Unit 03

Chemical bonding

Descriptive Questions

Q.1. (Ex. Q.4 (i)) Explain the formation of an ionic bond and a covalent bond.

09203001

Ionic Bond (Electrovalent Bond)

- Definition and its examples
- Conditions to form Ionic bond
- Chemical equation
- Electronic configuration/ Structure

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Ans. Formation of Ionic Bond

In sodium chloride ($NaCl$) crystal, the ions arrange themselves in specific three – dimensional structure known as face-centered cubic lattice and rock salt structure .This compound is formed when the elements sodium and chlorine react chemically. The electronic configurations of these elements are as

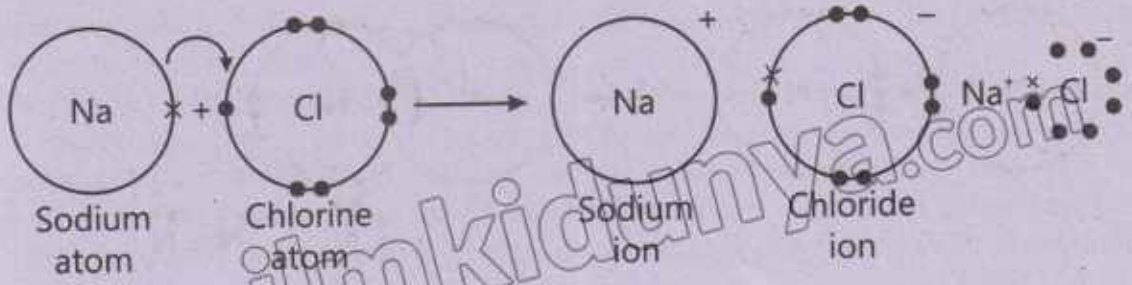
	1st shell	2nd shell	3rd shell
$_{11}Na$	2	8	1
$_{17}Cl$	2	8	7

Transfer of electrons

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.

In this way, ionic bond is formed between Na^+ ion and Cl^- ion.

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



Formation of Covalent bond:

Definition

A covalent bond is formed by the mutual sharing of an electron pair provided by the bonded atoms. This is called a covalent bond.

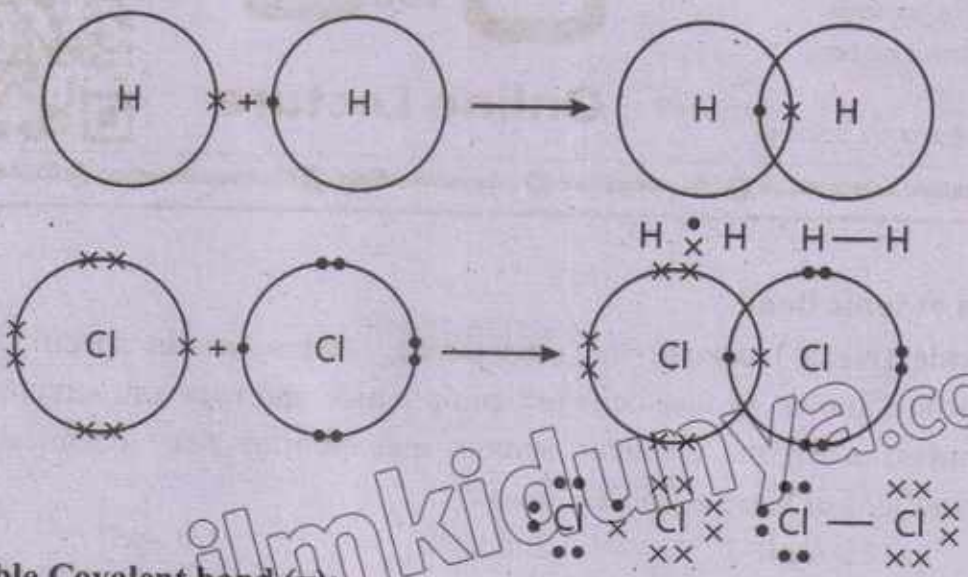
Types of Covalent bonds:

It is classified into three types.

i. Single Covalent bond (-):

In some compounds the atoms share one electron each to form a single covalent bond. A single covalent bond is represented by a single line (-)

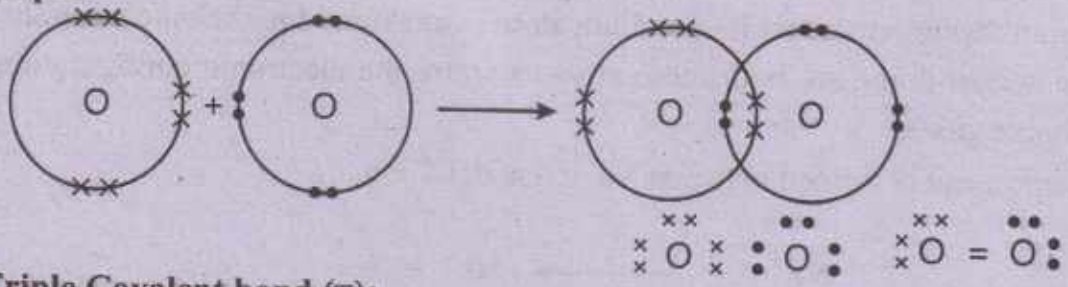
For Example:



ii. Double Covalent bond (=):

In some compounds, the atoms share two electrons each to form a double covalent bond. A double covalent bond is represented by two lines (=)

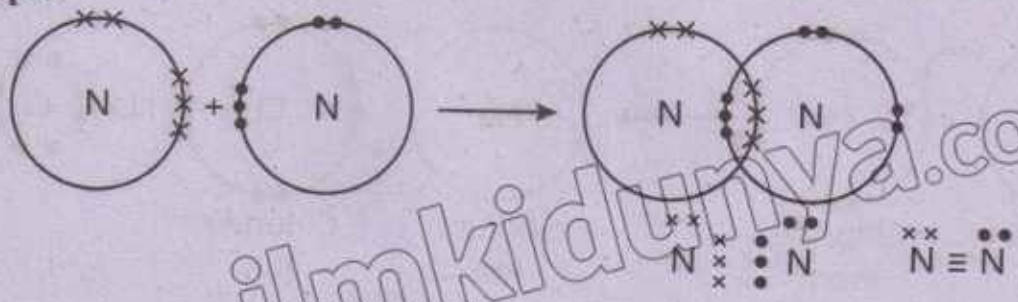
For Example:



iii. Triple Covalent bond (≡):

In some compound, the atoms share three electrons each to form a triple covalent bond. A triple covalent bond is represented by three lines (≡).

For Example:



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Q.2. (Ex. Q.4 (ii) How do ions arrange themselves to form $NaC\ell$ crystal. 09203002

Ans. In sodium chloride ($NaC\ell$) crystal, the ions arrange themselves in specific three – dimensional structure known as face-centered cubic lattice and rock salt structure. This compound is formed when the elements sodium and chlorine react chemically. The electronic configurations of these elements are as

