit structure [Recap of std. IX]



Before combination		After combination [CaO compound]	
Calcium atom [Ca]	*Oxygen atom* [O]	*Calcium ion* [Ca^{2+}]	*Oxide ion* [O^{2-}]
2,8,8,2	2,6	2,8,8	2,8

III. MAGNESIUM CHLORIDE - Formation

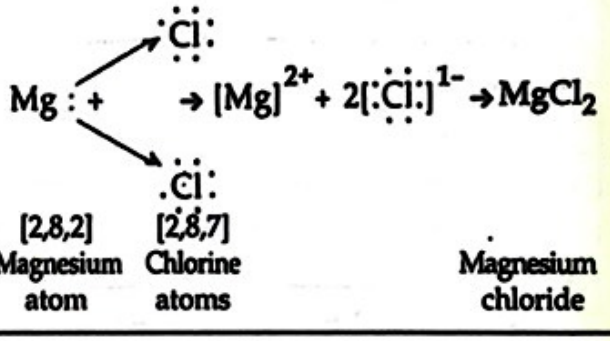
- *MAGNESIUM CHLORIDE* - is formed as a result of – *transfer of two valence electrons*
  - From one metallic magnesium atom $^{24}_{12}Mg$ - electronic configuration - 2, 8, 2
  - To two non-metallic chlorine atoms $^{35}_{17}Cl$ - electronic configuration - 2, 8, 7.

ATTAINMENT OF – Stable Electronic Configuration

- *MAGNESIUM ATOM* – attains stable electronic configuration of the nearest noble gas – Neon.
  - by losing two electrons from its valence shell and becomes a positively charged *magnesium ion [cation]* – Mg^{2+}.
- *CHLORINE ATOM* – attains stable electronic configuration of the nearest noble gas – Argon.
  - by gaining one electron in its valence shell and becomes a negatively charged *chloride ion [anion]* – Cl^-.
- *TRANSFER OF ELECTRONS* – Magnesium atom donates two electrons *[is oxidised]*,
  - whereas chlorine atom accepts only one electron *[is reduced]* to give chlorine ion.

  Thus to accept the other electron donated by 'Mg' atom, there must be another 'Cl' atom.
- *FORMATION OF COMPOUND* – Therefore one magnesium atom will combine with –
  - two chlorine atoms forming the electrovalent compound – magnesium chloride.

FORMATION OF MAGNESIUM CHLORIDE – Represented by electron dot structure :

Ionic equation	*ELECTRON DOT STRUCTURE*
$Mg - 2e^- \rightarrow Mg^{2+}$ [oxidation] [atom] [2,8,2] → [cation] [2,8] $2Cl + 2e^- \rightarrow 2Cl^-$ [reduction] [atom] [2,8,7] → [anion] [2,8,8] $Mg + 2Cl \rightarrow Mg^{2+}\,2Cl^{1-} \rightarrow MgCl_2$	

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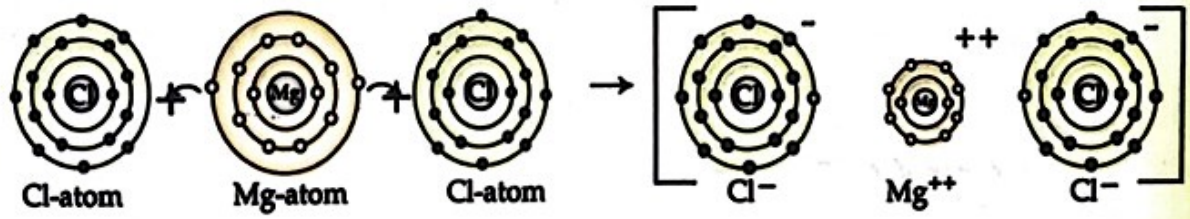


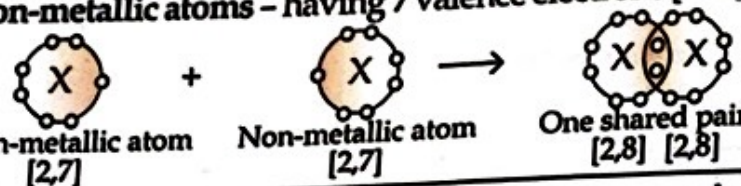
Before combination			After combination [$MgCl_2$ compound]	
Chlorine atom	*Magnesium atom*	*Chlorine atom*	*Magnesium* [Mg^{2+}]	*Two chloride ions* [$2Cl^{1-}$]
2,8,7	2,8,2	2,8,7	2,8	2,8,8 – 2,8,8

E. COVALENT BONDING – Covalent compounds

FORMATION OF – Covalent Compounds

- *Formation of covalent compounds – involves sharing of electron pairs –* between one atom – generally *non-metallic* & another atom – also *non-metallic.* Electrons in valence shell are *mutually shared* – by the atom of each element – such that each atom acquires a *stable electronic configuration.*

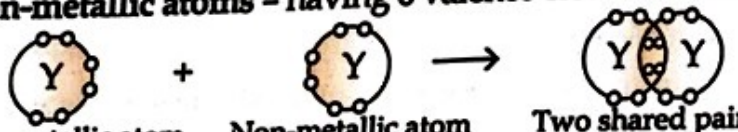
Non-metallic atoms – having 7 valence electrons [or 1] - share - ***one pair of electron.***



Non-metallic atom [2,7] + Non-metallic atom [2,7] → One shared pair [2,8] [2,8]

Covalent compound [*single* – covalent bond]

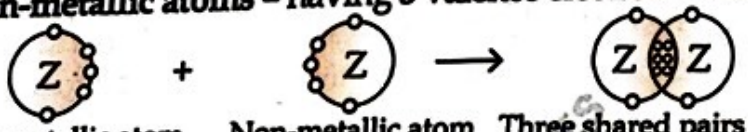
Non-metallic atoms – having 6 valence electrons - share - ***two pairs of electrons.***



