

Chapter # 4

CHEMICAL BONDING



Q1) What are valence electrons? What is meant by octet and duplet rule?

VALENCE ELECTRON

Electrons present in the outermost shell of any atom play an important role in determining the chemical properties of the atom, including its ability to form chemical bonds. These electrons in the outermost shell of an atom are called as valence electrons or outer electrons.

DUPLET

Atoms to acquire two electrons in the valence shell is called duplet rule,

OCTET

Atoms to acquire eight electrons in the valence shell is called octet rule,

Q2) Define Chemical bond. Name the types of chemical bond.

CHEMICAL BOND

Chemical bonding is the combining of atoms to form new substances. An interaction that holds two atoms together is called a chemical bond. Atoms can lose, gain or share valence electrons to form chemical bonds.

TYPES OF CHEMICAL BOND

There are three types of bonds depending on the tendency of an atom to lose or gain or share electrons.

1. Ionic Bond
2. Covalent Bond
3. Co-ordinate covalent bond or dative covalent

Q3) What do you know about cation and anion.

CATION

An atom loses electrons and changes into positive ion is known as cation

ANION

An atom gains this electron and changes into negative ion is known as anion

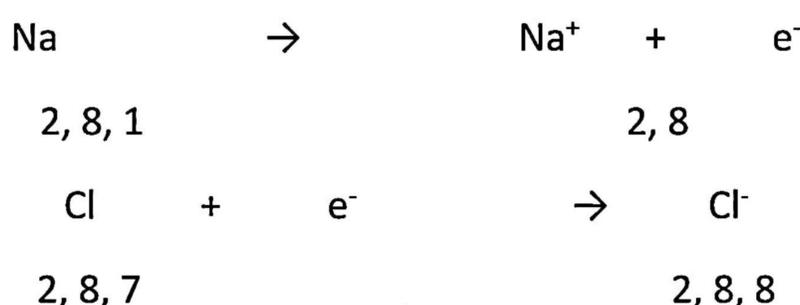
Q4) Define Ionic bonds. Explain if with two examples.

IONIC BOND

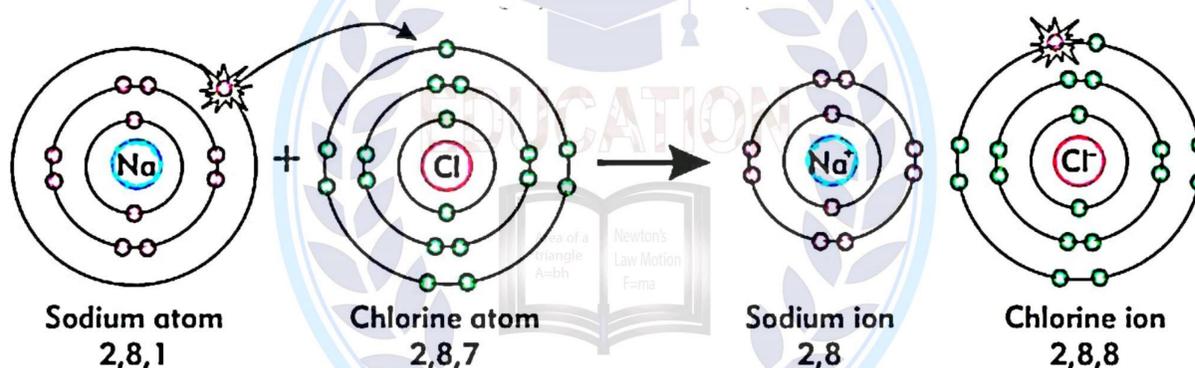
The force of attraction that holds the oppositely charged ions together are called as ionic bond or electrovalent bond.

EXAMPLE # 1

The Reaction between Sodium and Chlorine Sodium atom is a metal of IA group of the periodic table and has only one electron in the outer most shell. The electron arrangement of sodium atom is 2, 8, 1. By losing one electron from the outer most shell, sodium forms cation (Na⁺). Whereas chlorine atom is non-metal of VIIA group and has seven electrons in its outermost shell. The electron arrangement of chlorine atom is 2, 8, 7. Since chlorine atom has seven electrons in its outermost shell, it needs one electron to complete octet. By gaining one electron, chlorine atom now has eight electrons in its outermost shell and a chloride ion is formed (Cl⁻).