	1st shell	2nd shell	3rd shell
$_{11}Na$	2	8	1
$_{17}Cl$	2	8	7

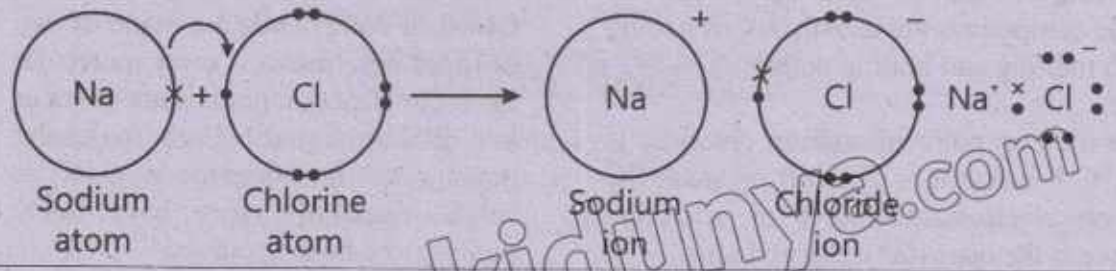
Transfer of electrons

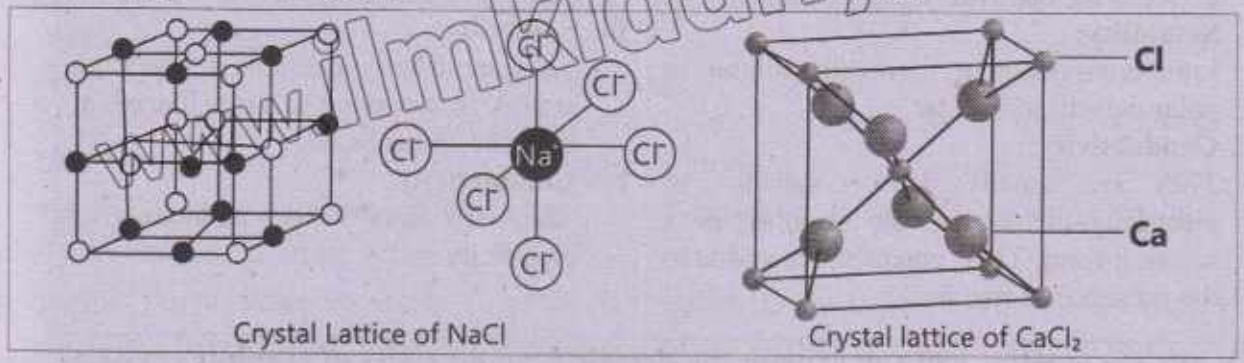
An electron from the outermost shell of sodium atom is transferred to the outermost shell of chlorine atom and in doing so, both these atoms acquire the electronic configurations of their nearest noble gases.

$$Na \longrightarrow Na^+ + e^-$$

$$e^- + Cl \longrightarrow Cl^-$$

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





Q.3. (Ex. Q.4 (iii) Explain the properties of metals keeping in view the nature of metallic bond. 09203003

Ans. Metals have several distinct properties that can be explained by the nature of metallic bonds.

i. **Electrical Conductivity:** The free-moving electrons in metals allow them to conduct electricity easily. When a voltage is applied, these electrons can flow, carrying electric current through the metal.

ii. **Thermal Conductivity:** Metals are also good conductors of heat. The free electrons can transfer thermal energy quickly throughout the metal, making it efficient for heat transfer.

iii. **Malleability and Ductility:** Metals can be hammered or rolled into thin sheets (malleability) and drawn into wires (ductility) without breaking. When stress is applied this is because the layers of atoms in a metal can slide over each other while maintaining the

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metallic bond due to the presence of the sea of electrons, which allows the structure to remain intact.

iv. **Metallic Luster:** Metals have a shiny appearance, known as luster. This is due to the ability of the free electrons to reflect light, giving metals their characteristic shine.

v. **High Melting and Boiling Points:** The strong metallic bonds between the atoms require a significant amount of energy to break, resulting in high melting and boiling points for most metals.

Q.4. (Ex. Q.4 (iv)) Compare the properties of ionic and covalent compounds.

Ans. 09203004

Ionic Compounds	Covalent Compounds
i. **Nature:** 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.	i. **Nature:** Covalent compounds mostly exist as discrete neutral molecules. There exists a strong electrostatic attraction between the two nuclei and the shared electrons.
ii. **Melting and Boiling Points:** Ionic compounds are usually solids having high melting and boiling points. **e.g:** 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.	ii. **Melting and Boiling Points:** Covalent compounds are made of two or 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.
iii. **Solubility:** Ionic compounds are generally soluble in polar solvent like water.	iii. **Solubility:** They are usually insoluble in water but soluble in non-polar solvents like ether, benzene and acetone.
iv. **Conductivity:** They are usually good conductor of electricity in molten state or in aqueous solution form. Their conductance is due to the presence of free ions.	iv. **Conductivity:** They are usually bad conductor of electricity

Q.5. (Ex. Q.4 (v)) How will you explain the electrical conductivity of graphite crystals?

09203005

Ans. Graphite is an allotropic form of carbon that exhibits electrical conductivity which can be explained by its unique structure and bonding.

Arrangement:

In graphite, each carbon atom is bonded to three other carbon atoms in a planar hexagonal arrangement forming layers of graphene. The fourth electron from each carbon atom is not involved in bonding and is free to move within the layer.

Electrical Conductivity:

When it comes to electrical conductivity, the free-moving electrons within each layer can carry an electric current. However, graphite's conductivity is primarily in the plane of the layers which means that it conducts electricity well along the layers but not as effectively perpendicular to them.

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Delocalized Electron/ Electrode formation:
The electrical conductivity of graphite is due to the presence of delocalized electrons that can move freely within the layers of carbon atoms, allowing it to conduct electricity efficiently along those layers.

Q.6. Ex. Q.4 (vi) Why are metals usually hard and heavy? 09203006

Ans. The strength of a metallic bond depends upon two factors:

i. The number of positive charges present on the positive ions
ii. The number of mobile electrons set free by each atom

Explanation:
Each sodium atom sets free only one electron. The metallic bond in sodium metal is therefore, not very strong. 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.

Conductivity of Metals:
The presence of freely moving electrons in metals make them good conductor of heat and electricity. Moreover, in metals, the atoms are strongly held and arranged in the form of rows one above the other. This arrangement makes them hard and heavy.

Investigative Questions

Q.1. (Ex. Q.5 (i)) The formula of $AlCl_3$ in vapour phase is Al_2Cl_6 which means it exists as a dimer. Explain the bonding between its two molecules? 09203007

Ans. In the vapour phase, aluminum chloride $AlCl_3$ exists as a dimer, represented by the formula Al_2Cl_6. This means that two $AlCl_3$ molecules combine to form a larger molecule. The bonding between the two $AlCl_3$ units in this dimeric form involves coordinate covalent bonds, resulting a stable structure (achieve a stable electronic configuration.

i. **Lewis Structure:** In the $AlCl_3$ molecule, the aluminum atom has three valence electrons and forms three covalent bonds with three chlorine atoms. However, aluminum is electron-deficient because it has only six electrons in its outer shell, which is less than the stable octet configuration.
ii. **Dimer Formation:** To achieve a more stable configuration, two $AlCl_3$ molecules can come together. One aluminum atom from one $AlCl_3$ donates an empty p-orbital to accept a pair of electrons from the chlorine atom of the other $AlCl_3$. This forms a coordinate covalent bond, where one atom provides both electrons for the bond.
iii. **Resulting Structure:** The dimer Al_2Cl_6 consists of two aluminum atoms and six chlorine atoms. Each aluminum atom is surrounded by four chlorine atoms: three from its own $AlCl_3$ unit and one that is shared with the other aluminum atom. This sharing of electrons stabilizes the dimer.
iv. **Bonding Characteristics:** The dimeric structure allows Al_2Cl_6 to achieve a more stable configuration than individual $AlCl_3$ molecules. This dimerization is favoured in the vapour phase due to the electron-deficient nature of aluminum and the ability of chlorine to donate electron pairs.