Non-metallic atom [2,6] + Non-metallic atom [2,6] → Two shared pairs [2,8] [2,8]

Covalent compound [*double* – covalent bond]

Non-metallic atoms – having 5 valence electrons - share - ***three pairs of electrons.***



Non-metallic atom [2,5] + Non-metallic atom [2,5] → Three shared pairs [2,8] [2,8]

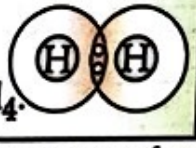
Covalent compound [*triple* – covalent bond]

Dissimilar non-metallic atoms – form covalent molecules – ***by sharing electron pairs.***

[1] + [2,6] + [1] → [2] [2,8] [2]

Covalent compound [*two single* – covalent bonds]

- ***Covalent bond*** *— The chemical bond* – formed due to *mutual sharing of electrons* – between the given pairs of atoms of *non-metallic elements.*
  Bond formed by a *shared pair of electrons*, each bonding atom contributing one electron to the pair.
  [depending on no. of electron pairs shared : bond is *single* [–], *double* [=], or *triple* [≡] covalent].
- ***Covalent compound*** *— The chemical compound* – formed due to *mutual sharing of electrons* – between the given pairs of atoms thereby forming a covalent bond between them.
- ***Covalency***
  The *number of electron pairs* – which an atom shares with one or more atoms – of the same or different kind to achieve stable electronic configuration is called **covalency.**

NON-POLAR COVALENT COMPOUNDS	POLAR COVALENT COMPOUNDS
• Covalent compounds are said to be – *non-polar* when *shared pair of electrons* are – *equally distributed* between the two atoms.	• Covalent compounds are said to be – *polar* when *shared pair of electrons* are – *unequally distributed* between the two atoms.
• *No charge separation* – takes place. The covalent molecule is *symmetrical* and – *electrically neutral.*	• *Charge separation* – takes place. The atom which attracts electrons more strongly develops a – *slight negative charge.*
e.g. H_2, Cl_2, O_2, N_2, CH_4, CCl_4. 	e.g. H_2O, NH_3, HCl 

The covalent bond in which electrons are *shared equally* between the combining atoms is — a *non polar covalent bond* & when shared unequally is a *polar covalent bond.*

F. STRUCTURE – Of Covalent compounds – *Hydrogen, Chlorine*

I. HYDROGEN – *Non-polar covalent compound*

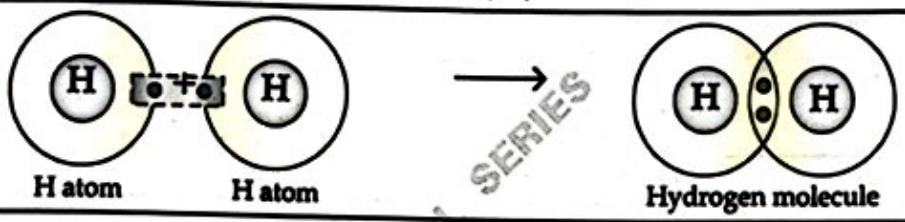
Atom	*Electronic configuration*	*Nearest noble gas*	*To attain stable electronic configuration of nearest noble gas*
HYDROGEN	$^{1}_{1}H$	Helium [2]	Hydrogen needs – *one electron* to attain stable – duplet structure of nearest noble gas – Helium [2].

- Each of the two 'H' atoms contributes one electron so as to have *one shared pair of electrons* between them. Both atoms attain stable – *duplet structure*, resulting in the – formation of a – *single covalent bond* [H-H] between them.

FORMATION OF – *HYDROGEN MOLECULE* – Represented by electron dot structure:

ELECTRON DOT STRUCTURE	
Before combination [H-atoms]	**After combination [H_2 — molecule]**
H• + •H → H-atom H-atom	H : H or [H–H] → H_2 One shared pair of electrons – *Single covalent bond*

REFERENCE – Orbit structure [Recap of std. IX]



II. CHLORINE – *Non-polar covalent compound*

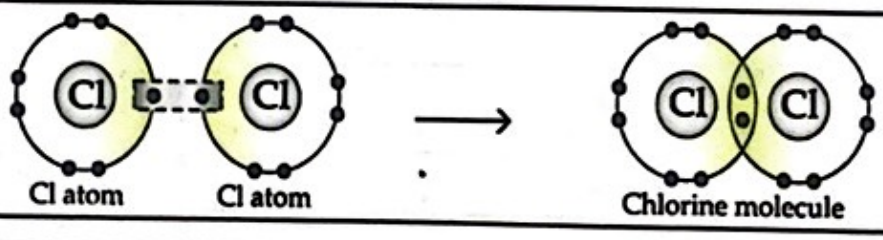
Atom	*Electronic configuration*	*Nearest noble gas*	*To attain stable electronic configuration of nearest noble gas*
CHLORINE	$^{35}_{17}Cl$ [2,8,7]	Argon [2,8,8]	Chlorine needs – *one electron* to attain stable – octet structure of nearest noble gas – Argon [2,8,8]

- Each of the two 'Cl' atoms contributes one electron so as to have *one shared pair of electrons* between them. Both atoms attain stable – *octet structure*, resulting in the – formation of a – *single covalent bond* [Cl - Cl] between them.

FORMATION OF – *CHLORINE MOLECULE* – Represented by electron dot structure:

ELECTRON DOT STRUCTURE	
Before combination [Cl - atoms]	**After combination [Cl_2 - molecule]**
:Cl• + •Cl: → Cl-atom Cl-atom	:Cl : Cl: → [Cl–Cl] → Cl_2 One shared pair of electrons – *Single covalent bond*

REFERENCE – Orbit structure [Recap of std. IX]



STRUCTURE – Of Covalent compounds – *Oxygen, Nitrogen* [Contd.]

