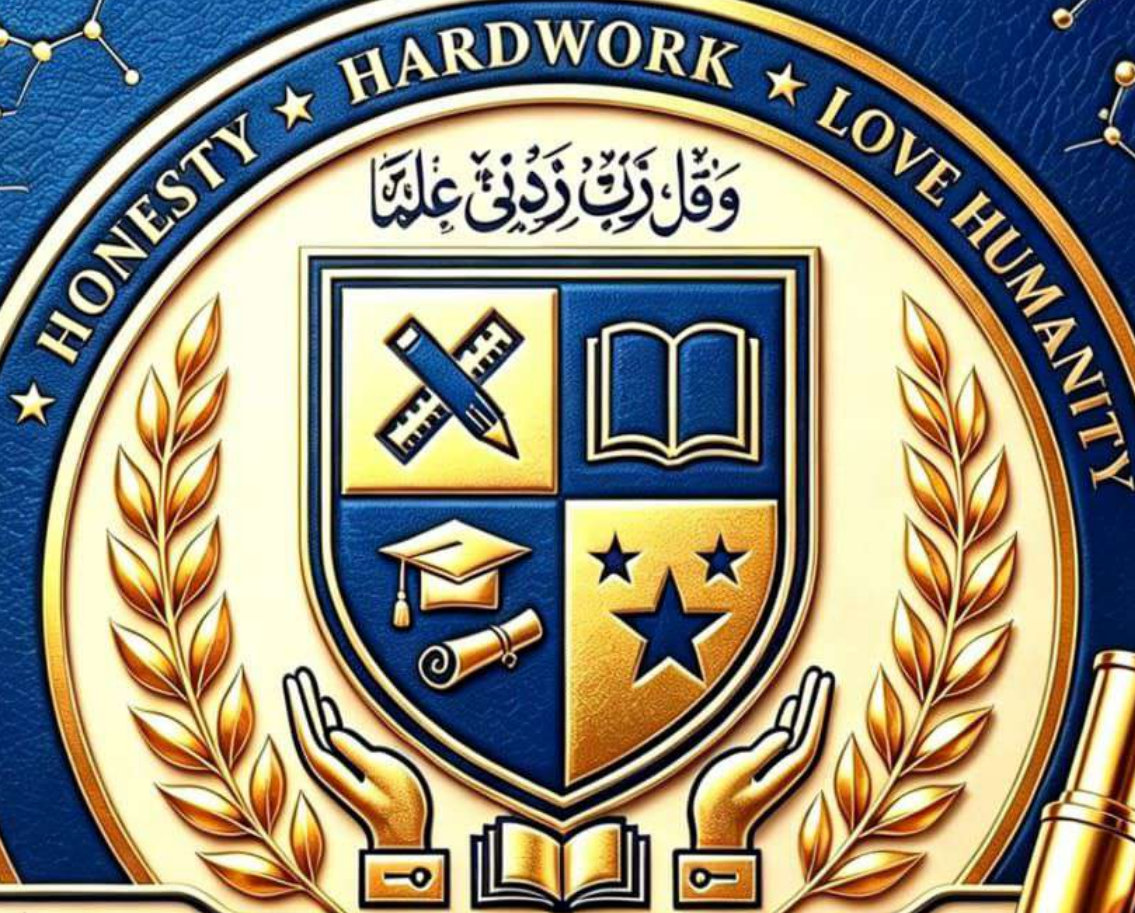




NATIONAL CADET SCHOOL MALKA

Chemistry Notes



Name: _____

Class: _____

9th

NCS MALKA

KAMAL ACADEMY

NO SECTARIANISM

Ibrahim kamal

(Gold Medalist in M.Phil Mathematics)



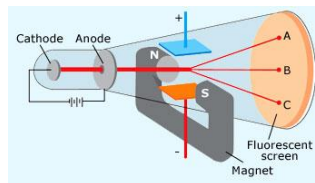


Discovery of Electron [CLICK HERE FOR VIDEO LECTURE](#)



Discharge Tube:-

A discharge tube is a hard glass tube provided with two metallic electrodes and a vacuum pump to evacuate the gas present in it.



Cathode Rays:-

When a very high voltage is applied to a gas at a very low-pressure present in a glass tube the glass surface behind the positive electrode started to glow, due to the rays emitted from the cathode. These rays were named as **Cathode Rays**.

Properties of Cathode Rays

- Cathode rays bent towards the positively charged plate showing that they carry negative charge.
- cathode rays were also diverted by the magnetic field.
- The nature of Cathode rays not depends on gas which present in the discharge tube.
- Cathode rays are negatively charged material particles.
- Charge to mass ratio can be calculated.

Subatomic Particles: -

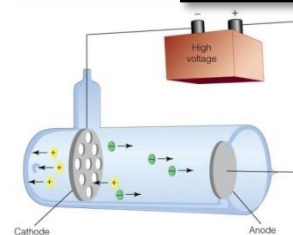
In 1897, British physicist Joseph John Thomson studied the properties of cathode rays by passing them through the oppositely charged electric plates. Thomson used the findings of his experiments to calculate the mass to charge ratio of cathode rays which finally proved that cathode rays are in fact, negatively charged material particles. These particles were later named as electrons. It was also shown that electrons are the **Subatomic particles** of all elements.



Discovery of proton [CLICK HERE FOR VIDEO LECTURE](#)

The presence of positively charged particles in an atom had been first observed by E. Goldstein in 1886. It was based on the concept that atoms are electrically neutral having same number of positive and negative charges.

Canal Rays



E. Goldstein performed a series of experiments with a gas-discharge tube having a perforated cathode. A new type of rays were produced from the anode which moved towards the cathode. He called these new rays as **Cathode rays** or **Canal rays**.

Properties of Canal Rays

- These rays produced from anode and move towards the cathode.
- The nature of the canal rays depends upon the nature of gas, present in the discharge tube.
- It is deflected by electric field.



Rutherford's Experiment

In 1917, Rutherford performed experiments which proved that the hydrogen nucleus is presenting other nuclei. Rutherford thought that a hydrogen nucleus or a proton must be the fundamental building block of all nuclei and also possibly a new fundamental particle as well.

Discovery of neutron [CLICK HERE FOR VIDEO LECTURE](#)



Discovery

Later on, in 1933, another particle neutron was also discovered, which is known to carry no charge. The mass of a neutron is almost the same as that of a proton.

Properties

- i. Neutron carry no charge
- ii. The mass of a neutron is almost the same as that of a proton

Fundamental particles

These three particles i.e. electron, proton and neutron were given the name **fundamental particles** and are shown to be present in all atoms (except ordinary hydrogen which does not have neutron) irrespective of the fact that these atoms behave very different from one another. It was, however, also shown that the number of these particles is different in different atoms.

Discovery of nucleus [CLICK HERE FOR VIDEO LECTURE](#)



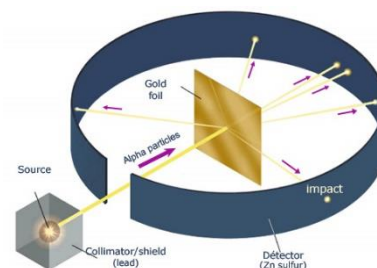
Q:1 How electron, proton, neutron (fundamental Particles) arranged in atom?