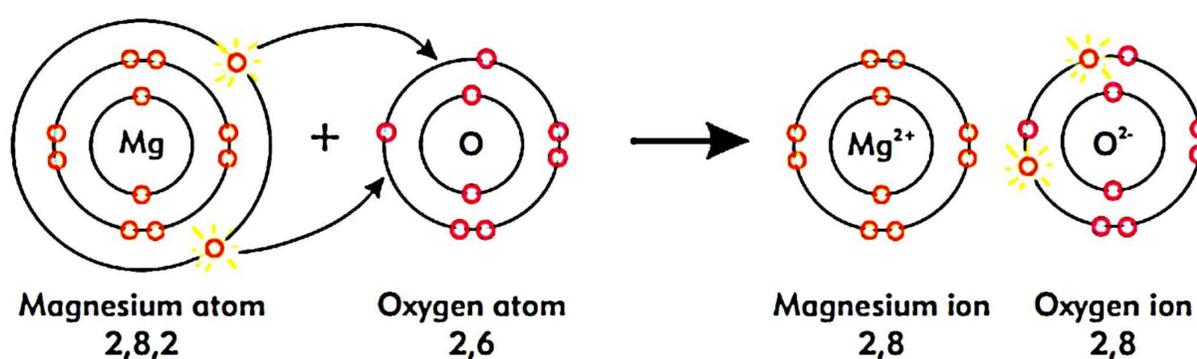
Both these atoms are now oppositely charged ions. Therefore, two charged ions are attracted to each other by electrostatic force of attraction. Thus Na⁺ and Cl⁻ ions are joint by ionic bond and form sodium chloride. The formation of ionic bonds by a 'dot and cross' diagram is shown.



EXAMPLE # 2

The Reaction between Magnesium and Oxygen

Consider another example of ionic bond formation is the reaction between magnesium and oxygen forming magnesium oxide. Magnesium is in group-II of the periodic table and has only two electrons to share and oxygen is in group VIA and has six electrons in its outermost shell. By losing two electrons from the outermost shell, magnesium becomes Mg²⁺ and it is left with 8 electrons in the second shell. By gaining two electrons, oxygen atom now also has eight electrons in its outermost shell and becomes O²⁻. Both these atoms are now changed into oppositely charged ions. The attraction between the oppositely charged ions forms the ionic bond between magnesium and oxygen. The formula of magnesium oxide is MgO. The formation of ionic bonds by a 'dot and cross' diagram is shown.



Q5) Define Covalent bond. Discuss the types of covalent bond with Example

COVALENT BOND

In this type of bond, electrons are not gained or lost by atoms. A covalent bond is formed by mutual sharing of electrons between two atoms. This type of bonding occurs between two atoms of the same element or atoms of different elements.

TYPES OF COVALENT BOND

Depending upon the number of bond pair, a covalent bond is further classified into three types.

- Single Covalent Bond
- Double Covalent Bond
- Triple Covalent Bond

SINGLE COVALENT BOND

A covalent bond which is formed by the mutual sharing of one bond pair is called a single covalent bond and it is represented by a single short straight line (-).

EXAMPLE:

Hydrogen H_2

Hydrochloric acid HCl

Methane CH_4

DOUBLE COVALENT BOND

A covalent bond which is formed by the mutual sharing of two bond pairs called a double covalent bond and it is represented by two short straight lines(=).

EXAMPLE:

Oxygen O_2

Ethene C_2H_4

TRIPLE COVALENT BOND

A covalent bond which is formed by the mutual sharing of three bond pairs is called a triple covalent bond and it is represented by three short straight line(\equiv).

EXAMPLE,

Nitrogen (N_2)

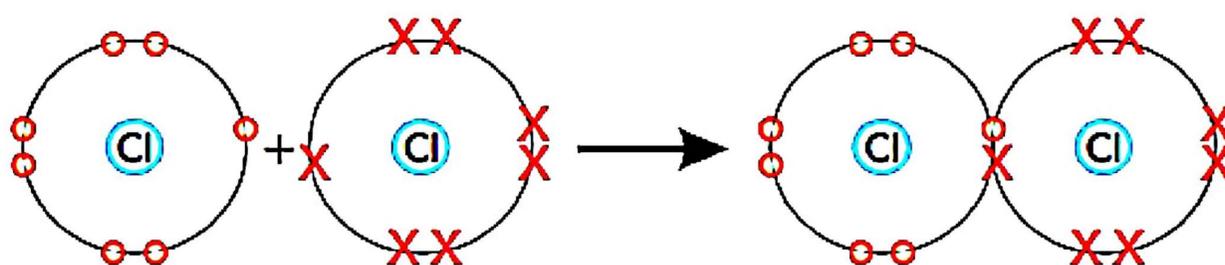
Ethyne (C_2H_2).