III. OXYGEN – *Non-polar covalent compound*

Atom	*Electronic configuration*	*Nearest noble gas*	*To attain stable electronic configuration of nearest noble gas*
OXYGEN	$^{16}_{8}O$ [2,6]	Neon [2,8]	Oxygen needs – *two electrons* to attain stable – octet structure of nearest noble gas – Neon [2,8]

- Each of the two 'O' atoms contributes two electrons so as to have *two shared pairs of electrons* between them. Both atoms attain stable – *octet structure,* resulting in the – formation of a – *double covalent bond.* [O=O] between them.

FORMATION OF – *OXYGEN MOLECULE* – Represented by electron dot structure:

ELECTRON DOT STRUCTURE

Before combination [O-atoms]	After combination [O_2 — molecule]
:Ö: + :Ö: → O-atom O-atom	:Ö: :Ö: → [O = O] → O_2 Two shared pair of electrons – *Double covalent bond*

REFERENCE – Orbit structure ***[Recap of std. IX]***

IV. NITROGEN – *Non-polar covalent compound*

Atom	*Electronic configuration*	*Nearest noble gas*	*To attain stable electronic configuration of nearest noble gas*
NITROGEN	$^{14}_{7}N$ [2,5]	Neon [2,8]	Nitrogen needs – *three electrons* to attain stable – octet structure of nearest noble gas – Neon [2,8]

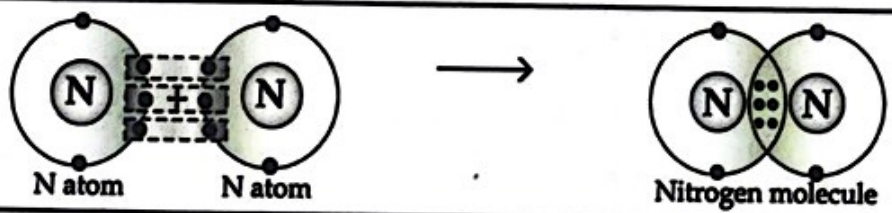
- Each of the two 'N' atoms contributes 3 electrons so as to have *three shared pair of electrons* between them. Both atoms attain stable – *octet structure,* resulting in the – formation of a – *triple covalent bond.* [N ≡ N] between them.

FORMATION OF – *NITROGEN MOLECULE* – Represented by electron dot structure:

ELECTRON DOT STRUCTURE

Before combination [N - atoms]	After combination [N_2 - molecule]
:N: + :N: → N-atom N-atom	:N: :N: → [N≡N] → N_2 Three shared pair of electrons – *Triple covalent bond* *[2 electrons in the outer shell of each nitrogen atom – are not involved in sharing, during formation of N_2 molecule]*

REFERENCE – Orbit structure ***[Recap of std. IX]***



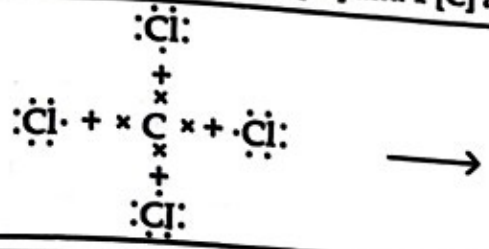
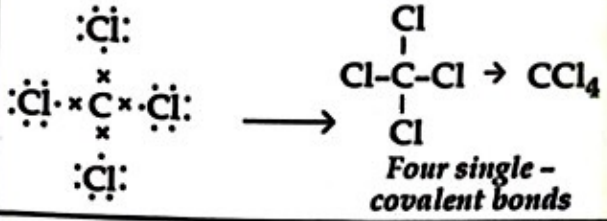
V. CARBON TETRACHLORIDE – *Non-polar covalent compound*

Atom	*Electronic configuration*	*Nearest noble gas*	*To attain stable electronic configuration of nearest noble gas*
CARBON	$^{12}_{6}C$ [2,4]	Neon [2,8]	Carbon needs – *four electrons* to attain – stable octet.
CHLORINE	$^{35}_{17}Cl$ [2,8,7]	Argon [2,8,8]	Chlorine needs – *one electron* to attain – stable octet.

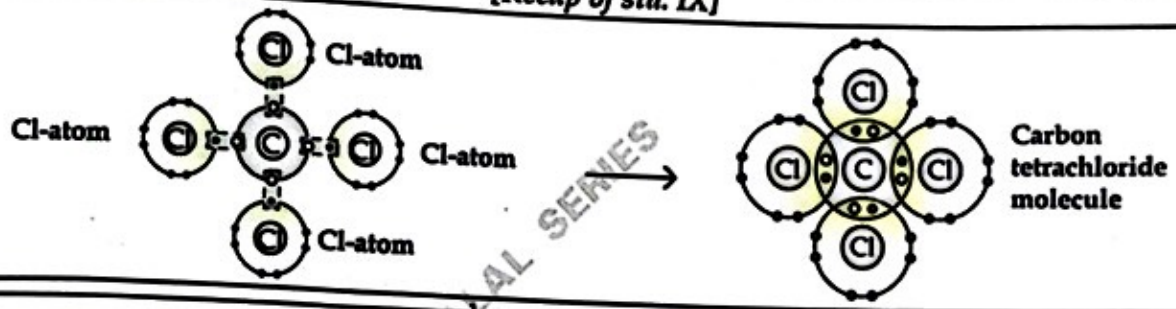
- One atom of carbon - *shares four electron pairs – one with each of the four atoms of chlorine.*

FORMATION OF – CARBON TETRACHLORIDE MOLECULE – Represented by electron dot structure:

ELECTRON DOT STRUCTURE

Before combination [4 [Cl] and 1 [C] atom]	After combination [CCl_4 - molecule]
	 *Four single – covalent bonds*

REFERENCE – Orbit structure [Recap of std. IX]