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Q.2. Explain the structure of sand (SiO_2). 09203008

Ans. Silicon dioxide commonly known as sand (SiO_2) has a unique structure that is essential to its properties. The structure of SiO_2 can be described as a three-dimensional network solid which means that it consists of a continuous framework of silicon and oxygen atoms.

i. **Basic Units:** The fundamental unit of SiO_2 is the silica tetrahedron. Each silicon atom is covalently bonded to four oxygen atoms, forming a tetrahedral shape. The silicon atom is at the center and the four oxygen atoms are located at the corners of the tetrahedron.

ii. **Tetrahedral Arrangement:** In the solid state, these tetrahedral are linked together in a three-dimensional network. Each oxygen atom in a tetrahedron is shared with neighboring silicon atoms in adjacent tetrahedra. This sharing creates a strong and stable structure.

iii. **Bonding:** The covalent bonds between silicon and oxygen are strong, which contributes to the hardness and high melting point of sand. The arrangement of these tetrahedral creates a rigid framework that is characteristic of network solids.

iv. **Properties:** The three-dimensional network structure of SiO_2 gives sand its characteristic properties, such as high strength, chemical stability, and resistance to weathering. These properties make it an important material in construction and various industrial applications.

SLO Based Additional Long Questions

Q.1. How Coordinate covalent bond is formed? 09203009

Ans. Definition: Coordinate covalent bond is a type of covalent bond in which the shared electron pair is donated by one atom only. This bond is formed when a species has an electron pair to donate to another species.

Donor: The species which donates the electron pair, is called a donor.

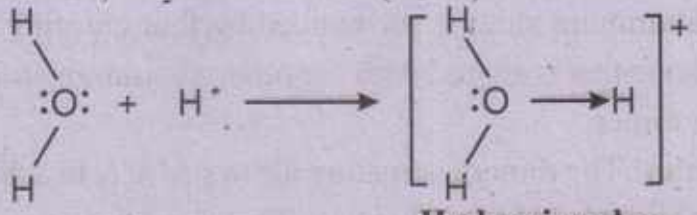
Acceptor: This species that accepts the electron pair is called an acceptor.

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

Example:

i. Hydronium 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, a hydronium ion (H_3O^+) is formed.



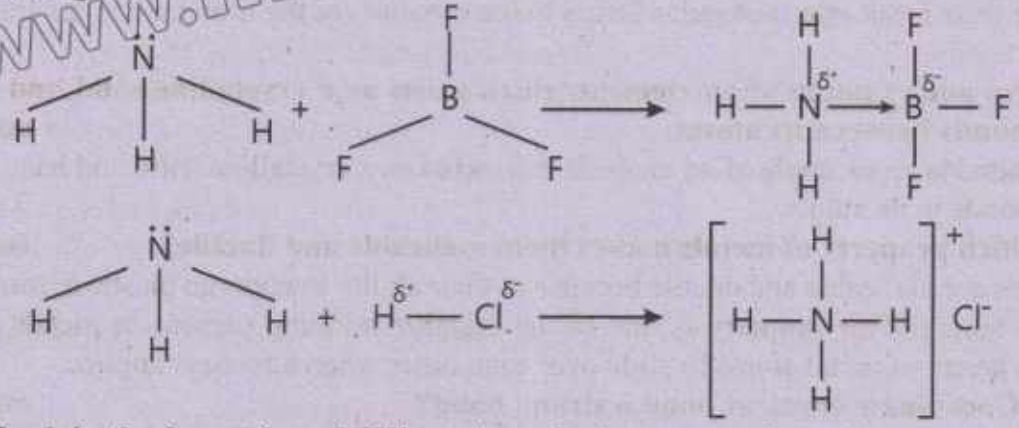
Hydronium Ion

The positive charge covers whole of the hydronium ion. After the formation of hydronium 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.

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ii. Reaction Between $\ddot{N}H_3$ and BF_3

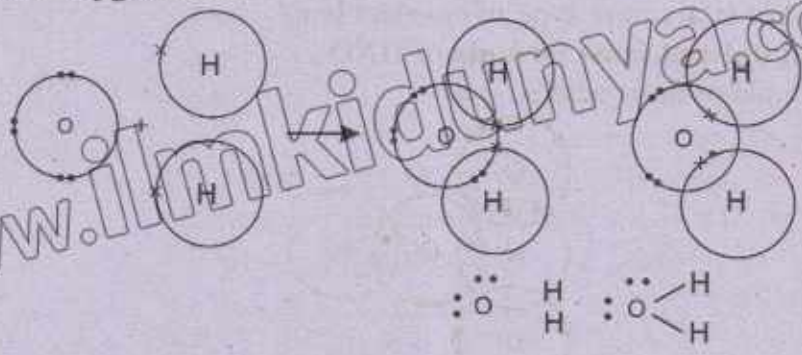
A reaction between ammonia ($\ddot{N}H_3$) and boron trifluoride (BF_3) is another example of the formation of a coordinate covalent bond. During the reaction, an electron pair from nitrogen of ammonia fills the partially empty outer shell of boron present in boron trifluoride Fig.



Q.2 Explain the formation of different covalent compounds. 09203010

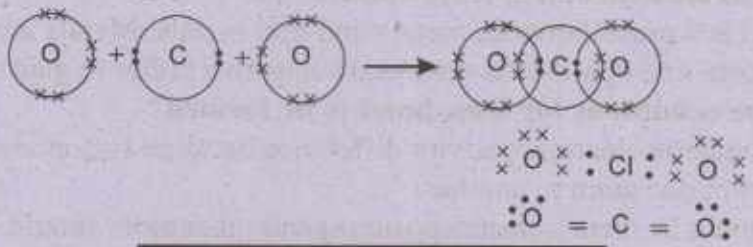
Ans. (i) Water

A water molecule is formed when two hydrogen atoms share their electrons separately with the electrons of one oxygen atom.



(ii) 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.



Exercise Short Question

Q. 1 What type of elements lose their outer electron easily and what type of elements gain electron easily? 09203011

Ans.

Metals are the elements which prefer to lose their valence electrons and form cation (positively charged ion). So, they are electropositive in nature.

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Non-metals are the elements which prefer to gain electrons from others and form anion (negatively charged ion). So, they are electronegative in nature.

Q. 2 Why does lower molecular mass covalent compound exist as gases or low boiling liquids? 09203012

Ans. Low molecular mass covalent compounds exist as gases or have low boiling liquids because of their weak intermolecular forces make it easier for the molecule to separate and move apart.

Q. 3 Give one example of an element which exists as a crystalline solid and it has covalent bonds between its atoms. 09203013

Ans. Diamond is an example of an element that exists as a crystalline solid and has covalent bonds in its atoms.

Q. 4 Which property of metals makes them malleable and ductile? 09203014

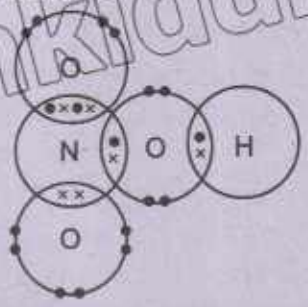
Ans. Metals are malleable and ductile because of their ability to undergo plastic deformation without breaking. This property is due to the metallic bonding present in metals which allows the layers of metal atoms to slide over each other when a force is applied.

Q. 5 Is Coordinate covalent bond a strong bond? 09203015

Ans. Coordinate covalent bonds are strong bonds but not stronger than covalent bond. In a coordinate covalent bond, the shared electron pair donated by one atom. This results in a strong bond because both electrons are held together tightly between the two atoms creating a stable molecular structure. This type of one sided sharing of electrons provides the strength which makes it a strong type of covalent bond.

Q. 6 Write down dot and cross formula of HNO_3. 09203016

Ans. Dot-cross formula of nitric acid is:



Practice Exercise Question

Q. 7 What types of elements form ionic bonds? 09203017

Ans. An ionic bond is formed between metals and non-metals. Metals are electropositive prefer to lose electrons and non-metals are electro-negative prefer to gain electrons.

Q. 8 What are the conditions for ionic bond to be formed? 09203018

Ans. There should be large electronegativity difference between two atoms, allow them to transfer electrons, from one atom to another.

i. One atom should be metal (electro-positive) and other atom should be non-metal (electro negative) in nature.

ii. There should be strong electrostatic force of attraction between atoms to hold them together.