Q:2 How its proved that atom has two portions?

Q:3 why all the mass of atom concentrated in the nucleus?

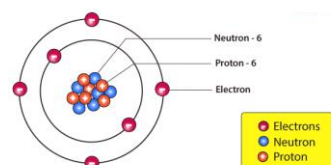
Lord Rutherford, in 1911, provided answer to this question.

He carried out a remarkable experiment in which he hit a stream of special type of particles (Alpha Particle) to a very thin gold foil. From this experiment he concluded that an atom has two portions.



Portions of nucleus

A tiny central portion which he called as **nucleus** and a relatively large area surrounding this, which he called **extra nuclear portion**. It was discovered that almost all the mass of an atom is concentrated in the nucleus, because



both the heavy particles i.e. protons and neutrons are found to be present here. In the nucleus these two particles are held together by a strong nuclear force.



Orbits or Shells

In 1913, Niels Bohr proposed a model for the hydrogen atom which is called Bohr's atomic model. According to this model the electron can revolve around the nucleus of the atom in specific paths called orbits or shells.

Ground state of atom or grater energy

When the electron is revolving in one of these orbits, its energy is fixed. Also, when the electron is present in the orbit which is closest to the nucleus, its energy is minimum and it is called the **ground state** of the atom. The orbits that are further away from the nucleus possess successively greater energy. The electron is not allowed to occupy a space in between the orbits.

Shells

Since electron present in each- shell has a fixed energy, these shells are also named as **energy levels**. The shell which is nearest to the nucleus is called **first shell or K shell** and the electron present in it has a fixed value of energy. Similarly, the second shell will also be at a definite distance from the nucleus which will, of course, be greater than the first shell and electron present in it will also possess greater value of energy. Similarly, electron may also be present in the third or higher shells.

Sub- Shells

Each shell is further sub-divided into sub-shells or orbitals. The number of sub-shells present in a shell is equal to the value of n for that shell. For the first shell, ($n = 1$), it will, therefore, have only one sub-shell which is called **s** sub-shell. For ($n = 2$), there will be two sub-shells **s** and **p**. The second shell will therefore, have two sets of sub-shells. The third shell ($n = 3$) has three sub-shells **s**, **p** and **d**. The fourth shell consists of four sub-shells **s**, **p**, **d** and **f**.

Accommodation of Electron in shells

The formula $2n^2$ we use to find how many electrons can accommodate in a shell where n represent the number of shells.

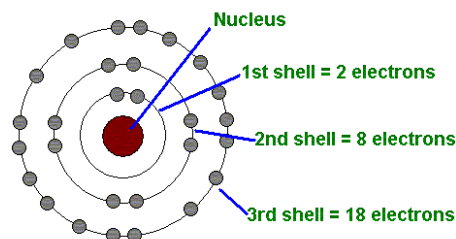
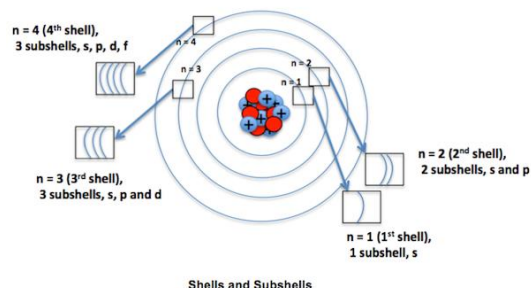
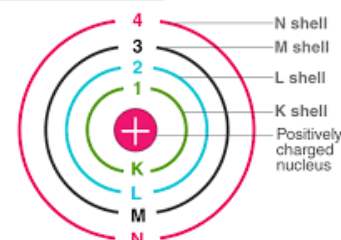
$$\text{For first shell(K)} = 2n^2 = 2(1)^2 = 2$$

$$\text{For second shell(L)} = 2n^2 = 2(2)^2 = 8$$

$$\text{For third shell(M)} = 2n^2 = 2(3)^2 = 16$$

$$\text{For fourth shell(N)} = 2n^2 = 2(4)^2 = 32$$

BOHR'S MODEL OF AN ATOM





Accommodation of Electron in sub-shells

The maximum number of electrons which can be accommodate in sub-shells s, p, d and f are 2, 6 10 and 14 respectively. In the first shell there are 2 electrons which shell go to (s) sub-shell.

In the second shell, 8 electrons will be further sub-divided, s-subshell will have 2 electrons and 6 electrons will be accommodated in p sub-shell.

Shell	Subshell	Max electrons in subshell	Max electrons in shell
K	1s	2	2
L	2s	2	2 + 6 = 8
	2p	6	
M	3s	2	2 + 6 + 10 = 18
	3p	6	
	3d	10	
N	4s	2	2 + 6 + 10 + 14 = 32
	4p	6	
	4d	10	
	4f	14	

Atomic number and Atomic mass number [CLICK HERE FOR VIDEO LECTURE](#)



Atomic number

The number of protons present in the atoms of an element is always fixed and it is called the atomic number of that element. Since an atom, as a whole is electrically neutral, the number of electrons present in an atom will be the same as the number of protons.

Representation

Atomic number of an element is represented by **Z**

Atomic mass number

The total number of protons and neutrons present in an atom almost accounts for the total mass of that atom and hence it is called its nucleon number or mass number. The mass of electron being very small is not included in the mass number.

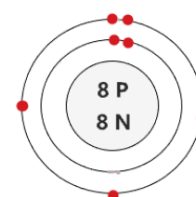
Representation

It is represented by **A**.

Example

the number of protons present in an oxygen atom is 8, so its atomic number is 8 while the total number of protons and neutrons present in it is 16, so its mass number is 16. so oxygen

atom would be symbolized as $^{16}_8\text{O}$.



Calculation of Neutron

The number of neutrons **N** present in an atom can be calculated if its atomic number **Z** and mass

number (**A**) are known $N = A - Z$ Thus, the number of neutrons in sulphur atom, symbolized $^{32}_{16}\text{S}$ as can be calculated as $32 - 16 = 16$.

Isotopes and their Masses [CLICK HERE FOR VIDEO LECTURE](#)

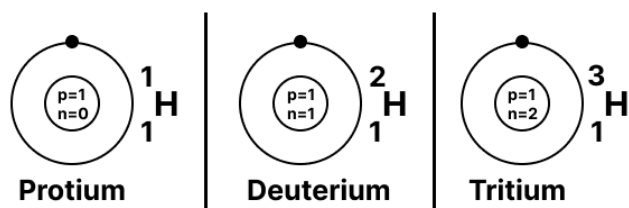


Atoms of the same element (have same atomic number) having different number of neutrons in their nuclei are called isotopes. For example, element carbon has three isotopes as its atoms have six, seven

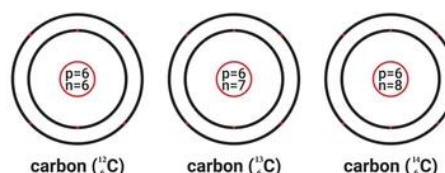


and eight neutrons in their nuclei. These isotopes are represented as $^{12}_6\text{C}$ $^{13}_6\text{C}$ $^{14}_6\text{C}$. Similarly, hydrogen exists in three isotopes Hydrogen isotopes protium, Deuterium and Tritium represented by ^1_1H ^2_1H and ^3_1H . Hydrogen ^1_1H is the only atom which does not have a neutron. Since the chemical properties of the elements are determined by the number of electrons, all three isotopes will show almost the same chemical behavior, although their physical properties may be different. ^2_1H has twice the mass of ^1_1H while the mass of ^3_1H is thrice as the mass of ^1_1H . Similarly, the masses of three different isotopes of carbon are different.