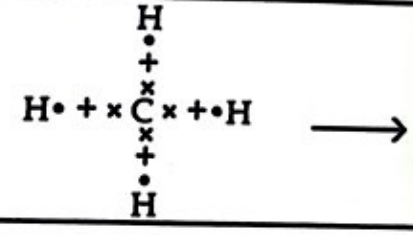
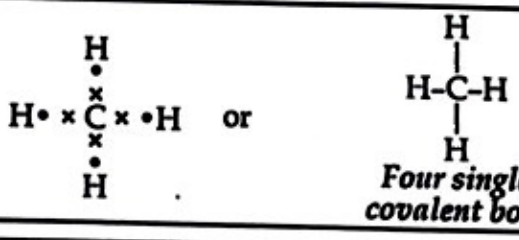
VI. METHANE – *Non-polar covalent compound*

Atom	*Electronic configuration*	*Nearest noble gas*	*To attain stable electronic configuration of nearest noble gas*
CARBON	$^{12}_{6}C$ [2,4]	Neon [2,8]	Carbon needs – *four electrons* to attain – stable octet.
HYDROGEN	$^{1}_{1}H$ [1]	Helium [2]	Hydrogen needs – *one electron* to attain – stable duplet.

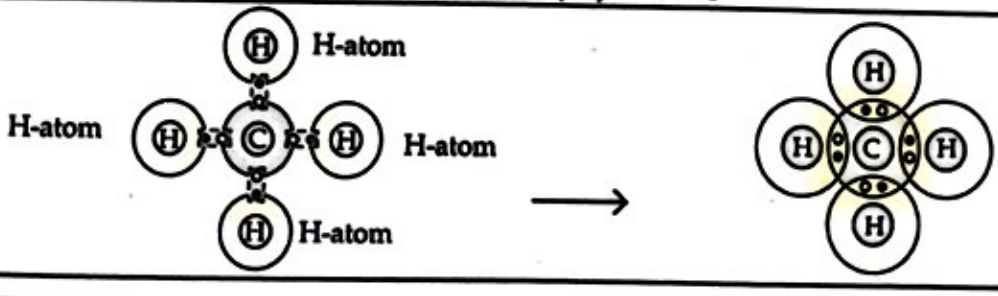
- One atom of carbon – *shares four electron pairs – one with each of the four atoms of hydrogen.*

FORMATION OF – *METHANE MOLECULE* – Represented by electron dot structure:

ELECTRON DOT STRUCTURE

Before combination [4 [H] and 1 [C] atom]	After combination [CH_4 - methane molecule]
	 *Four single – covalent bonds*

REFERENCE – Orbit structure [Recap of std. IX]



STRUCTURE – Of Covalent compounds – *Water, Ammonia* [Contd.]

VII. WATER – *Polar covalent compound*

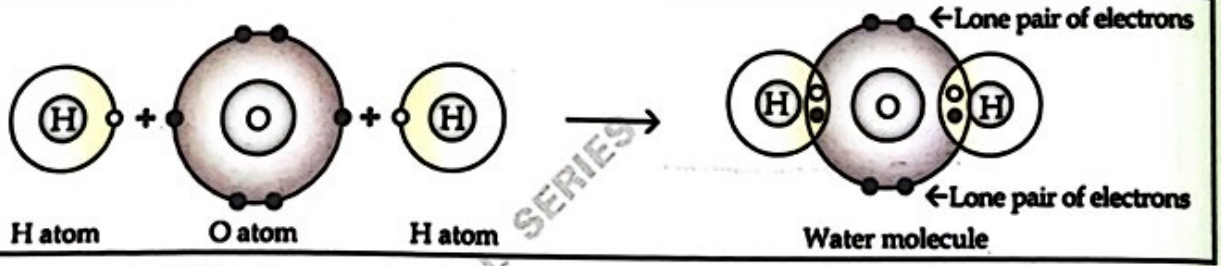
Atom	*Electronic configuration*	*Nearest noble gas*	*To attain stable electronic configuration of nearest noble gas*
HYDROGEN	$^{1}_{1}H$ [1]	Helium [2]	Hydrogen needs – *one electron* to attain – stable duplet.
OXYGEN	$^{16}_{8}O$ [2, 6]	Neon [2,8]	Oxygen needs – *two electrons* to attain – stable octet.

- Each of the two hydrogen atoms – *shares an electron pair with the oxygen atom* – such that hydrogen acquires a – *duplet configuration* and oxygen an *octet configuration* – resulting in formation of– *two single covalent bonds* [H-O-H] in the molecule of water.

FORMATION OF – *WATER MOLECULE* – Represented by electron dot structure:

ELECTRON DOT STRUCTURE	
Before combination [2H and 1[O] atom]	**After combination [Water molecule]**
H× + ·Ö· + ×H → H-atom O-atom H-atom	H×Ö×H or H–O–H → H_2O *Two single – covalent bonds*

REFERENCE – Orbit structure [Recap of std. IX]



VIII. AMMONIA – *Polar covalent compound*

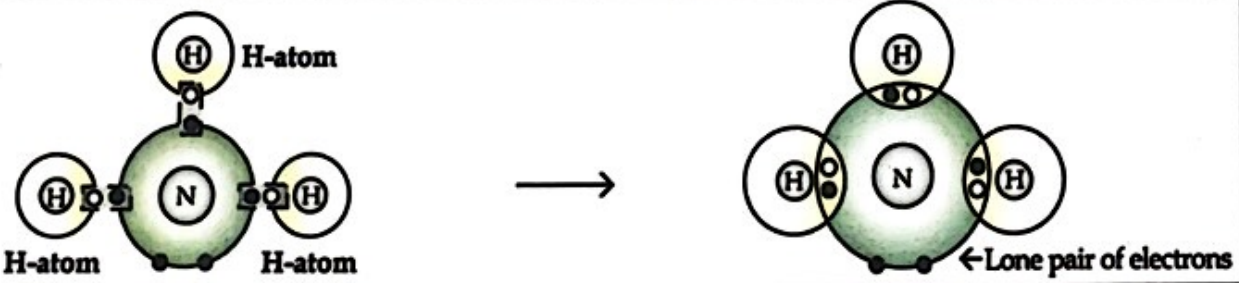
Atom	*Electronic configuration*	*Nearest noble gas*	*To attain stable electronic configuration of nearest noble gas*
NITROGEN	$^{14}_{7}N$ [2,5]	Neon [2,8]	Nitrogen needs – *three electrons* to attain – stable octet.
HYDROGEN	$^{1}_{1}H$ [1]	Helium [2]	Hydrogen needs – *one electron* to attain – stable duplet.