Q. 9 What type of elements form covalent bond? 09203019

Ans. The non-metals elements show tendency of sharing electrons between them and form covalent bond.

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Q.10 How covalent bond is different from an ionic bond? 09203020

Ans. In a covalent bond, atoms share electrons while in an ionic bond, one atom gives up electrons to another. Covalent bonds form between non-metals whereas, ionic bond form between metal & non-metal.

Q.11 Which compound is not able to form a coordinate covalent bond? 09203021

Ans. An ionic compound is not able to form a coordinate covalent bond.

Q.12 What type of atoms form metallic bond? 09203022

Ans. Metallic bonds consist of sea of mobile electrons with positive metal ions. They are present in elements which have loosely bound electrons that do not remain in the valence shell and leave the atom to form a sea of electrons. Such a structure is observed usually in atoms **e.g.,** sodium and iron.

Q.13 Give a comparison of metallic bond with an ionic bond. 09203023

Ans.

Property	Metallic Bond	Ionic Bond
Definition	A bond which has positively charged ions, bound together by the mobile electrons.	A bond formed by the transfer of electrons from one atom (metal) to another (non-metal), resulting in ions.
Nature	Non-directional; electrons are delocalized and shared across all atoms.	Non-directional; electrostatic attraction occurs between specific positively and negatively charged ions.
Formation	Found in pure metals and alloys.	Found in compounds between metals and non-metals.
Electron Behavior	Electrons form a "sea of electrons" that move freely within the metal lattice.	Electrons are transferred from the metal (which becomes a cation) to the non-metal (which becomes an anion).
Bond Strength	Strong due to the attraction between the positive metal ions and the sea of delocalized electrons.	Strong due to the electrostatic forces between oppositely charged ions.
Electrical Conductivity	High delocalized electrons allow metals to conduct electricity efficiently.	Low in solid form; high when dissolved in water or molten, as ions become free to move.
Thermal Conductivity	Free electrons transfer energy efficiently.	Low; thermal conduction depends on ionic vibrations rather than free electrons.
Malleability/Ductility	High the delocalized electron cloud allows layers of atoms to slide over each other without breaking the bond.	Low; ionic bonds are brittle, and shifting the lattice causes repulsion between like charges, leading to fracture.
Examples	Found in metals like copper, gold, aluminum, and alloys like brass.	Found in compounds like sodium chloride (NaCl) and magnesium oxide (MgO).

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Why do atoms form chemical bonds?

Q.14 Why do atoms react? 09203024

Ans. Atoms react to form a chemical bond and achieve stability by acquiring inert gas electronic configuration.

Q.15 What is meant by duplet rule? 09203025

Ans. The attaining of two electrons in the outermost shell by sharing, by losing or by gaining electrons is called duplet rule. **e.g.** helium.

Q.16 What is meant by octet rule? 09203026

Ans. The attaining of eight electrons in the outermost shell by sharing, by losing or by gaining electrons is called octet rule. **e.g.** neon.

Q.17 Name different types of chemical bond. 09203027

Ans. Types of Bonds

We shall consider here three types of bonds.

i. Ionic bond
ii. Covalent bond
iii. Coordinate covalent bond

Q.18 Why do atoms follow duplet or octet rule? 09203028

Ans. Because they would like to lower their energy by completing their duplet or octet. For example, for sodium atom it is easy to lose one electron and stabilize itself than to gain seven electrons while completing its octet.

Q.19 Differentiate between Electropositive and Electronegative Elements. 09203029

Ans. Electropositive Elements:

i. Electropositive means tendency to lose electron to form cation.

ii. All metals are electropositive in nature.

iii. They have low ionization energy and low electronegativity.

Example:

$$Na \rightarrow Na^{+} + 1e^{-}$$

$$Mg \rightarrow Mg^{2+} + 2e^{-}$$

Electronegative Elements:

i. Electronegative means tendency to accept electron to form anion.

ii. All non-metals are electronegative in nature.

iii. They have high ionization energy and high electronegativity.

For example:

$$F + e^{-} \rightarrow F^{-}$$

$$O + 2e^{-} \rightarrow O^{2-}$$

Q.20 Why do atoms form chemical bonds? 09203030

Ans. 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.

Q.21 How do atoms succeed in lowering their energy? 09203031

Ans. Atoms can lower their energy by forming chemical bonds with other atoms and to achieve more stable configuration with lower energy.

Q.22 When are atoms considered to be unstable? 09203032

Ans. The atoms having less than 2 or 8 electrons in their valence shells are unstable.

Chemical Bond

Q.23 Define electronic configuration. 09203033

Ans. The arrangement of electrons around

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the nucleus of an atom in shells and sub-shells is called electronic configuration.

Q. 24 What is meant by a chemical bond? 09203034

Ans. A force of attraction between atoms that holds them together in a molecule is called a chemical bond. **e.g.** H – H (hydrogen molecule)

Q. 25 What is the effect of attractive and repulsive forces in the formation of a chemical bond? 09203035

Ans. If attractive forces become dominant, the decrease in the energy of the system takes place, due to which chemical bond is formed. While, if repulsive forces become dominant, the increase in the energy of the system takes place, due to which no chemical bond is formed.

Ionic Bond

Q. 26 Describe the applications of ionic compounds? 09203036

Ans. Conduction of ionic compounds in molten state and in form of an aqueous solution has been utilized to prepare many important elements and compounds.

For example, electrolysis of molten sodium chloride gives us sodium metal and chlorine gas. Similarly electrolysis of aqueous sodium chloride gives sodium hydroxide and chlorine gas.

Q.27 Define ionic bond with an example. 09203037

Ans. The bond formed by the complete transfer of electrons from one atom (electropositive) to another (electronegative) is called ionic bond. **e.g.** Formation of bond between sodium and chloride ions.

Q. 28 Define ionic compounds and why these compounds are neutral? 09203038

Ans. Compounds that consist of ions joined by electrostatic forces are called **ionic compounds.** The total positive charge of the cations must be equal to the total negative charge of the anions. This is because ionic compounds are electrically neutral as a whole.

Q.29 Why do the ionic compounds high have melting and boiling points? 09203039

Ans. As ionic compounds are made up of positive and negative ions, there exist strong electrostatic forces of attraction between oppositely charged ions. So, a great amount of energy is required to break these forces.

Q. 30 What is crystal lattice? 09203040

Ans. Ions are spherical and oppositely charged they can surround each other from all the sides, ionic bonds are non-directional. This arrangement of ions is called **crystal lattice.**

Q.31 Ionic compounds conduct electricity in solution or molten form. Why? 09203041

Ans. Ionic compounds in solid state are bad conductor of electricity because ions are tightly packed and unable to move, whereas in solution or molten form ions can move freely which make them good conductor of electricity.

Q.32 Ionic compounds are solids. Justify. 09203042

Ans. Ionic compounds have strong electrostatic forces of attraction between positively and negatively charged ions which holds them together in a three dimensional crystalline or solid form. **e.g.** sodium chloride (NaCl) is crystalline solid.

Q. 33 Why are ionic compounds easily soluble in water? 09203043

Ans. Water has high dielectric constant that weakens the attraction between the ions of ionic compounds due to which they are easily soluble in water.

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Covalent Bond

Q. 34 Why covalent compounds have lower melting points than ionic compounds? 09203044

Ans. This is because ionic compounds involve breaking the ionic bond. Breaking the electrostatic forces between ions requires large amounts of energy. Thus, ionic compounds have high melting points and boiling points. Melting of covalent solids involves the breaking of intermolecular forces, which are much weaker than electrostatic forces. Thus, less energy is required to break the intermolecular forces between covalent molecule.

Q. 35 What is meant by bonding electrons? 09203045

Ans. The valence electrons, which are involved in chemical bonding, are termed as bonding electrons. **e.g.** H• ×H

Q. 36 What is meant by covalent bond? 09203046

Ans. The bond formed by the mutual sharing of electrons between non-metals is called covalent bond. Covalent bond is classified into three types.