Isotopes of Hydrogen Atom ^1_1H ^2_1H ^3_1H .



Isotopes of Carbon $^{12}_6\text{C}$ $^{13}_6\text{C}$ $^{14}_6\text{C}$



Radioactive isotopes

[CLICK HERE FOR VIDEO LECTURE](#)

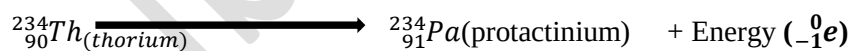
The isotopes of the same element do not have the same physical properties. Several isotopes of the same elements exist whose nuclei are unstable. They emit excess energy in the form of radiation. This process of emission of radiation is called radioactivity and the isotope which emits energy is called a radioactive isotope. Tritium ^3_1H is a radioactive isotope and the other two isotopes of hydrogen are stable and do not emit any radiation.

Radioactive decay

When a radioactive element emits radiation, it is transformed into another chemical element. This process is called radioactive decay. This new element may be stable or may be radioactive so that it also emits radiation.



$^{234}_{90}\text{Thorium}$ is unstable and further disintegrates to give $^{231}_{90}\text{Pa}$ (protactinium)



Application of radioactive isotopes

Use in Medical

Radioactive isotopes are useful in medical imaging. Doctors use them to diagnose the disease by injecting the patient with a small amount of radioactive fluid. Technetium - 99m is used for diagnostic imaging across human organs like brain, lungs, etc. Doctors use a special camera to watch how the radioactive fluid moves.

Use in radiocarbon dating



Radiocarbon dating is a method for finding out the age of an historical object containing organic material with the help of radioactive isotope of carbon $^{14}_6\text{C}$. The method involves measuring the proportion of $^{14}_6\text{C}$ in a sample from a dead plant or animal like a piece of wood or a bone which provides information that can be used to calculate when an animal or plant died. The older the sample is, the less $^{14}_6\text{C}$ is to be detected.

Use in test the Metals

Radioactive isotopes are used to test the strength of metals and concrete mixture. They are used to generate cheap nuclear power and to find oil fields. In medicine they are used to diagnose and treat many medical conditions and diseases, including cancer and thyroid disorders.

Ionization of atoms by radioactive source [CLICK HERE FOR VIDEO LECTURE](#)



Radiation emitted from a radioactive source causes atoms to ionize. For example, radiation emitted by radioactive element radium -226 can remove electron or electrons from the atom. However, this ionizing radiation should have enough energy to remove the tightly bound electron from the orbit of an atom. Electron can be lost because an ionizing radiation collides with the atom and forces the electron away from the atom. If an atom of sodium is hit by an ionizing radiation, it may lose an electron. This process converts the atom into a positively charged ion (**CATION**).



Relative Atomic Mass [CLICK HERE FOR VIDEO LECTURE](#)



In 1961, the chemists adopted a new scale for the measurement of the relative masses of atoms. The unit mass on this scale is $1/12$ of the mass of lighter isotope of carbon taken as 12. The mass of one atom of carbon on this scale is exactly 12 and the masses of the other atoms are measured relative to this unit. The relative atomic mass of an element is thus defined as the mass of an atom of that element relative to the mass of light isotope of carbon taken as 12. The relative atomic masses of elements are expressed in atomic mass unit (amu). It is defined as one-twelfth the mass of an atom of carbon-12.

$$1\text{amu} = 1.67377 \times 10^{-27}\text{Kg}$$

For example the mass of the atoms of hydrogen -1 on atomic mass scale is 1.007amu, similarly the mass of one atom of sulphur -32 is 31.972

Calculation of Relative Atomic Mass from Isotopic Abundance

An element usually consists of a few different isotopes with different mass numbers. These mass numbers are called relative isotopic masses. Each isotope will also have its own naturally occurring abundance which is called isotopic abundance. Relative atomic mass of an element can be calculated from the relative isotopic masses (m) and isotopic abundances (p) by the following formula

$$\text{Relative atomic mass} = \frac{m_1p_1 + m_2p_2 + m_3p_3 + \dots}{100}$$



Exercise

2 Questions for short answers [CLICK HERE FOR VIDEO LECTURE](#)



i. Why it is said that almost all the mass of an atom is concentrated in its nucleus?

It was discovered that almost all the mass of an atom is concentrated in the nucleus, because both the heavy particles i.e. protons and neutrons are found to be present here. In the nucleus these two particles are held together by a strong nuclear force.

ii. Why are elements different from one another?

Elements are different from one another because the atoms one element different from the other atoms of the element because they contain different number of fundamental particles.

iii. How many neutrons are present in $^{210}_{83}\text{Bi}$.

Atomic number = $Z = 83$

Atomic mass number = $A = 210$

Number of Neutrons = $A - Z$

Number of neutrons = $210 - 83 = 127$

iv. Why is tritium (^3_1H) a radioactive element?

Tritium is a radioactive element because its nucleus is unstable it emit excess energy in the form of radiation so tritium (^3_1H) a radioactive element. it has extra neutrons in their nucleus which makes it unstable.

v. How can an atom absorb and involve energy?

When electron jump from higher energy level to lower energy level it release energy when electron jump from lower energy level to higher energy level it absorb energy.

3 constructed response questions [CLICK HERE FOR VIDEO LECTURE](#)



(i) Why does the energy of electron increase as we move from first shell to second shell?

The energy of electron increase as we move from first shell to second shell because the second shell is further away from the nucleus as first shell.

(ii) Why is it needed to lower the pressure of the gas inside the discharge tube?

It needed to lower the pressure of the gas inside the discharge tube because current cannot pass through the gases at ordinary pressure

(iii) What is the classical concept of an electron? How has this concept changed with time?

j.j Thomson and bohar's atomic model explain the classical concept electron is a particle but concept change after sometime in modern concept electron is a wave.

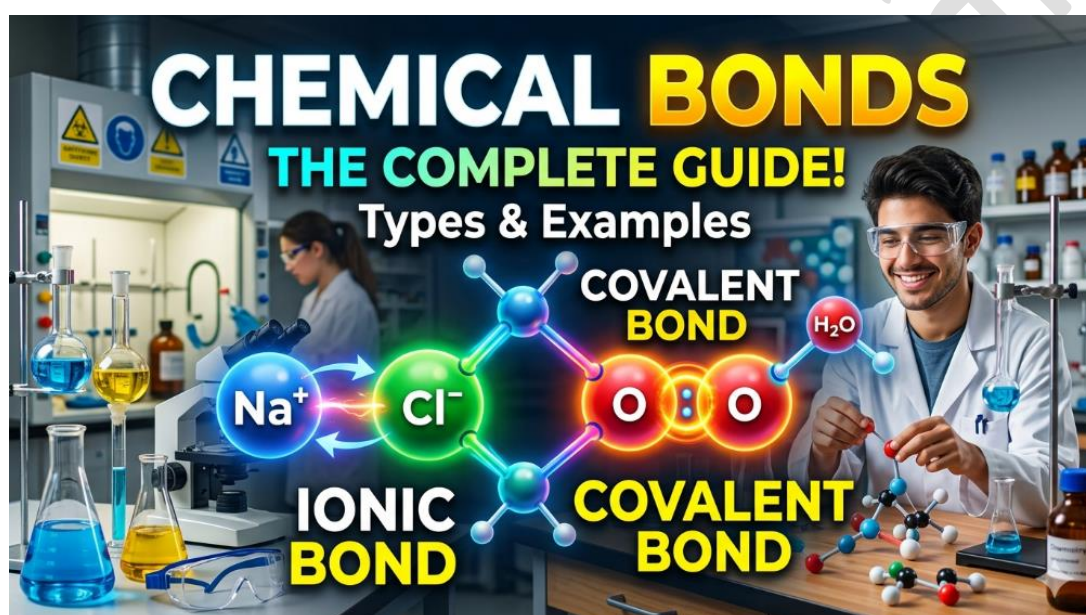
(iv) Why the nuclei of the radioactive elements are unstable?