- One atom of nitrogen *shares three electron pairs one with each of the three atoms of hydrogen.*

FORMATION OF – *AMMONIA MOLECULE* – Represented by electron dot structure:

ELECTRON DOT STRUCTURE	
Before combination [3 [H] and 1 [N] atom]	**After combination [NH_3 - ammonia molecule]**
H • + × H• + ×N× + •H → ××	H • × H• ×N× •H or H–N–H ×× [lone pair] *Three single – covalent bonds*

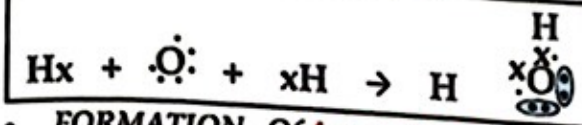
REFERENCE – Orbit structure [Recap of std. IX]



G. COORDINATE BOND – Formation of H_3O^+ & NH_4^+ ion

THE LONE PAIR EFFECT – Of oxygen atom of *Water* & nitrogen atom of *Ammonia*

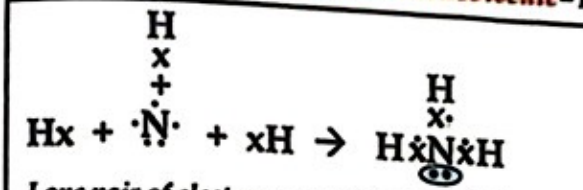
- *FORMATION – Of Water Molecule – Lone pair effect of the oxygen atom of water molecule*



WATER MOLECULE

IN THE MOLECULE OF WATER –
Oxygen atom has –
- *Two lone pairs of electrons.*

- *FORMATION – Of Ammonia Molecule – Lone pair effect of the nitrogen atom of ammonia molecule*

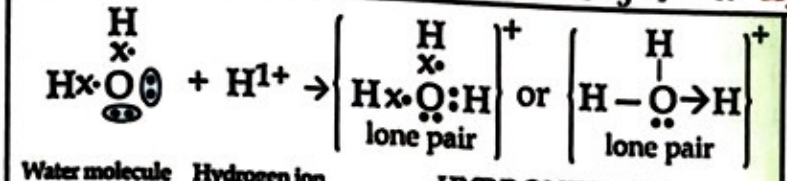


AMMONIA MOLECULE

IN THE MOLECULE OF AMMONIA –
Nitrogen atom has –
- *One lone pair of electrons.*

Lone pair of electrons – are a pair of electrons not shared with any other atom.

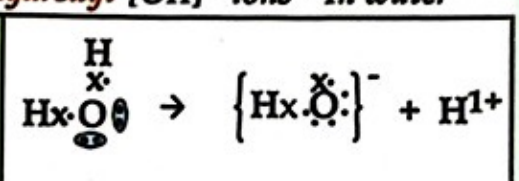
- *FORMATION – Of Hydronium ion $[H_3O]^+$ & Hydroxyl $[OH]^-$ ions – In water*



Water molecule Hydrogen ion

$H_2O + H^{1+} \rightarrow$ HYDRONIUM ION H_3O^+

From acid Hydronium ion *(stable positive ion)*



Water molecule HYDROXYL ION

$H_2O \rightarrow OH^{1-} + H^{1+}$

Hydroxyl ion

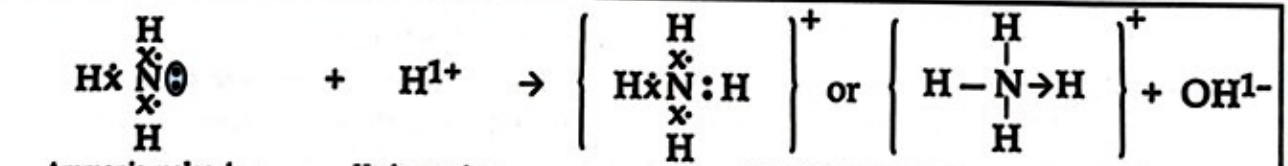
Addition of acid [HCl - polar covalent] to water [polar solvent] results in release of hydrogen ion [H^{1+}] from the acid

Hydrogen Chloride Water

H^+ Hydrogen ion + Cl^- Chloride ion

- ***In water*** – the 'O' atom contains ***two lone pairs of electrons*** after completing its octet.
- ***The hydrogen ion*** – accepts one lone pair of electrons of the oxygen atom of water molecule leading to formation of a ***coordinate covalent bond.*** [–O→H]

- *FORMATION – Of Ammonium ion – NH_4^+*



Ammonia molecule Hydrogen ion AMMONIUM ION

NH_3 Ammonia gas + H^{1+} From water molecule → NH_4^{1+} Ammonium ion + OH^{1-} Hydroxyl ion ⇌ NH_4OH

- ***Ammonia*** – dissolves in water [polar solvent] leading to formation of – ammonium ion.
- ***In ammonia*** – the 'N' atom contains ***one lone pair of electrons*** after completing its octet.
- ***The hydrogen ion*** – from water – accepts the lone pair of electrons of the nitrogen atom of ammonia molecule, leading to formation of a ***coordinate covalent bond.*** [–N→H]

COORDINATE BOND

- Type of covalency which involves one of the combining atoms *contributing both of the shared electrons.*
- i.e. a bond formed by a shared pair of electrons with *both electrons coming from the same atom.*

[It has properties of both ionic & covalent bonds & is also called as - *dative* or co-ionic bond.] Compounds containing