- Single covalent bond
- Double covalent bond
- Triple covalent bond

Q. 37 What is meant by single covalent bond? Give examples. 09203047

Ans. When one electron is contributed by each bonded atom, one bond pair is formed and it forms a single covalent bond. It is represented by (—). **Examples:** Molecules with single covalent bonds are hydrogen, (H—H), hydrochloric acid, (H—Cl).

Q. 38 What is meant by double covalent bond? Give examples. 09203048

Ans. When each bonded atom contributes two electrons, two bond pairs are shared and a double covalent bond is formed. It is represented by (=).

e.g. A molecule with double covalent bond is oxygen, (O = O) ; or O_2.

Q. 39 What is a triple covalent bond? Explain with an example. 09203049

Ans. When each bonded atom contributes three electrons, three bond pairs are shared and a triple covalent bond is formed. It is indicated by (≡).

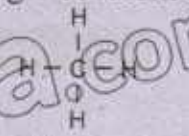
Example: molecules with triple covalent bonds are nitrogen (N_2) and ethyne (C_2H_2).

$:\dot{N}\bullet + \times\dot{N}\times \longrightarrow :N\vdots\vdots N:$ or $N \equiv N$ or N_2

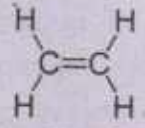
Q. 40 Point out the type of covalent bonds in CH_4, C_2H_4, N_2 and O_2 09203050

Ans.

i. CH_4 has 4 Single covalent bond



ii. C_2H_4 has 1 Double covalent bond and 4 Single covalent bond.



iii. N_2 has triple covalent bond $N \equiv N$

iv. O_2 has double covalent bond. $O = O$

Q. 41 Considering the electronic configuration of nitrogen atom, how many electrons are involved in bond formation and what type of covalent bond is formed? 09203051

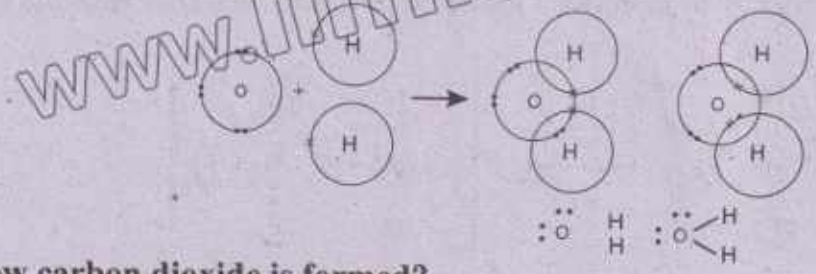
Ans. The electronic configuration of nitrogen is $N_7 = Is^2, 2s^2, 2p^3$. The valence shell of nitrogen is deficient of three electrons. Thus two nitrogen atoms share their three valence electrons each to form a triple covalent bond with three pairs of electrons and six electrons as a total are shared, i.e., $:N\vdots\vdots N:$

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Formation of Covalent Compound

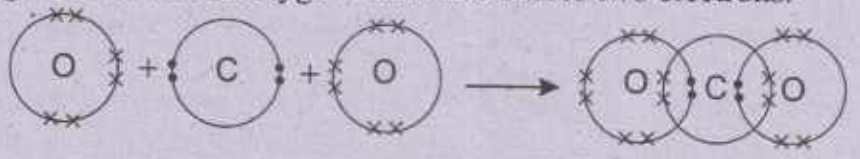
Q.42 How water molecule is formed? 09203052

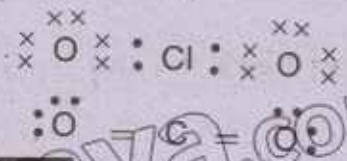
Ans. A water molecule is formed when two hydrogen atoms share their electrons separately with the electrons of one oxygen atom.



Q.43 How carbon dioxide is formed? 09203053

Ans. 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.





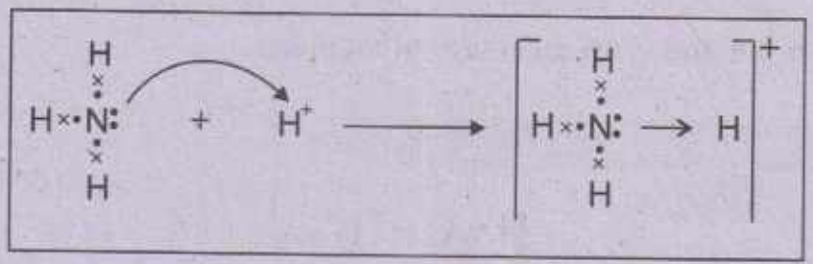
Coordinate Covalent Bond

Q.44 Define coordinate covalent bond. 09203054

Ans. A type of covalent bond in which the bond pair of electrons is donated by one of the bonded atoms only is called coordinate covalent or dative bond. **Example:** $[H_3O]^+$

Q.45 How is coordinate covalent bond formed in NH_4^+? 09203055

Ans. Nitrogen from ammonia molecule donates its lone pair of electrons to H^+ in order to form a coordinate covalent bond.



Q.46 Differentiate between donor and acceptor atom. 09203056

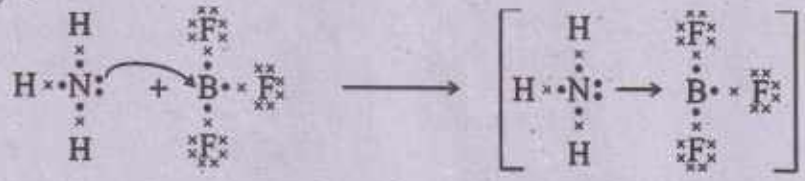
Ans.

Donor atom	Accepter atom
i. During the formation of coordinate covalent bond the atom which donate a lone pair of electron is called donor. **Example:** In formation of NH_4^+, N is donor.	**i.** During the formation of coordinate covalent bond the atom which accept an electron pair is called acceptor. **Example:** In formation of NH_4^+, H^+ is accepter.

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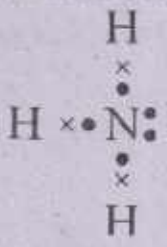
Q. 47 Why is the BF_3 electron deficient? 09203057

Ans. Boron has the electronic configuration as $1s^2\ 2s^2\ 2p^1$. This means that it needs five more electrons to be stabilized. In BF_3 it shares three electrons with three fluorine atoms and attains six electrons in its valence shell and still two electrons are required to complete octet. It still retains the tendency to gain two more electrons and therefore remains electron deficient.



Q. 48 Draw Lewis dot and cross structure of ammonia molecules. 09203058

Ans.



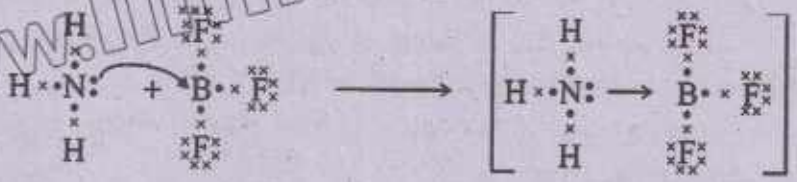
Q. 49 Draw Lewis dot and cross structure of nitrogen molecule. 09203059

Ans.



Q. 50 How is coordinate covalent bond formed between NH_3 and BF_3? 09203060

Ans.



Q. 51 Draw Lewis dot and cross structure of methane. 09203061

Ans.



Q.52: Draw Lewis dot and cross structure of ethyne. 09203062

Ans.



Q.53: What is meant by electronegative atom?