The nuclei of the radioactive elements are unstable because of an imbalanced number of protons and neutrons.

- (v) During discharge tube experiments, how did the scientists conclude that the same type of electrons and protons are present in all the elements?

During discharge tube experiments the scientists conclude that the same type of electrons and protons are present in all the elements change to mass ratio is constant.





Why do atoms form Chemical bonds? [CLICK HERE FOR LECTURE](#)

Atoms have a tendency to decrease their energy. They can do this by combining with other atoms. It is a natural phenomenon because it increases the stability of atoms.

How does atoms succeed in lowering their energy?

Atoms succeed in lowering their energy to attain the noble gases electronic configuration. The elements of [group viii-A name He, Ne, Ar, Kr, Xe, Rn, Og] have complete valance shell and have no tendency to combine with other elements hence are called noble or inert gases. In other words atoms succeed lower their energy to attain the stability.

Duplet Rule

The ability of an atom to gain two electrons in their valance shell is called Duplet rule.

Example:

H, Li follow duplet rule to complete their valance shell.

Octet Rule

The ability of an atom to gain eight electrons in their valance shell is called Duplet rule.

Example:

Na(sodium) Cl(chlorine), O(Oxygen) follow octet rule to complete their valance shell.

Electropositive elements

The elements which lose their electron from outermost shell to form chemical bond are called electropositive elements.

Example:

Na(sodium) is the example of electropositive elements.

Electronegative elements

The elements which gain electrons in their outermost shell to form chemical bond are called electronegative elements.

Example:

O(oxygen), Cl(chlorine) are the examples of electronegative elements.



3.2 chemical Bond

Define chemical bond? OR How chemical bond Form? [CLICK HERE FOR VIDEOLECTURE](#)

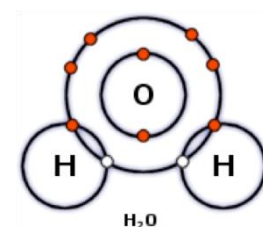


Formation of chemical Bond?

A chemical bond is a force of attraction between atoms which holds them together in the form of a molecule or a compound.

Formation

When atoms of different substances approach each other, there are two possibilities. They may attract or repel each other. If the forces of attraction between them dominate the forces of repulsion, the energy of the system gets lowered and as a result the two atoms will react to form a new molecule. Conversely, the two atoms simply move away from each other.



Types of Chemical Bond

- Ionic bond
- Covalent bond
- Coordinate bond

Define Ionic Bond / electrovalent . Discuss the formation of ionic bond between sodium and chlorine.

The chemical bond which is formed by the complete transfer of one electron from one atom to another atom is called ionic bond. The elements which belongs to metals (electropositive) and non-metals (electronegative) are react to form ionic bond.

Conditions to be formed ionic bond

- Electronegative difference should be greater than 1.7
- Combinations between metals and non-metals
- Transfer of electron

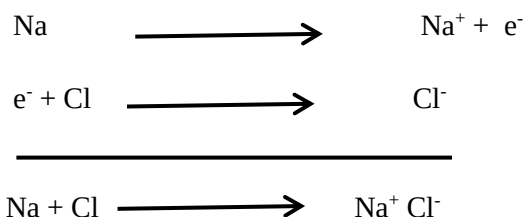
Electronic configurations of sodium an chlorine

The formation of simple and important compound sodium chloride. This compound is formed when the elements sodium and chlorine are react chemically.

Elements	1 st shell	2 nd shell	3 rd shell
₁₁ Na	2	8	1
₁₇ Cl	2	8	7

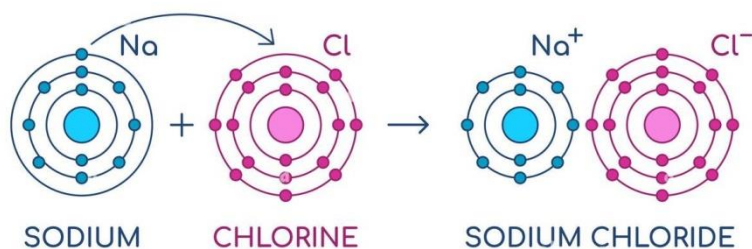
Formation of Sodium chloride(NACL)

An electron from the outermost shell of sodium atom is transferred to the outermost shell of chlorine atom and in doing so, both these atoms acquire the electronic configurations of their nearest noble gases.

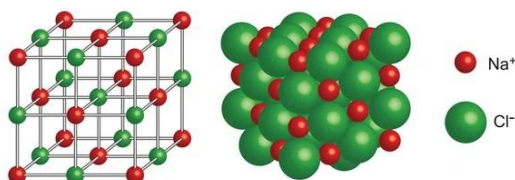




NaCl IONIC BOND FORMATION

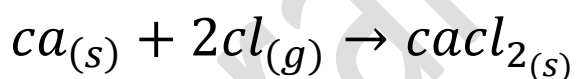


CRYSTAL LATTICE OF NaCl



Formation of calcium chloride

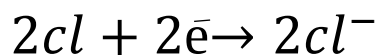
Formation of calcium chloride is formed by the react of calcium with chlorine



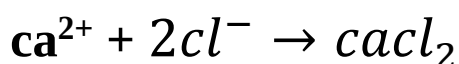
calcium atom loses two electrons to get noble gases electronic configuration and become Ca^{2+} .



similarly two chlorine atoms gain these two electrons and become $2Cl^-$.



These oppositely charged ions (Ca^{2+} , Cl^-) formed ionic bond between calcium and chlorine.





Covalent bond [CLICK HERE FOR VIDEO LECTURE](#)

A chemical bond which is formed by the mutual sharing of electron is called covalent bond.

Types of covalent Bond

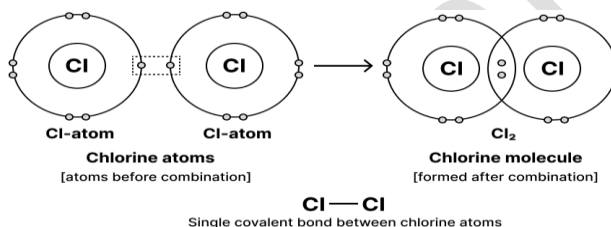
- (i) Single covalent Bond (ii) Double Covalent Bond (iii) Triple covalent Bond

Single covalent bond: a covalent bond which is formed by mutual sharing of one pair of electrons is called single covalent bond.