- *Electrovalent & Covalent bond:* $Na^+[O-H]$ *[NaOH]*, $CaCO_3$: *Covalent & Coordinate bond :* $C \equiv O$ *[CO]*, [H–O–N=O] ↓ O *[HNO_3]*

Ionic, covalent & coordinate bond - NH_4Cl i.e. $\left[H-\underset{H}{\overset{H}{N}}\rightarrow H\right]^+ Cl^-$, $K_4[Fe(CN)_6]$

H. PROPERTIES & COMPARISON – Electrovalent & Covalent compounds

ELECTROVALENT [IONIC] COMPOUNDS	COVALENT COMPOUNDS
1. STATE – Bonding – electrovalent • Existence – *Crystalline hard solids [room temp.]* • Constituent Units – *Ions [metallic, non-metallic]* • Force of attraction – *Strong Electrostatic forces* exist between – ions. *REASON: Ions [charged particles which attract one another to form electrovalent compounds]* – are *closely packed* with strong force of attraction, hence ionic compounds are – hard solids.	**1. STATE – Bonding – covalent** • Existence – *Gases, liquids* or *soft solids.* • Constituent Units – *Molecules* • Force of attraction – *Weak Van der Waal's forces* exist between – molecules. *REASON: Molecules* have *weak forces of attraction* between them & hence covalent compounds are gaseous [if molecules are less] & liquid or soft solids [if molecules are more].
2. VOLATILITY • Non-volatile	**2. VOLATILITY** • Volatile
3. MELTING & BOILING POINT • *High* melting point and *high* boiling point. *REASON: Strong electrostatic* force of attraction between ions. *Large amount of energy* – required to break the force of attraction.	**3. MELTING & BOILING POINT** • *Low* melting point and *low* boiling point. *REASON: Weak Vander Waals* force of attraction between molecules. *Less amount of energy* – required to break the force of attraction.
4. CONDUCTION OF HEAT • *Good – conductors of heat*	**4. CONDUCTION OF HEAT** • *Bad or non-conductors of heat*
5. CONDUCTION OF ELECTRICITY • Solid state – *Non-conductors* • Molten or aq. soln. state – *Good conductors* *REASON: Strong* electrostatic force keeps ions in fixed position in the – *solid state.* The force is weakened in the *molten state* & disappears in *soln. state,* hence free ions formed migrate to – oppositely charged electrodes.	**5. CONDUCTION OF ELECTRICITY** • Gaseous or liquid state – *Non-conductors* • Soft solid state – *Non-conductors* *REASON: Non-polar covalent compounds* e.g. CCl_4 contain molecules & not free ions, hence are non-conductors. *Polar covalent compounds* e.g. HCl, NH_3 show charge separation & dissociate in H_2O [polar solvent].
6. ELECTROLYSIS • Can – *be electrolysed* in molten/aq. soln. state. On electrolysis the ions being charged are attracted towards the respective electrodes.	**6. ELECTROLYSIS** • Cannot – *be electrolysed* in normal state. In soln. state, polar covalent compounds undergo electrolysis. e.g. HCl & NH_3 gas.
7. SOLUBILITY • Soluble – *in water* • Insoluble – *in organic solvents.* *REASON: Water* [polar solvent] has a high dielectric constant i.e. capacity to weaken the force of attraction, thus resulting in free ions. *Organic solvents* [non-polar] have low dielectric constants and do not cause dissolution.	**7. SOLUBILITY** • Soluble – *in organic solvents* [non-polar] • Insoluble – *in water* [polar] *REASON: Organic solvents* [non-polar] e.g. benzene, alcohol, dissolve non-polar covalent compounds [like dissolves like]. *Water* [polar solvent] cannot dissolve non-polar covalent compounds, but dissolves polar.
8. REACTIONS • Undergo – high speed *ionic reactions.* *REASON:* Free ions easily formed in solution, – *rapidly* regroup in solution.	**8. REACTIONS** • Undergo – slow speed *molecular reactions.* *REASON:* Covalent molecules are first broken & new bonds are – *slowly* established.
9. DISSOCIATION • Undergoes *electrolytic dissociation* – on passage of electric current. Process involves – *separation of ions* already present in the ionic compound. e.g. $NaCl \rightleftharpoons Na^{1+} + Cl^{1-}$ [in molten state]	**9. IONISATION** • Undergoes *ionisation* – in solution state on passage of electric current. Process involves – *formation of ions* from molecules which are not in ionic state. e.g. $HCl \longrightarrow H^{1+} + Cl^{1-}$ [in solution state]

SUMMARY CHART – Structure of Electrovalent & Covalent Compounds

1. Electrovalent – Sodium Chloride

ELECTRON DOT STRUCTURE

$Na^{\cdot} + {:}\ddot{Cl}{:} \rightarrow [Na]^{1+} + [{:}\ddot{Cl}{:}]^{1-} \rightarrow NaCl$

[2,8,1] [2,8,7]

Sodium atom — Chlorine atom — Sodium chloride

2. Electrovalent – Calcium Oxide

ELECTRON DOT STRUCTURE

$Ca{:} + {:}\ddot{O}{:} \rightarrow [Ca]^{2+} + [{:}\ddot{O}{:}]^{2-} \rightarrow CaO$

[2,8,8,2] [2,6]

Calcium atom — Oxygen atom — Calcium oxide

3. Electrovalent – Magnesium chloride

ELECTRON DOT STRUCTURE

$Mg{:} + 2{\cdot}\ddot{Cl}{:} \rightarrow [Mg]^{2+} + 2[{:}\ddot{Cl}{:}]^{1-} \rightarrow MgCl_2$

[2,8,2] Magnesium atom — [2,8,7] Chlorine atom — Magnesium chloride

4. Covalent - Hydrogen

$H{\cdot} + {\cdot}H \rightarrow H{:}H \text{ or } [H\text{-}H] \rightarrow H_2$

H-atom *H-atom*

5. Covalent - Chlorine

$:\ddot{Cl}{\cdot} + {\cdot}\ddot{Cl}: \rightarrow :\ddot{Cl}{:}\ddot{Cl}: \rightarrow [Cl\text{-}Cl] \rightarrow Cl_2$