Q6) Describe the formation of single covalent bond. With a suitable example

FORMATION OF CHLORINE MOLECULE



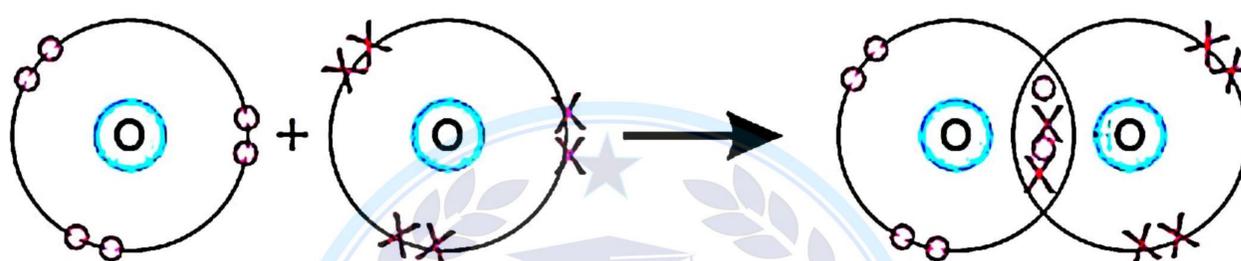
A chlorine atom belongs to group VIIA and it has seven outer electrons. It needs one more electron to achieve a stable octet electronic configuration. When two chlorine atoms share their valence electrons, both atoms achieve the electronic configuration of noble gas. The single bond in chlorine molecule is represented by a dot and cross diagram as shown



Q7) Describe the formation of double covalent bond. With a suitable example

FORMATION OF OXYGEN MOLECULE

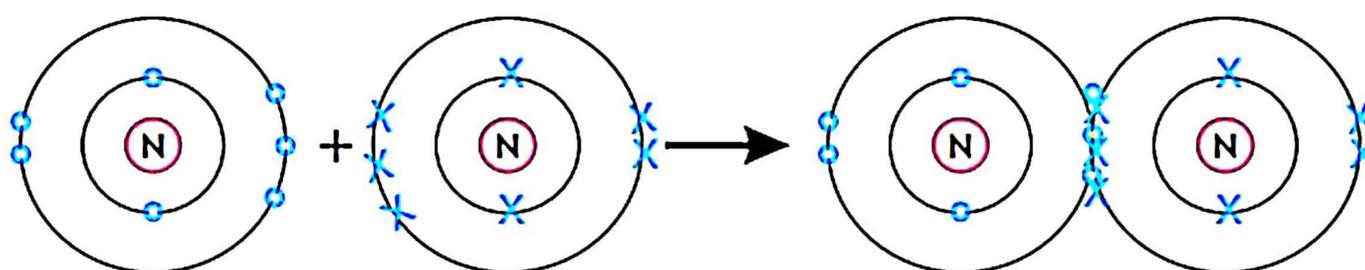
Oxygen atom belongs to group VIA of the periodic table and it has 6 valence electrons in its outer shell. It needs two more electrons to achieve a stable octet electronic configuration. Each oxygen atom will share two of its outer electrons with another oxygen atom to form an oxygen molecule (O_2). Thus, two pair of electrons are shared between the two oxygen atoms to form a double covalent bond. The double covalent bond in an oxygen molecule is represented by a dot and cross diagram as shown



Q8) Describe the formation of triple covalent bond. With a suitable example

FORMATION OF NITROGEN MOLECULE

Nitrogen is a non-metal. Each nitrogen atom has five electrons in its outer shells. Two nitrogen atoms will share three electrons to form three covalent bonds which is called triple covalent bond and formed a nitrogen molecules (N_2). The triple bond in nitrogen molecule is represented by dot and cross diagram is shown



Q9) Distinguish polar and non-polar bond.

<u>Polar bond</u>	<u>Non – polar bond</u>
The covalent bond formed between similar atoms is called polar covalent bond	The covalent bond formed between identical atoms is called non-polar covalent bond
Both atoms exert unequal force on the shared electron pairs.	Both the identical atoms exert some force on the shared electron pairs.

non-polar covalent bonds are formed when the electro negativities of the two atoms are unequal.	non-polar covalent bonds are formed when the electro negativities of the two atoms are equal.
Example:HCl, NaCl	Example: H ₂ , Cl ₂

Q10) What is Coordinate Covalent Bond or Dative Covalent Bond? Discuss it with an example.