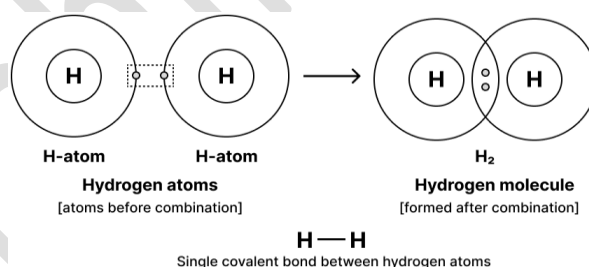
Representation : It is represented by a single short straight line(—).

Examples:

- (i) Formation of chlorine molecule: when two atoms of chlorine combine a pair of electrons is shared between these atoms and a stable chlorine molecule is formed



- (ii) Formation of hydrogen molecule: When two atoms of hydrogen combine, a pair of electrons is shared between these atoms and a stable hydrogen molecule is formed.

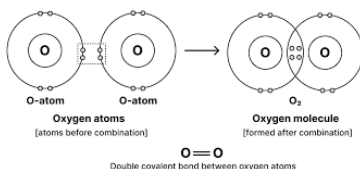


Double covalent Bond: a covalent bond which is formed by mutual sharing of one pair of electrons is called single covalent bond.

Representation : It is represented by a two short straight line(=).

Examples:

Formation oxygen molecule



Formation of CO_2



Triple covalent bond

a covalent bond which is formed by mutual sharing of three pair of electrons is called triple covalent bond.

Representation: It is represented by three short straight lines ($\equiv$).

Example: formation of nitrogen molecule

Formation of covalent compounds

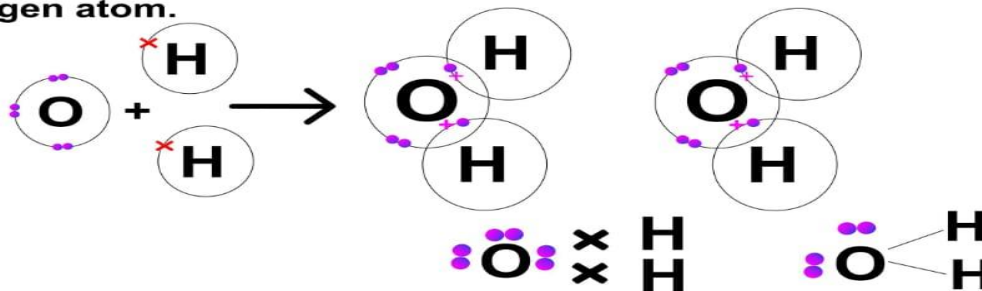
[CLICK HERE FOR VIDEO LECTURE](#)



Formation Of Covalent Compounds

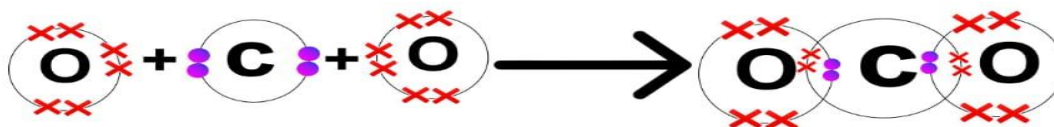
Water

A Water Molecule is formed Whwen tow hydrogen atoms Share Their electrons Separately With the electrons of one Oxygen atom.



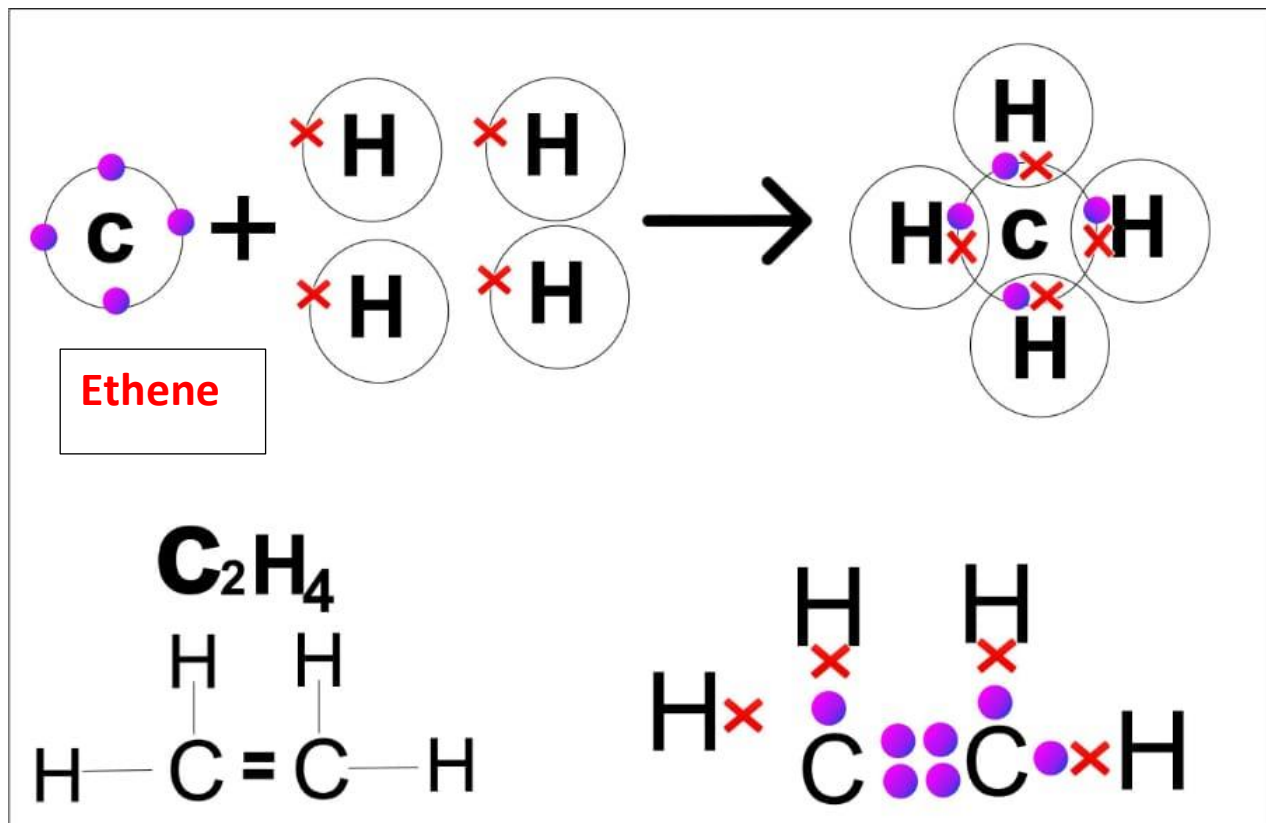
Carbon dioxide

A Carbon dioxide molecule is formed when An atom of carbon shares its four electrons with two Oxygen atoms. Each Oxygen atom also shares two electrons.