Cl-atom *Cl-atom*

6. Covalent - Nitrogen

$:N{:} + {:}N: \rightarrow :N{:}{:}N: \rightarrow [N{\equiv}N] \rightarrow N_2$

N-atom *N-atom*

7. Covalent - Carbon tetrachloride

$:\ddot{Cl}{\cdot} + \times\dot{C}\times + {\cdot}\ddot{Cl}: \rightarrow :\ddot{Cl}{\cdot}\times\dot{C}\times{\cdot}\ddot{Cl}: \rightarrow Cl\text{-}C(Cl)\text{-}Cl \rightarrow CCl_4$

Four single – covalent bonds

8. Covalent - Methane

$H{\cdot} + \times\dot{C}\times + {\cdot}H \rightarrow H{\cdot}\times\dot{C}\times{\cdot}H$ or $H\text{-}C(H)\text{-}H$

Four single – covalent bonds

9. Covalent - Water

$H\times + {\cdot}\ddot{O}{\cdot} + \times H \rightarrow H\times\ddot{O}\times H \text{ or } H\text{-}O\text{-}H \rightarrow H_2O$

H-atom *O-atom* *H-atom*

[Two lone pairs] in water — *Two single covalent bonds*

10. Covalent - Ammonia

$H{\cdot} + \times N\times + {\cdot}H \rightarrow H{\cdot}\times N\times H \text{ or } H\text{-}N(H)\text{-}H$

[One lone pair] in ammonia — *Three single covalent bonds*

11. Covalent - HCl

$H\times + {\cdot}\ddot{Cl}: \rightarrow H\times\ddot{Cl}: \text{ or } H\text{-}Cl$

H-atom *Cl-atom*

One single covalent bond

QUESTIONS

2008

1. *State which is not a characteristic of an electrovalent compound.* A: High m.p. B: Conducts electricity when molten. C: Consists of oppositely charged ions. D: Ionizes when dissolved in water. State why CCl_4 is a non-electrolyte [pg.34, 31]
2. State the terms defined in each case: A bond formed by – a] a shared pair of electrons, each bonding atom contributing one electron to the pair. b] a shared pair of electrons with both electrons coming from the same atom. [pg.34, 28, 33]

2009

1. The one which is composed of all the three kinds of bond [ionic, covalent and corodinate bond] is : A] Sodium chloride B] Ammonia C] Carbon tetrachloride D] Ammonium chloride [pg.33,24,28]
2. Draw the structural formula of carbon tetrachloride & state the type of bond present in it. [pg.31]

2010

1. Select the correct answer from A, B, C & D - Metals lose electrons during ionization - this change is called [pg.24,133]
   A : Oxidation B : Reduction C :Redox D : Displacement
2. Select the right answer from the choices – covalent bond/ionic bond/covalent & coordinate bond for each of the following – i] *Sodium chloride* ii] *Ammonium ion* iii] *Carbon tetrachloride.* [pg.25,33,31]

2011

1. i] In covalent compounds, the bond is formed due to ___ [sharing/transfer] of electrons. ii] Electrovalent compounds have a ___ [low/high] boiling point. iii] A molecule of ___ contains a triple bond. [hydrogen, ammonia, nitrogen] [pg.28,34,30]
2. *Draw an electron dot diagram:* showing the lone pair effect for formation of – NH_4^{1+} ion from NH_3 gas & H^{1+} ion. [pg.33]
3. Give reasons – Hydrogen chloride can be termed as a polar covalent compound. [pg.28]

2012

1. Draw an electron dot diagram of the structure of – hydronium ion. State the type of bonding present in it. [pg.33]
2. There are three elements E, F, G with atomic numbers 19, 8 & 17 respectively. Give the molecular formula of the compound formed between E & G & state the type of chemical bond in this compound. [pg.25]

2013

1. *A chemical term for:* A bond formed by a shared pair of electrons with both electrons coming from the same atom. [pg.33]
2. Among the compounds identify the compound that has all three bonds [ionic, covalent & coordinate bond] [pg.33]
   A: Ammonia B: Ammonium chloride C: Sodium hydroxide D: Calcium chloride
3. State which is not a typical property of an ionic compound. A: High m.p. B: Conducts electricity in molten & in the aq. soln. state. C: Are insoluble in water. D: Exist as oppositely charged ions even in the solid state. [pg.34]
4. Compare carbon tetrachloride & sodium chloride with regard to solubility in water & electrical conductivity. [pg.34]

2014

1. Compound 'X' consists of only molecules. 'X' will have- A: Crystalline hard structure [pg.34]
   B: A low m.p. & low b.p. C: An ionic bond D: A strong force of attraction between its molecules.
2. The molecule which contains a triple covalent bond is: A: ammonia B: methane C: water D: nitrogen [pg 30]
3. Give *word/phrase* for: Formation of ions from molecules. [pg.34]
4. Give a reason why covalent compounds exist as gases, liquids or soft solids. [pg.34]

2015

1. Bonding in which – A: CCl_4 B: H_2; C: HCl; D: NH_4Cl – *involves coordinate bonding.* [pg.33, (28)]
2. Give *scientific reasons*: Carbon tetrachloride does not conduct electricity. [pg.34, (31)]
3. Explain the bonding in methane molecule using electron dot structure. [pg.31]
4. An element L consists of molecules. i] What type of bonding is present in the particles that make up L. [pg.34]
   ii] When L is heated with iron metal, it forms a compound FeL. What chemical term would you use to describe the change undergone by L. [pg.24, (51, 13)]