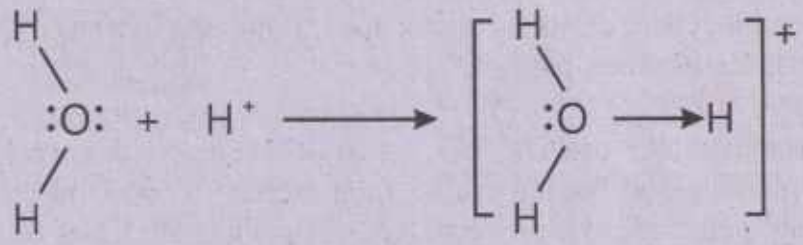
Ans. The atom which attract the bond pair of electrons more strongly than the other one in polar covalent bond formation will be called as more electronegative atom as compared to

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the other bonded atom. **For example**, in HCl molecule, Cl is more electronegative atom as compared to H atom .

Q.54 How hydronium ion(H_3O) is formed? 09203063

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



Metallic Bond

Q.55 What is meant by metallic bond? 09203064

Ans. A bond formed between metal atoms (positively charged ions) due to mobile or free electrons is called metallic bond.

Q.56 State the physical properties of metals. 09203065

Ans.

i. Metals have high melting and boiling points.
ii. They are good conductor of heat and electricity.
iii. They are mostly solids, possess metallic luster and can be polished.
iv. They are hard, malleable and ductile.

Q.57 Metals are good conductor of electricity. Why? 09203066

Ans. Electricity is produced as a result of movement of free electrons. Metals are good conductor of electricity as they have free or mobile electrons which move freely in the spaces between atoms of a metal.

Q.58 What do you mean by malleable and ductile? 09203067

Ans. Malleable means a material that can be hammered into sheets and ductile means a material that can be drawn into wires.

Q.59 What are the uses of metals? 09203068

Ans. Metals are extensively used in many industries. They are used in machinery, automobiles, railways, air crafts, rockest, construction industry, electronics industry, jewellery, electric wires and many more.

Electropositive Character of Metals

Q. 60 What is electropositivity? Explain with an example. 09203069

Ans. Electropositivity is the property of a metal element to readily lose its valence electrons and gain a positive charge. Metals are highly electropositive elements, **e.g.** Sodium atom can lose 1 electron to from a positive ion.

Electronegative Character of Non-Metals

Q. 61 What is meant by electronegative character of Non-metals? 09203070

Ans. Non-metals have an affinity towards y electrons. They tend to gain electrons and become negatively charged ions called anions. They are therefore, named as electronegative elements. Non-metals readil react with metals forming ionic bonds.

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Compare the properties of ionic and covalent compounds

Q.62 Compare the properties of ionic and covalent compound. 09203071

Ans.

Ionic	Covalent
i. 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.	i. Covalent compounds mostly exist as discrete neutral molecules. There exists a strong electrostatic attraction between the nuclei and the shared electrons.
ii. Ionic compounds are usually solids having 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.	ii. Covalent compounds are made of two or 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.

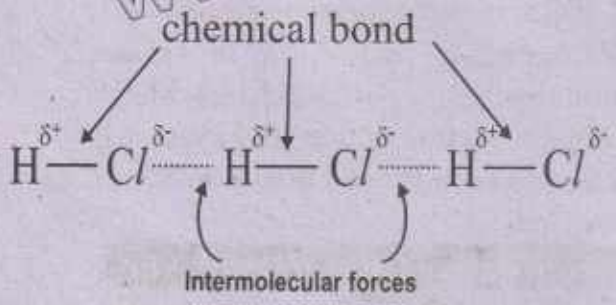
Intermolecular Forces of Attraction

Q. 63 Define intermolecular forces. 09203072

Ans. A weak force of attraction formed between two molecules is called intermolecular force.

e.g: i) Dipole-Dipole force attraction

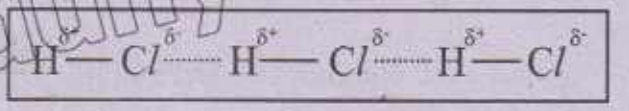
ii) Hydrogen Bonding



Q. 64 Why HCl has dipole-dipole forces of attraction? 09203073

Ans. In HCl chlorine being more electronegative atom attracts the shared pair of electron and partial negative charge is created on chlorine and in turn partial positive charge on hydrogen.

When partial positive and partial negative charges exist at different poles in a molecule, the adjacent molecules will arrange themselves in such a way that negative end of that molecule comes near to positive end of other molecule. It results a net force of attraction called **dipole-dipole interaction.**



Q. 65 Why are dipole forces of attraction not found in halogen molecules? 09203074

Ans. Halogen molecules form a non-polar covalent bond between them. In order to make non-polar bonds, no electronegativity difference of elements is required, due to which dipole forces do not develop in halogen molecules.

Q. 66 What types of attractive forces exist between HCl molecules? 09203075

Ans. Weak intermolecular forces exist between HCl molecules, **i.e.** Dipole - Dipole forces between HCl molecule.

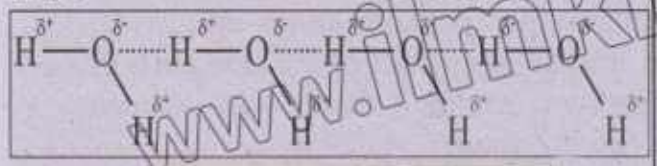
Q.67 What is meant by hydrogen bonding? 09203076

Ans. A bond formed between partially positive charge hydrogen atom of one molecule and partially negative charge atom (F, O or N) of the other molecule is called hydrogen bonding. **e.g.** HF, H_2O, NH_3 etc.

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Q.68 Draw a structure of water molecules showing hydrogen bonding.

Ans. 09203077



Nature of Bonding and Properties

Q.69 What do you know about coal? 09203078

Ans. Coal is the amorphous form of carbon whereas diamond and graphite are its crystalline forms. Coal is used as a fuel in electricity generating plants.

Q.70 Why diamond is considered so hard? 09203079

Ans. Diamond is an allotrope of carbon in which the carbon atoms are arranged in a diamond cubic crystal lattice. Due to the presence of strong covalent bonds and a rigid tetrahedral structure, diamond is the hardest material ever discovered.

Q.71 What is the structure of Graphite? 09203080

Ans. In graphite, each carbon atom is linked with 3 other carbon atoms by a single covalent bond resulting in the hexagonal ring arranged in a layer. It has a 2-dimensional layers structure. The 4 valency of the carbon atom is satisfied by weak van der waal's forces between 2 layers.

Q. 72 Give two uses of Graphite. 09203081

Ans. (i) Due to its stability in high temperatures and chemical inertness, graphite is used in many refractory items such as carbon refractory bricks.

(ii) The electrodes of graphite are used in electrical metallurgical furnaces. It is used as an anode in electrolytic processes.

Q. 73 Enlist two uses of diamonds. 09203082

Ans. Diamonds, due to their exceptional hardness, are highly valued in industries.

i. Diamond tipped glass cutters are used to make clean cuts in glass.
ii. Diamond-tipped drill bits are used to drill through hard rocks in mining operation.

Constructed Response Question

Q.1. Ex Q. 3 (i) **Why HF is a liquid while HCl is a gas?** 09203083

Ans. Hydrofluoric acid (HF) is a liquid at room temperature, while hydrochloric acid (HCl) is a gas. The primary reason for this difference lies in the nature of the intermolecular forces present in each substance.

- **Intermolecular Forces**: HF molecules can form strong hydrogen bonds due to the highly electronegative fluorine atom. These hydrogen bonds lead to stronger attractions between HF molecules, resulting in a higher boiling point and allowing it to exist as a liquid at room temperature.
- **Molecular Structure**: HCl is a polar molecule but does not form hydrogen bonds as strong as those in HF. The intermolecular forces in HCl are primarily dipole-dipole interactions and London dispersion forces, which are weaker than hydrogen bonds. As a result, HCl has a lower boiling point and exists as a gas at room temperature.