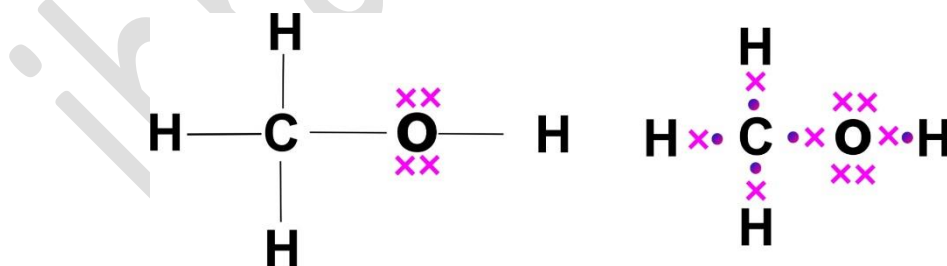




Methane CH_4



Methanol

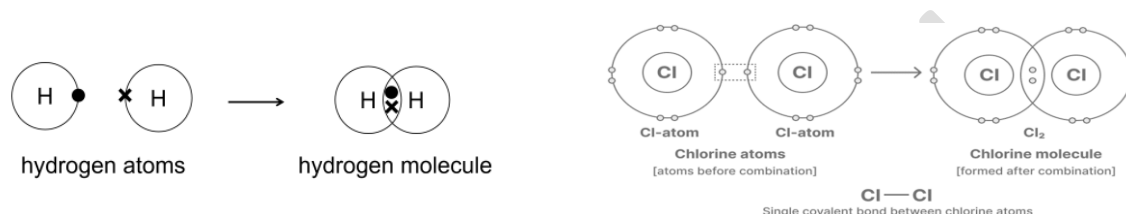




Polar and Non-polar covalent bonds [CLICK HERE FOR VIDEO LECTURE](#)

When a covalent bond is formed between two identical atoms, the shared pair of electrons lies at the middle of the two bonded atoms this gives rise to a pure covalent bond called **non-polar covalent bond**.

Example: Covalent bonds in hydrogen and chlorine molecules are non-polar in nature.



When a covalent bond is formed between two non-identical atoms, the shared pair of electrons bend towards the atom which has more electronegativity. As a result a partial negative charge is created on the more electronegative atom and an equal partial positive charge is created on the less electronegative atom. A **polar covalent bond** is thus formed.

Example: HCL and water molecules are examples of polar covalent bond.



Coordinate Covalent Bond [CLICK HERE FOR VIDEO LECTURE](#)

Coordinate covalent bond is a type of covalent bond in which the shared electron pair is donated by one atom only.

Formation:

This bond is formed when a species has an electron pair to donate to another species. The species which donates the electron pair, is called a **donor** while that which accepts it is called an **acceptor**.

Representation:

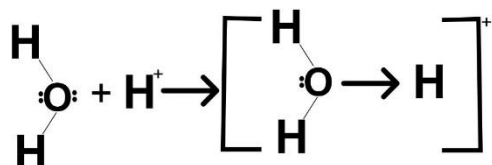
An arrow head (→) pointing towards the acceptor represents this type of bond.

Examples : Here we discuss some examples of coordinate bond.



Hydroxonium ion (H_3O^+)

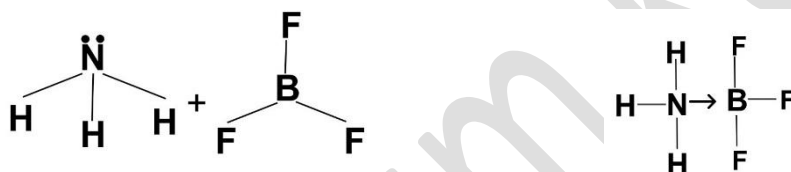
Acids provide protons (H^+) when dissolved in water. This proton has an empty outer shell and can accept one of the two pairs of electrons present on the oxygen atom in water molecule. As a result of this, hydroxonium ion (H_3O^+) is formed.



The positive charge covers whole of the hydroxonium ion. After the formation of hydroxonium ion, there does not remain any difference between a coordinate covalent bond and a covalent bond. All the three bonds of oxygen behave exactly alike.

Reaction between ammonia and boron trifluoride

A reaction between ammonia (NH_3) and boron trifluoride (BF_3) is another example of the formation of a coordinate covalent bond. During the reaction, an electron pair from nitrogen of ammonia fills the partially empty outer shell of boron present in boron trifluoride.



Metallic Bond

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When positively charged metal ions are held together by freely moving electrons, the bond which is formed called metallic bond.

Formation of metallic Bond

Metals have low ionization energy values. The metals atoms can easily lose their valence electrons. The nuclei of metal atoms cannot held the outer electrons firmly and they can move freely in vacant spaces present between atoms. No electrons remains attached with any particular atom. All the electrons are attached with all the atoms. When all the atoms will attract all the electrons, collectively they will bound together, and a metallic bond is formed.

Properties of metals

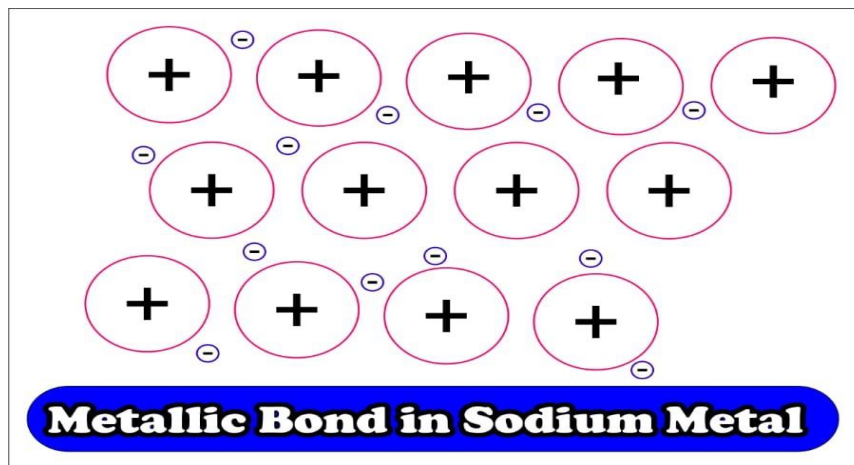
- Metals usually show metallic lustre
- Metals usually have high melting and boiling points.
- Metals are good conductors of heat and electricity
- Metals are usually hard and heavy.
- Metals can be made into different shapes by applying pressure.



Metallic bond in sodium metal

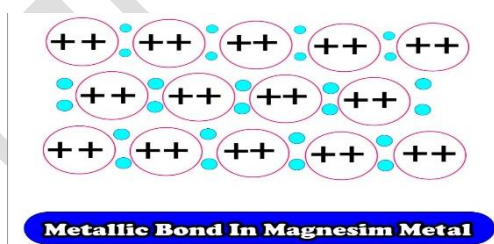
In sodium metal, each sodium atom is surrounded by eight other sodium atoms. The outer electrons of these atoms move freely between the vacant spaces.

No electron remains attached with any particular nucleus. Instead, all the electrons, at the same time, get attached with all the nuclei. When all the atoms attract all the electrons collectively, obviously they will be bound together. A metal will appear to have a sea of electrons in which all the nuclei of atoms.



Metallic bond in magnesium Metal

In magnesium metal, each magnesium atom releases two electrons to acquire two positive charges. The metallic bond in magnesium metal will evidently be stronger than that in sodium metal. This explains why the magnesium metal melts at a higher temperature than sodium metal.