2016

1. Fill in the blanks from the choices given: Electrovalent compounds have ___ [*high/low*] melting points. [pg.34]
2. Elements - W, X, Y & Z have electronic configurations W = 2,8,1 ; X = 2,8,7 ; Y = 2,5 ; Z = 1
   i] What type of bond is formed between: a] W & X b] Y & Z [pg.24, 32]
   ii] What is the formula of the compound formed between: a] X & Z b] W & X [pg.29, 25]
3. Draw an electron dot diagram to show the formation of *ammonium ion* [N=7, H=1] [pg.33]

2017

1. *Fill in the blank* – The compound that *does not have a lone pair of electrons* is ___ [water, ammonia, carbon tetra chloride] [pg.31,32]
2. State which of the following is a *common characteristic of a covalent compound.* A. High melting point B. Consists of molecules C. Always soluble in water D. Conducts electricity when it is in the molten state. [pg.34]
3. State the type of bonding in the following molecules – i] Water; ii] Calcium oxide [pg.32, 26]
4. Draw an electron dot diagram to show the formation of each of the following compounds – i] Methane ii] Magnesium chloride [H = 1, C = 6, Mg = 12, Cl = 17] [pg.31,27]

2018

1. Give one word or a phrase for – Process of formation of ions from molecules which are not in the ionic state. [pg.34]
2. Give a *reason* for – Ionic compounds have a high melting point. [pg.34]
3. Fill in the blank with the correct choice given in the bracket – Ionic or electrovalent compounds do not conduct electricity in their _____ state. [fused/solid] [pg.34]
4. *State the meaning of* – 'lone pair of electrons'. Draw the *electron dot diagram* of – Hydronium ion. [H=1; O=8] [pg.33]

2019

1. *Give the appropriate term for*: The *covalent bond in which the electrons are shared equally* between the combining atoms. [pg.28]
2. Draw the *electron dot structure* of: i] *Nitrogen molecule* [N=7]; ii] *Sodium chloride* [Na=11, Cl=17]; iii] *Ammonium ion* [N=7, H=1] [pg.30, 25, 33]

2020

1. *Choose the correct answer from the options given:* A compound with *low* boiling point, is: [pg.34]
   A. Sodium chloride B. Calcium chloride C. Potassium chloride D. Carbon tetrachloride
2. *Give one word or a phrase for:* The chemical bond formed by a shared pair of electrons, each bonding atom contributing one electron to the pair. [pg.28]
3. *Fill in the blanks from the choices given:* The polar covalent compound in gaseous state that does not conduct electricity is _____. [carbon tetra chloride, ammonia, methane] [pg.34(28)]
4. Draw the electron dot diagram for the compounds given. Represent the electrons by [·] & [x] in the diagram. [Ca=20, O=8, Cl=17, H=1] – i] Calcium oxide ii] Chlorine molecule iii] Water molecule [pg.26, 29, 32]

UNIT TEST PAPER 2 – Chemical Bonding

30 marks

Q.1 Give reasons for the following: [5]

1. NH_3 gas a covalent compound does not conduct electricity but its aq. soln. NH_4OH is a weak electrolyte.
2. $MgCl_2$ is soluble in water but insoluble in acetone, while methane is insoluble in water, but soluble in acetone.
3. Iron displaces copper from a solution of a copper salt. The reaction is deemed as a redox reaction.
4. A non-metallic atom [at. no. 9] forms a molecule of the same, containing a single covalent bond.
5. In the formation of MgO the magnesium atom [at. no. 12] loses two electrons from its valence shell.

Q.2 With reference to a molecule of water, fill in the blanks with the correct word. [at. no. of H = 1, O = 8] [5]

Water is a _____ [non-polar/polar] covalent molecule in which the atom of _____ [hydrogen/oxygen] attracts electrons more strongly towards itself. The water molecule shows the presence of _____ [double/one single/two single] covalent bond/s and _____ [one/two] lone pair of electrons present in the _____ [hydrogen/oxygen] atom.

Q.3 Complete the table given below: [5]

Element	*Element*	*Type of bond likely in molecule of*	*Formula of compound*
A: At. no. = 20	B: At. no. = 8	A and B	
A: At. no. = 20	C: At. no. = 17	A and C	
D: At. no. = 9	D: At. no. = 9	D and D	
E: At. no. = 12	F: At. no. = 16	E and F	
G: At. no. = 1	F: At. no. = 16	G and F	

Q.4 Fill in the blanks with the correct word from the brackets: [5]

1. The bond between two elements in group 17[VIIA] of the periodic table is likely to be ____ [ionic/covalent]
2. In the reaction of $Cl_2 + 2KI \rightarrow 2KCl + I_2$ the conversion of 2I to I_2 is deemed as ____ [oxidation/reduction]
3. The covalent molecule containing three single covalent bonds is _____ [water / methane / ammonia].
4. The molecule of water combines with a _____ [hydrogen atom / proton / hydrogen molecule] to form a hydronium ion.
5. For formation of an electrovalent bond between elements 'X' and 'Y' which are a metal and non-metal respectively, X should have a _____ [high/low] ionization potential and 'Y' a _____ [high/low] electron affinity.

Q.5 Electronic configuration of the following elements are given : [5]

1. Sodium - Na = 2,8,1
2. Hydrogen - H = 1
3. Carbon - C = 2, 4
4. Chlorine - Cl = 2,8,7
5. Lithium - Li = 2,1

State which of the compounds given below :

a] have high/low boiling points, b] are soluble/insoluble in organic solvents.

A: Hydrogen chloride. B: Sodium chloride. C: Sodium hydride.
D: Lithium chloride. E: Carbon tetrachloride.

Q.6 A compound has a formula = "H_2Y". Y denotes a non-metal. State the following : [5]

1. The electronic configuration of Y.
2. The valency of Y.
3. The bonding present in 'H_2Y'.
4. The bonding present in the compound formed between potassium [$^{39}_{19}K$] and 'Y'.
5. The formula of the compound formed between calcium [$^{40}_{20}Ca$] and Y.