Q.2. Ex Q. 3 (ii) **Why covalent compounds are generally not soluble in water?** 09203084

Ans. Covalent compounds are generally not soluble in water because they do not dissociate into ions when they are dissolved in water. Water is a polar molecule; it has partial positive charge on one end and a partial negative charge on the other. Ionic compounds dissolve in water because water molecules surround and separate the ions due to their charges. However, covalent

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compounds do not have ions to interact with water molecules. So, they do not dissolve easily in water.

Q.3. Ex Q. 3 (iii) **How do metals conduct heat?** 09203085

Ans. Metals conduct heat because of their free moving electrons. These electrons can move throughout the metal structure carrying heat energy from one part of the metal to another. This ability of electrons to move freely in metals allows them to transfer heat efficiently making metals good conductors of heat.

Q.4. Ex Q. 3 (iv) **How many oxides does nitrogen form. Write down the formula of oxides.** 09203086

Ans. Nitrogen forms several oxides including:

- Nitrogen monoxide (NO)
- Nitrogen dioxide (NO_2)
- Dinitrogen trioxide (N_2O_3)
- Nitrous oxide (N_2O)
- Dinitrogen pentaoxide (N_2O_5)

Q.5. Ex Q. 3 (v) **What will happen if NaBr is treated with $AgNO_3$ in water?** 09203087

Ans. When sodium bromide is treated with silver nitrate in water, a chemical reaction will occur. The silver nitrate will react with the sodium bromide to form silver bromide which is insoluble in water and will precipitate out of the solution as a white solid. The other product of the reaction will be sodium nitrate which will remain dissolved in water.

$$NaBr + AgNO_3 \rightarrow AgBr + NaNO_3$$

Q.6. Ex Q. 3 (vi) **Why does iodine exist as a solid while Cl_2 exist as a gas?** 09203088

Ans. Iodine exists as a solid while chlorine (Cl_2) exists as a gas due to differences in their molecular structures and intermolecular forces.

Iodine (I_2) is larger molecule than chlorine. The larger size of iodine molecule leads to stronger vander Waals forces (dispersion forces) between them. These stronger intermolecular forces require more energy to overcome that's why, iodine is a solid at room temperature.

Chlorine (Cl_2) consists of smaller molecules with weaker vander Waals forces. This allows chlorine to remain in a gaseous state at room temperature because the energy is sufficient for the molecules to move freely and not be held together as a solid.

MCQ's Question (Exercise)

1. **When molten copper and molten zinc are mixed together, they give rise to a new substance called brass. Predict what type of bond is formed between copper and zinc.** 09203089
   (a) Coordinate covalent bond
   (b) Ionic bond
   (c) Metallic bond
   (d) Covalent bond
2. **Which element is capable of forming all the three types of bonds; covalent, coordinate covalent or ionic?** 09203090
   (a) Carbon
   (b) Oxygen
   (c) Magnesium
   (d) Silicon
3. **Why is H_2O a liquid while H_2S is a gas?** 09203091
   (a) Because in water, the atomic size of oxygen is smaller than that of Sulphur
   (b) Because water is a polar compound and there exists strong forces of attraction between its molecules
   (c) Because H_2O molecule is lighter than H_2S
   (d) Because water can easily freeze into ice

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4. **Which of the following bonds is expected to be the weakest?** 09203092
(a) C-C (b) Cl-Cl
(c) O-O (d) F-F

5. **Which form of carbon is used as a lubricant?** 09203093
(a) Coal (b) Diamond
(c) Graphite (d) Charcoal

6. **Keeping in view the intermolecular forces of attraction, indicate which compound has the highest boiling point.** 09203094
(a) H_2O (b) H_2S
(c) HF (d) NH_3

7. **Which metal has the lowest melting point?** 09203095
(a) Li (b) Na
(c) K (d) Rb

8. **Which ionic compound has the highest melting point?** 09203096
(a) $NaCl$ (b) KCl
(c) $LiCl$ (d) $RbCl$

9. **Which compound contains both covalent and ionic bonds?** 09203097
(a) $MgCl_2$ (b) NH_4Cl
(c) CaO (d) PCl_5

10. **Which among of the following has a double covalent bond?** 09203098
(a) Ethane (b) Methane
(c) Ethylene (d) Acetylene

SLO Based Additional MCQ's

Why do atoms form chemical bonds

11. **Atoms achieve stability by attaining electronic configuration of:** 09203099
(a) Alkali metals
(b) Inert gases
(c) Alkaline earth metals
(d) Coinage metals

12. **Attaining two electrons in the valence shell is called:** 09203100
(a) Duplet rule
(b) Triplet rule
(c) Octet rule
(d) All of these

13. **All the noble gases have their valence electrons:** 09203101
(a) Partially filled
(b) Completely filled
(c) Incomplete
(d) None of the above

14. **Noble gases are non-reactive, because they do not:** 09203102
(a) Gain electrons
(b) Lose electrons
(c) Share electrons
(d) All of these

15. **Every atom has a natural tendency to accommodate electrons in its valence shell:** 09203103
(a) 2 or 6
(b) 2 or 4
(c) 2 or 8
(d) 2 or 10

16. **Hydrogen and Helium follow:** 09203104
(a) Octet rule
(b) Duplet rule
(c) Triplet rule
(d) None of these

17. **Which of the following atoms obey duplet rule?** 09203105
(a) O_2 (b) H_2
(c) Cl_2 (d) Li_2

18. **Which of the following is not true about the formation of Na_2S:** 09203106
(a) Each sodium atom loses one electron
(b) Sodium forms cation
(c) Sulphur forms anion
(d) Each Sulphur atom gains one electron

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19. Octet rule is: 09203107
(a) Description of eight electrons
(b) Picture of electronic configuration
(c)Pattern of electronic configuration
(d) Attaining of eight electrons in its valence shell

20. Atoms react with each other because: 09203108
(a) They are attracted towards each other
(b) They are short of electrons
(c) They want to attain stability
(d) They want to disperse

21. An atom having six electrons in its valence shell will achieve noble gas electronic configuration by: 09203109
(a) Gaining one electron
(b) Losing all electrons
(c) Gaining two electrons
(d) Losing two electrons

Ionic Bond

22. Which of the following atoms will form anion of charge -2? 09203110

	Atomic number	Mass number
(a)	12	24
(b)	14	28
(c)	8	16
(d)	10	20

23. The formation of ionic bond between two ions is due to: 09203111
(a) Hydrogen bonding
(b) Metallic force
(c) Electrostatic forces
(d) All of the above

24. Which group of the periodic table has the tendency to gain electrons? 09203112
(a) Group 1 (b) Group 18
(c) Group 2 (d) Group 17

25. Which of the following atoms will not form cation or anion? 09203113
(a) (atomic no. 16)
(b) (atomic no. 17)
(c) (atomic no. 18)
(d) (atomic no. 19)

26. Transfer of electrons between elements result in: 09203114
(a) Metallic bonding
(b) Ionic bonding
(c) Covalent bonding
(d) Coordinate covalent bonding

27. When an electronegative element combines with electropositive element, the type of bonding is: 09203115
(a) Covalent
(b) Ionic
(c) Polar covalent
(d)Coordinate covalent

28. Which of the following compounds is non-ionic in its bonding? 09203116
(a) CH_4 (b) KBr
(c) CO_2 (d) H_2O

29. How many electrons are there in the valence shell of sodium atom? 09203117
(a) One (b) Two
(c) Three (d) Four

30. The electropositive elements have the tendency to: 09203118
(a) Gain electrons
(b) Lose electrons
(c) Share electrons
(d) All of these

31. How many valence shell electrons are there in Na^+ ion? 09203119
(a) 8 (b) 9
(c) 10 (d) 1

32. During the formation of ionic bond, heat is? 09203120
(a) Absorbed
(b) Released
(c) Remains same
(d) Both a & b

33. Which type of attractive forces are present in ionic compounds: 09203121
(a) Covalent bonds
(b) Coordinate covalent bonds
(c) Metallic bonds
(d) Electrostatic forces of attraction