COORDINATE COVALENT BOND



The type of bond in which bond pair of electrons is contributed by one atom only, is called coordinate covalent or dative covalent bond.

REACTION BETWEEN AMMONIA AND HYDROGEN CHLORIDE

The reaction between ammonia and hydrogen chloride involves the formation of a dative bond between N atom in NH₃ containing lone pairs and H⁺ ion from HCl. When ammonia reacts with hydrogen ions (H⁺) in an aqueous solution of an acid, the hydrogen ion is attracted to the lone pair and a coordinate covalent bond is formed.

Q11) Define the following

ACCEPTOR

The other atom which accepts the electron pair is called acceptor.

DONOR

The atom that donates the electron pair is called the donor

INTERMOLECULAR FORCES

Intermolecular forces are defined as the set of all the forces that occur between two neighboring molecules.

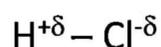
Q12) Define Dipole-Dipole Interaction also give the formation with an example

DIPOLE-DIPOLE INTERACTION

Dipole-Dipole interactions result when the two dipolar molecules interact with each other. When partially negative portion of one of the polar molecules is attracted to the partially positive portion of the second polar molecule, the electrostatic attraction is created between two molecules. These attractive forces are called Dipole-Dipole interactions

EXAMPLE DIPOLE-DIPOLE INTERACTION

Dipole-dipole interaction can be seen in hydrogen chloride. Chlorine atoms are much more electro negatives than hydrogen atoms. A partial negative charge is created on Chlorine and in turn a partial positive charge on hydrogen due to electronegative difference.



When two molecules of hydrogen chloride come close to each other, the slightly negative end of one molecule is attracted to the slightly positive end of another molecule. These attractive forces are simply called dipole-dipole interaction



Q13) Define Hydrogen Bonding also give the formation with an example

HYDROGEN BONDING

The interaction between partially positive charged hydrogen atom of one molecule with electronegative atom of other molecule is called Hydrogen bond.

Consider the example of hydrogen fluoride. The fluorine atom is more electronegative.

EXAMPLE OF HYDROGEN BONDING

They tend to pull on the shared pair of electrons, creating a partial negative charge on itself and a partial positive charge on the hydrogen. The partial positive charge bearing hydrogen, then forms a bond with the electronegative atom of a neighboring molecule, while its electronegative element forms another bond with the positive hydrogen of another neighboring molecule

Q14) Write some properties of ionic compounds.

PROPERTIES OF IONIC COMPOUNDS

- i) Ionic compounds form crystals.
- ii) Ionic compounds tend to be hard and brittle
- iii) Ionic compounds have high melting points. For example, melting point of NaCl is 801°C and boiling point 1413°C .
- iv) Aqueous solutions of ionic compounds also conduct electricity. This is because when an ionic compound dissolves in water, the ions are free to move in aqueous solution.
- v) Ionic compounds usually dissolve in polar solvent like water and are insoluble in non-polar solvents like oil, petrol, kerosene oil etc.

Q15) Write some properties of covalent compounds.

PROPERTIES OF COVALENT COMPOUNDS

- i) Covalent compounds can exist as crystals, examples include sugar crystals and diamond.
- ii) The melting and boiling points of most covalent compounds are usually low.

iii) They are bad conductors of electricity.

iv) They are insoluble in water, but soluble in non-polar solvents like oil, petrol, kerosene, etc.

Q16) Write some properties of non-polar compounds.

PROPERTIES OF NON POLAR COMPOUNDS



i) Nonpolar covalent compounds are generally insoluble in water

ii) Non-polar covalent compounds do not conduct electricity in the solid, molten or aqueous solution,

iii) Non-polar covalent compounds are soluble in non-polar solvent like petrol, benzene etc.

iv) Few examples of polar covalent compounds are H_2SO_4 , H_2O , HCl , HF , HBr

Q17) Write some properties of polar compounds.

PROPERTIES OF POLAR COMPOUNDS

I. Polar covalent compounds are soluble in water.

II. polar covalent compounds usually conduct electricity due to the formation of ions with water.

III. polar covalent compounds insoluble in non-polar solvent.

IV. Few examples of non-polar covalent compounds are CO_2 , CH_4 , C_2H_6 .

Q18) Write some properties of metals.