Electropositive character of Metals [CLICK HERE FOR VIDEO LECTURE](#)

It is the tendency of a metal to lose electrons and form positive ions (cations). This property is called the electropositive character of metals.

Examples

Alkali metals sodium (Na) and Potassium (P) are the examples of electropositive character of metals.

Why alkaline earth metals are less electropositive than alkali metals?



Alkaline earth metals (Mg, Ca) lose their outer electron easily but less electropositive than alkali metals due to their smaller atomic size and higher nuclear charge.

Electronegative character of Non-Metals

It is the tendency of non-metals to gain electrons to form negative ions (anions). This property is called the electronegative character of Non-metals.

Examples

Fluorine; it has the strongest tendency to attract electrons in a chemical bond, oxygen and chlorine are also example of electronegative elements.

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Compare the proprieties of ionic and covalent compounds



ionic Compounds	Covalent Compound
In ionic compounds oppositely charged ions are properly arranged to give a crystalline structure. As a whole the compound is neutral. There exists a strong electrostatic force between their ions.	Covalent compounds mostly exist as discrete neutral molecules. There exists a strong electrostatic attraction between the nuclei and electrons.
High melting and boiling points. The melting point of sodium chloride is 801°C because it is difficult to break the strong electrostatic forces of attraction between the oppositely charged ions.	More non-metals. Lower molecular mass covalent compounds are gases or low boiling liquids. High molecular mass covalent compounds exist as solids. Generally, they have lower melting and boiling points.
Ionic compounds are generally soluble in polar solvents like water.	They are usually insoluble in water but soluble in non-polar solvents like ether, benzene and acetone They are usually bad conductor of electricity.
They are usually good conductor of electricity in molten state or in solution form. Their conductance is due to the presence of free ions in these forces.	They are usually bad conductor of electricity.

Intermolecular forces of attraction

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The forces of attraction which are present between the molecules and compounds are called intermolecular forces of attraction or Van der Waals forces. It is weaker than bonding forces. It is strong between solid, molecule than gases.

Representation:

it is represented by dotted (.....) lines

Role of intermolecular forces

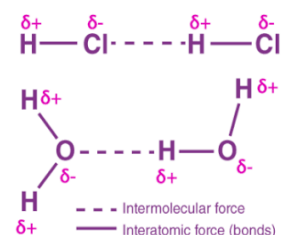
it is responsible for all physical proprieties like

melting points, boiling points and vapor pressure.

Dipole-Dipole forces of attraction

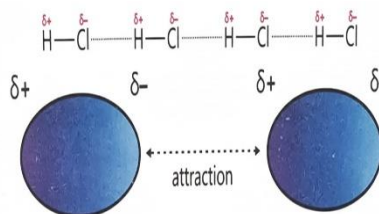
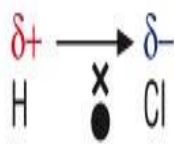
It is the force of attraction between polar compounds due to partial positive and negative charges on different atoms.

Electronegativity





The ability of atoms to attract the shared pair of electron is called electronegativity



Hydrogen Bonding

The attractive force present between the molecules of water is called hydrogen bonding.

Formation of Hydrogen bonding

Hydrogen bonding is a special case of dipole-dipole attractive forces.

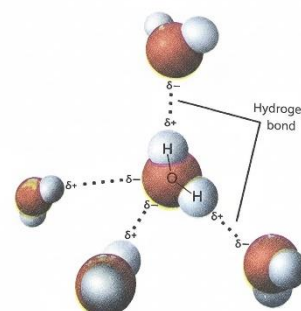
When hydrogen is covalent bonded to highly electronegative elements

Like F, O or N then the large difference of electronegativity values

Will make the covalent bond highly polar. As a result strong

Dipole-dipole attractions are observed among the molecules.

For example, in H_2O , The O-H of bonds are highly polar. Due to this, strong attractive forces are developed between water molecules. The water have high melting point and boiling point as compared to H_2S and NH_3 .



Nature of bonding and proprieties [CLICK HERE FOR VIDEO LECTURE](#)

ionic compound

The ionic compounds is oppositely charged ions are held together by the strong electrostatic force of attraction in the form of crystal lattice

Crystal Lattice

ions are spherical and oppositely charged they can surround each other from all the sides ions bonds are non-directional. This arrangement of atoms is called Crystal Lattice.

Brittle : If an external force is applied on crystal lattice , it breaks easily .it shows that ionic solids are brittle.

Why ionic compounds are not good conductor of electricity in solid?

ionic compounds are not good conductor of electricity in solid because ions are tightly held and cannot moved.

Why ionic compounds are good conductor of electricity in aqueous solution or molten form ?

ionic compounds are good conductor of electricity in aqueous solution or molten form

because the free ions can now move towards their respective electrodes.

Properties of ionic compound

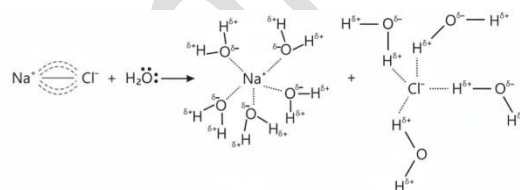




- The compounds which contain ionic bonds are called ionic compounds , NaCl , MgO.
- They consists of positive and negative ions
- They exist only in the solid state at room temperature.
- They have high melting and boiling points.
- They are soluble in polar solvents e.g water
- They are non-volatile .
- They are good conductor of heat and electricity in aqueous form or in the fused state.
- They are hard.

Solubility of Sodium chloride in water through hydration

Ionic solids are generally soluble in water. Water not only breaks the electrostatic force of attraction but also hydrates the resulting free ions.



Covalent compounds

The compounds having covalent bonds are called covalent compounds. They are made up of molecules e.g. CH₄, H₂O, HCl

Properties of covalent compound

- Covalent compounds have low melting and boiling points.
- Pure covalent compounds are bad conductors of electricity but some polar covalent compound are good conductors of electricity in aqueous form.
- Pure covalent compounds are insoluble in water but are soluble in non-aqueous solvent like benzene
- Bigger covalent molecules are stable and hard and have high melting and boiling points.
- Covalent compounds usually have low density.

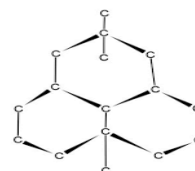
Define coal and write its use?

Coal is the amorphous form of carbon. It is use as a fuel in electricity generating plants

Why diamond is hard, also write its uses.

In diamond, each carbon atom is surrounded by four other carbon atoms linked together by strong covalent bonds due to this rigid structure, diamond is the hardest thing on this planet.

Uses: It is used as a cutting, polishing and drilling tool





Why graphite used as a lubricant and good conductor of electricity?

Graphite consists of a layered structure, made of hexagonal rings of carbon. Since layers are not bonded strongly, they can slip past each other. Graphite is thus used as a lubricant in industry. It's also a good conductor of electricity due to mobile free electrons.

What are binary covalent compound? Give three examples?

Binary covalent compounds: The compounds which consist of two different non-metal are called binary compounds.