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Covalent Bond

34. Number of electrons in nitrogen molecule is: 09203122
(a) 2 (b) 4
(c) 6 (d) 8

35. How many covalent bonds do N_2 molecule have? 09203123
(a) 2 (b) 3
(c) 4 (d) 5

36. Silicon belongs to Group IVA. It has ____ electrons in the valence shell: 09203124
(a) 2 (b) 3
(c) 4 (d) 6

37. Phosphorus belongs to third period of Group VA. How many electrons it needs to complete its valence shell. 09203125
(a) 2 (b) 3
(c) 4 (d) 5

38. In the formation of A/F_3, aluminum atom loses _____ electrons. 09203126
(a) 1 (b) 2
(c) 3 (d) 4

39. Identify the covalent compound:
(a) NaCl (b) MgO
(c) H_2O (d) KF

40. A bond formed between two non-metals is expected to be: 09203127
(a) Covalent
(b) Ionic
(c) Coordinate covalent
(d) Metallic

41. A bond pair in covalent molecules usually has: 09203128
(a) One electron
(b)Two electrons
(c) Three electrons
(d) Four electrons

42. Covalent bond involves the: 09203129
(a) Donation of electrons
(b) Acceptance of electrons
(c) Sharing of electrons
(d) Repulsion of electrons

43. How many covalent bonds does C_2H_2 molecule have? 09203130
(a) Two (b) Three
(c) Four (d) Five

44. Triple covalent bond involves how many electrons? 09203131
(a) Eight (b) Six
(c) Four (d) Only three

45. Which pair of the molecules has same type of covalent bonds? 09203132
(a) O_2 and HCl (b) O_2 and N_2
(c) O_2 and C_2H_4 (d) O_2 and C_2H_2

46. Identify the compound which is not soluble in water: 09203133
(a) C_6H_6 (b) NaCl
(c) KBr (d) $MgCl_2$

47. Identify which pair has polar covalent bonds: 09203134
(a) O_2 and Cl_2
(b) H_2O and N_2
(c) H_2O and C_2H_2
(d)$H_2O$and HCl

48. Which one of the following is the weakest force among the atoms? 09203135
(a) Ionic force
(b) Metallic forces
(c) Intermolecular force
(d) covalent forces

49. Covalent bond is most commonly found between the elements of group: 09203136
(a) 13 to 17
(b) 1 to 13
(c) 16 to 18
(d) 15 to 18

50. A bond formed by the mutual sharing an electron pair is called: 09203137
(a) Ionic bond
(b) Covalent bond
(c) Coordinate covalent bond
(d) Metallic bond

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51. **A covalent bond formed by the mutual sharing of two pairs of electrons between bonded atoms is called:** 09203138
(a) Single covalent bond
(b) Double covalent bond
(c) Triple covalent bond
(d) Polar covalent bond

52. **Which molecule contains a single covalent bond?** 09203139
(a) CH_4
(b) C_2H_4
(c) C_2H_2
(d) O_2

53. **Nitrogen molecule contains:** 09203140
(a) Polar covalent bond
(b) Single covalent bond
(c) Double covalent bond
(d) Triple covalent bond

54. **How many electrons are involved in the formation of single covalent bond?** 09203141
(a) One (b) Two
(c) Three (d) Four

55. **A covalent bond formed by two similar atoms is known as:** 09203142
(a) Polar covalent bond
(b) Non-polar covalent bond
(c) Metallic bond
(d) Double covalent bond

Coordinate Covalent Bond

56. **Dative covalent bond is also known as:** 09203143
(a) Coordinate covalent bond
(b) Covalent bond
(c) Ionic bond
(d) Metallic bond

57. **Which one of the following in as electron deficient molecule?** 09203144
(a) NH_3 (b) BF_3
(c) N_2 (d) O_2

58. **How many lone pairs are present on nitrogen in ammonia molecule?** 09203145
(a) One (b) Two
(c) Three (d) Four

59. **Which type of bond is present between NH_3 and BF_3?** 09203146
(a) Covalent bond
(b) Coordinate covalent bond
(c) Ionic bond
(d) Metallic bond

Metallic Bond

60. **In metals, the hold of nucleus over the valence shell electrons is weak due to:** 09203147
(a) Large sized atoms
(b) High ionization energies
(c) Highelectron affinity
(d) All of the above

61. **Malleability is the property by virtue of which a metal can be drawn into:** 09203148
(a) Sheets (b) Wires
(c) Rods (d) Plates

62. **Metals have the tendency to lose electrons due to:** 09203149
(a) High ionization energies
(b) Low electron affinity
(c) Low ionization energy
(d) none of the above

Intermolecular Forces of Attraction

63. **Hydrogen bonding is always found in:** 09203150
(a) Non-polar molecules
(b) Polar molecules
(c) Homoatomic molecules
(d) All of the above

64. **Which of the following is an example of polar covalent compound?** 09203151
(a) HCl (b) Cl_2
(c) O_2 (d) H_2

65. **The force of attraction between water molecule is:** 09203152
(a) Ionic bonding
(b) Covalent bonding
(c) Hydrogen bonding
(d) Coordinate covalent bonding

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66. The boiling point of water is: 09203153

(a) 0^0C (b) 35^0C
(c) 100^0C (d) 25^0C

67. The boiling point of alcohol is: 09203154

(a) 44^0C (b) 19^0C
(c) 53^0C (d) 78^0C

68. Water has high boiling points as compared to alcohol due to: 09203155

(a) Hydrogen bonding
(b) High vapour pressure
(c) Low density
(d) High surface tension

69. The density of ice at 0°C is: 09203156

(a) 0.917 g/cm^3
(b) 1.24 g/cm^3
(c) 1.7g/cm^3
(d) 2.17 g/cm^3

70. The density of water at 0°C is: 09203157

(a) 0.917 g/cm^3
(b) 1.24 g/cm^3
(c) 1.00g/cm^3
(d) 1.17 g/cm^3

Nature of Bonding and Properties

71. The compounds formed by opposite charges are known as: 09203158

(a) Non-polar Covalent compounds
(b) Ionic compounds
(c) Metallic solids
(d) None of the above

72. Ionic compounds are good conductors electricity in: 09203159

(a) Solid state
(b) Molten state
(c) Solution
(d) Both b and c

73. Ionic compounds have: 09203160

(a) High melting and boiling points
(b) High melting and low boiling points
(c) Low melting and high boiling points
(d) Low melting and boiling points

74. The melting point of NaCl is: 09203161

(a) 318 °C (b) 1000 °C
(c) 510 °C (d) 801 °C

75. Which of the following is an example of a covalent compound? 09203162

(a) $C_6H_{12}O_6$
(b) CH_4
(c) H_2SO_4
(d) All of these

76. Non-polar compounds are insoluble in: 09203163

(a) Water (b) Benzene
(c) Ether (d) Alcohol

Answer Key

1	c	2	a	3	b	4	d	5	c
6	a	7	d	8	a	9	b	10	c
11	b	12	a	13	b	14	d	15	c
16	b	17	b	18	d	19	d	20	c
21	c	22	c	23	c	24	d	25	c
26	b	27	b	28	b	29	a	30	b
31	a	32	b	33	d	34	c	35	b
36	c	37	b	38	c	39	c	40	a
41	b	42	c	43	d	44	b	45	c
46	a	47	d	48	c	49	a	50	b
51	b	52	a	53	d	54	b	55	b
56	a	57	b	58	a	59	b	60	a
61	a	62	c	63	b	64	a	65	c
66	c	67	d	68	a	69	a	70	c
71	b	72	d	73	a	74	d	75	d
76	a								

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