PROPERTIES OF METALS

i. Metals are usually malleable and ductile.

ii. They are conductor of electricity and heat due to the presence of delocalized electrons (mobile electrons).

iii. Melting and boiling points of metal are usually high as the atoms in metals are packed tightly.

iv. Metals have high densities

Q19) Write uses of adhesive material.

USES OF DIFFERENT SYNTHETIC ADHESIVES

1. It is used in book binding.

2. It is used in fixing of soles to the bodies of shoes and wood working.

3. It is used in self-adhesive envelopes.

4. Conductive adhesive is commonly used in electronics to repair equipment.

5. It is use for epoxy resin is the decorative flooring applications

- Q20) Why an atom forms chemical bond?
- Q21) When atoms are considered to be unstable?
- Q22) Why doesn't helium atom tend to gain electron?
- Q23) Where are valence electrons located, and why are they important?
- Q24) What is meant by bonding electrons?
- Q25) Why, noble gases do not react with other element to form compounds?
- Q26) Find the number of valence electrons in the following atoms.

(a) Chlorine (b) Sodium (c) Magnesium (d) Potassium

- Q27) Draw dot and cross diagrams to show how different types of chemical bonds are formed when fluorine reacts with

(a) Hydrogen (b) potassium

- Q28) Can you draw an ion which is formed by the atom losing three electrons?

- Q29) Complete the chart

Atomic Number	Number of protons	Number of electrons	Electronic configuration	Number of valence electrons
1				
2				
4				
8				
10				
11				
12				
13				
14				
15				
16				
18				

MULTIPLE CHOICE QUESTIONS

1. An example of ionic compound is:

- (a) H_2 (b) CH_4 (c) N_2 (d) $NaCl$



2. Interaction between highly electron deficient hydrogen and highly electronegative atom is called

- (a) covalent bond (b) ionic bond (c) hydrogen bond (d) metallic bond

3. Two fluorine atoms share one electron each in their outermost shell to achieve electronic configuration of:

- (a) Xe (b) Ar (c) Kr (d) Ne

4. Number of electrons lost by atoms of group IIIA equals:

- (a) 1 (b) 2 (c) 3 (d) 4

5. Atom which loses two electrons from its outer shell to form ion is called:

- (a) oxygen (b) potassium (c) magnesium (d) carbon

6. In $NaCl$ crystal lattice each Na^+ ion is surrounded by:

- (a) 6 Cl^- ions (b) 6 Na^+ ions (c) 8 Cl^- ions (d) 12 Cl^- ions

7. At room temperature most of ionic compounds are:

- (a) amorphous solids (b) crystalline solids (c) liquids (d) gases

8. Tendency of atoms to acquire eight electrons in their valence shell is:

- (a) octet rule (b) duplet rule (c) triplet rule (d) none of above

9. When one atom forms cation by losing electron and other forms anion by accepting that electron then bond form between them is:

- (a) Covalent bond (b) Ionic bond (c) coordinate covalent bond (d) hydrogen bond

10. Nobel gases are stable because they contain:

- (a) 4 electrons in valence shell (b) 6 electrons in valence shell
(c) 8 electrons in valence shell (d) 10 electrons in valence shell

11. Bond which involve 3 shared electron pairs is a:

- (a) double covalent bond (b) single covalent bond
(b) triple covalent bond (d) none of above

12. A non-metal atom form anion by

- (a) loses of electrons (b) gain of electrons (c) loses of protons (d) gain of protons

13. When two identical atoms share electron pairs and exert force on each other than bond form is:

- (a) non-polar covalent bond (b) polar covalent bond
(c) double covalent bond (d) co-ordinate covalent bond

14. Synthetic resins are used on places where:

- (a) electric resistance is required (b) water resistance is required
(c) adhesion is required (d) friction is required

15. Oxygen belongs to group VIA so number of electrons in its valence shell are:

- (a) 3 (b) 4 (c) 5 (d) 6



16. Electron pairs which are not shared by atoms are called:

- (a) electron pairs (b) lone pairs (c) bond pairs (d) shared pairs

17. Strength of intermolecular forces from ionic or covalent bond is:

- (a) Weaker (b) stronger (c) equal (d) none of above

18. Ionic crystals have _____ melting points

- (a) high (b) moderate (c) low (d) none of above

19. Bond formed by mutual sharing of electron is:

- (a) ionic bond (b) metallic bond (c) covalent bond (d) co-ordinate covalent bond

20. Which of the following diagram shows atoms are bonded with same electro negativity?

- (a) A ----- ● ----- B (b) A - ● ----- B (c) A --- ● ----- B (d) A ----- ● - - B