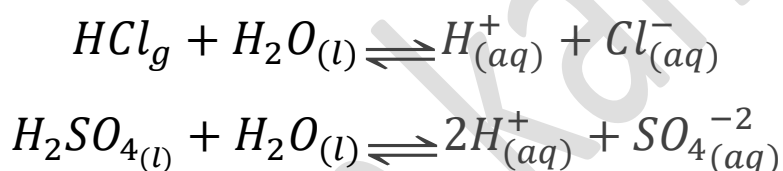
Examples: ammonia (NH_3), Methane (CH_4), hydrogen chloride (HCl)

Why water and hydrogen fluoride are liquid at room temperature?

Water and hydrogen fluoride are liquid at room temperature and have lower boiling points because of strong intermolecular forces.

What are strong acid give two examples ?

The acids which are completely ionized in water is called strong acids.



Exercise short Questions [CLICK HERE FOR VIDEO LECTURE](#)



i. What type of elements lose their outer electron easily and what type of elements gain electron easily?

Answer: Metals (electropositive elements) lose their outer electrons easily, while non-metals (electronegative elements) gain electrons easily.

ii. Why does lower molecular mass covalent compounds exist as gases or low boiling liquids?

Answer: Lower molecular mass covalent compounds have weak intermolecular forces of attraction and cannot hold the molecule strongly, resulting in low boiling points.

iii. Give one example of an element which exists as a crystalline solid and has covalent bonds in its atoms.

Answer: Diamond (crystalline form of carbon with covalent bonds).

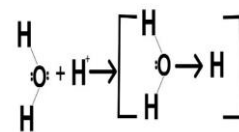
iv. Which property of metals makes them malleable and ductile?

Answer: When pressure is applied on the metals, the upper row of atoms slip past the lower



rows as a result, their shape is changed. Therefore, metals can be easily drawn into wires and sheets. Arrangement of atoms and delocalized electrons make them malleable and ductile.

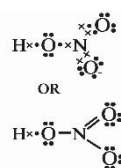
(v) Is coordinate covalent bond a strong bond?



Answer: Yes, coordinate covalent bond is as strong as regular covalent bonds, because it involves the sharing of an electron pair.

(vi) Write down dot and cross formula of HNO_3 .

Answer:



Constructed Response Questions [CLICK HERE FOR VIDEO LECTURE](#)



Q3 (i): Why is HF a liquid while HCl is a gas?

Answer: HF is a liquid because it forms strong hydrogen bonds between its molecules, which require more energy to break. In contrast, HCl has weaker van der Waals forces and lacks hydrogen bonding, so it remains a gas at room temperature.

Q3 (ii): Why are covalent compounds generally not soluble in water?

Answer: Covalent compounds are generally not soluble in water because they are non-polar or weakly polar and do not form strong interactions with polar water molecules. Water cannot effectively break the intermolecular forces between covalent molecules.

Q3 (iii): How do metals conduct heat?

Answer: Metals conduct heat through the free movement of electrons. These electrons transfer heat rapidly from one part of the metal to another, allowing heat to flow efficiently.

Q3 (iv): How many oxides does nitrogen form? Write down the formulae of these oxides.

Answer: Nitrogen forms five oxides. The formulae are:

1. N_2O (Nitrous oxide)
2. NO (Nitric oxide)
3. N_2O_3 (Dinitrogen trioxide)
4. NO_2 (Nitrogen dioxide)
5. N_2O_5 (Dinitrogen pentoxide)

Q3 (v): What will happen if NaBr is treated with AgNO_3 in water?

Answer: When NaBr is treated with AgNO_3 in water, a white precipitate of silver bromide (AgBr) is formed, and sodium nitrate (NaNO_3) remains in solution.



Ibrahim kamal (Gold Medalist in M.phil Math)
Managing director of NCS MALKA & founder of KAMAL ACADEMY



Q3 (vi): Why does iodine exist as a solid while Cl_2 exists as a gas?

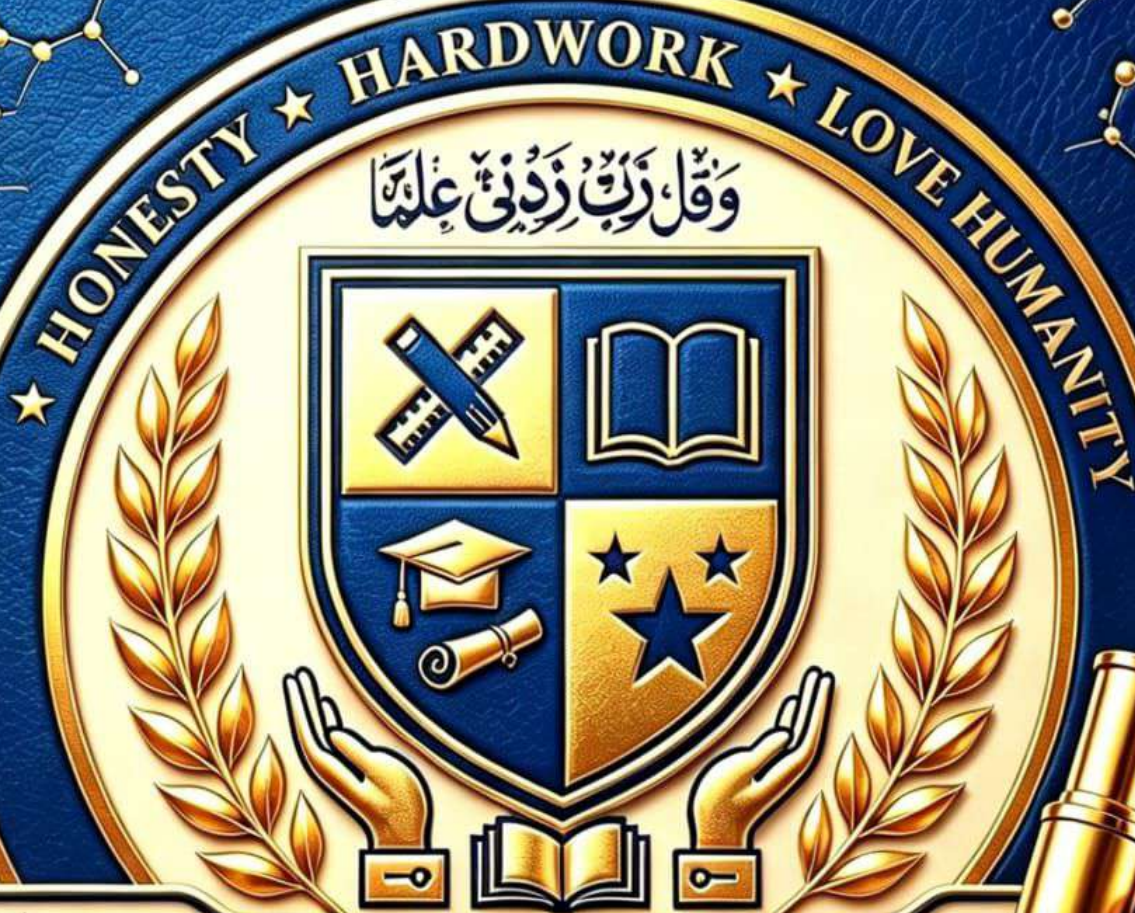
Iodine exists as a solid because its larger molecular size results in stronger intermolecular forces between its molecules. Chlorine (Cl_2) being smaller, has weaker intermolecular forces and exists as a gas at room temperature.

ibrahim kamal



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Chemistry Notes



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9th

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(Gold Medalist in M.Phil Mathematics)

