CHAPTER: No.4
Structure of Molecules

Chemical Bond:-

Chemical bond is a force of attraction which hold atoms together to form a compound or a molecule.

Duplet Rule:-

The tendency of an atom to acquire two electron configuration in their valence shell, when bonding is called duplet rule.

Octet Rule:-

The tendency of an atom to acquire eight electron configuration in their valence shell, when bonding is called octet rule.

Page NO. 77 Self Assessment Exercise No. 4.1

Find the number of electrons in valence shell of the following atoms?

a). Silicon:-

We know that silicon belongs to fourth group of the periodic table. So it contains four electrons in its valence shell.

b). Sulphur:-

We know that sulphur belongs to sixth group of the periodic table so it contains six electrons in its valence shell.

c). Bromine:-

We know that bromine belongs to seventh group of the periodic table so it has seven electrons in its valence shell.

Types of Chemical Bond:-

There are two main types of chemical bond.

1. Ionic Bond
2. Covalent Bond

Ionic Bond:-

The chemical bond which is formed between two oppositely charged ions is called ionic bond. When ionic bond is formed then one atom loses electron to form cation and the other atom gains this electron to form anion.

Ionic bond is electrically neutral because total positive charges are equal to total negative charges.

Example:-

The formation of Sodium Chloride (NaCl) is an example of ionic bond.

Formation of Sodium Chloride (NaCl):-

Sodium belongs to group I-A of the periodic table and its electronic configuration is.

$$_{11}Na = 1s^2, 2s^2, 2p^6, 3s^1$$

$$_{11}Na = \underset{K}{1s^2} , \underset{L}{2s^2, 3p^6} , \underset{M}{3s^1}$$

Sodium has two electrons in its first shell, eight electrons in its second shell and only one electron in its valence shell.

Cholrine belongs to group VII –A of the periodic table and its electronic configuration is

$$_{17}Cl = 1s^2, 2s^2, 2p^6, 3s^2, 3p^5$$

Chlorine has two electrons in its first shell, eight electrons in its second shell and seven electrons in its valence shell. Sodium atom loses one electron from its valence shell and chlorine atom gain this electron of sodium in its valance shell.

As a result both sodium and chlorine are left with eight electrons in their valence shell and complete their octet.

As a result of this transfer of electron ionic bond is formed.

Covalent Bond:-

A bond which is formed due to mutual sharing of electrons is called covalent bond.

Example:-

Formation of two hydrogen molecules is an example of covalent bond.

A hydrogen atom has only one electron in its valence shell two hydrogen atoms combine with other and share their electrons. As a result of this sharing of electrons a covalent bond is formed between two hydrogen atoms.

Types of Covalent Bond:-

There are three types of covalent bonds.

1. Single covalent bond

2. Double covalent bond
3. Triple covalent bond

1. Single Covalent Bond:-

A covalent bond which is formed by the sharing of one electron pair is called single covalent bond. It is represented by a single dash (—).

Example:-

Formation of a bond between two fluorine atoms is an example of single covalent bond.

Fluorine belongs to group VII A of the periodic table so it has seven electrons in its valence shell. It needs only one electron to complete its octet. Therefore two fluorine atoms combine with each other and share their electrons with each other. As a result of this sharing both fluorine atoms complete their octet.

2. Double Covalent Bond:-

A covalent bond which is formed by the sharing of two electron pair is called double covalent bond. It is represented by a two dashes (=).

Example:-

Formation of a bond between two oxygen atoms is an example of double covalent bond. Oxygen atoms belongs to group VI-A of the periodic table so it has six electrons in its valence shell. It needs two more electrons to complete its octet. Therefore two oxygen atoms combine with each other and share two electrons with each other. As a result of this sharing two oxygen atoms complete their octet.

3. Triple Covalent Bond:-

A covalent bond which is formed by the sharing of these electron pairs is called triple covalent bond. It is represented by three dashes (≡).

Example:-

Formation of a bond between two nitrogen atoms is an example of triple covalent bond. Nitrogen atom belongs to group V-A of the periodic table so it has five electrons in its valence shell. It needs three more electrons to complete its octet. Therefore two nitrogen atoms are combine with each other and share three electrons with each other. As a result of this sharing both nitrogen atoms complete their octet.

Page no 78 Example no. 4.2

Describe the formation of Na^+ and Mg^{+2} Cations.

(i) Formation of Na^+ cations:-

Sodium (Na) belongs to group IA of the periodic table. It has one electron in its valance shell. Its electronic configuration is

$$_{11}Na = 1s^2, 2s^2, 2p^6, 3s^1$$
$$= 2, 8, 1$$

Sodium (Na) 1oses one electron from its valence shell and left with octet. After loosing one electron Na^+ cation is formed. The electron dot structure is

(ii) Formation of Mg^{+2} cations:-

Magnesium belongs to group IIA of the periodic table. It has two electrons in its valence shell. Its electronic configuration is

$$_{12}Mg = 1s^2, 2s^2, 2p^6, 3s^2$$
$$= 2, 8, 2$$

Magnesium (Mg) loses two electrons from its valence shell and left with octet. After losing two electrons Mg^{+2} cations are formed.

The electron dot structure is

Page no 79 Self Assessment Exercise 4.2

Describe the formation of cations for the following metal atoms.

(a) Li (Atomic no.3)

(b) Al (Atomic No. 13)

(A) Li (Atomic no.3)

Lithium (Li) belongs to group IA of the periodic table so it has one electron in its valence shell its electronic configuration is

$$\underset{3}{Li} = 1s^2, 2s^1$$
$$= K, L$$
$$2, 1$$

Lithium loses one electron from its valence shell and left with, duplet. After losing one electron 'Li^{+1}' cation is formed. The electron dot structure is

(B) Al (Atomic no.13)

Aluminum belongs to group III-A of the periodic table so it has three electrons in its valence shell. Its electronic configuration is.

$$\underset{13}{Al} = 1s^2, 2s^2, 2p^6, 3s^2, 3p^1$$
$$= K, L, M$$
$$2, 1 \quad 3$$

Aluminum loses three electrons from its valence shell and left with octet. After losing these electrons 'Al^{+3}' cations are formed.

The electrons dot structure is

Polar Covalent Bond:-

Such a covalent bond in which two different atoms share their electrons with each other is called polar covalent bond.

Example:

The covalent bond between hydrogen atom and chlorine atom is a polar covalent bond.

Non-Polar Covalent Bond:-

Such a covalent bond is which two similar atoms share their electrons with each other is called non-polar covalent bond.

Example:

The covalent bond between two hydrogen atoms is non-polar covalent bond.

Intermolecular Forces:-

The forces of attraction between the molecules of a compound are called intermolecular forces. These intermolecular forces are much weaker than bonding forces.

Types of Intermolecular Forces:-

There are two main types of intermolecular forces.

1. Dipole- dipole forces.
2. Hydrogen Bonding

1. Diploe-Dipole Interaction (Forces):-

The forces of attraction between the positive end of one polar molecule and the negative end of the other polar molecule is called dipole-dipole forces or dipole-dipole interaction. Dipole-dipole forces are weak forces. If an element has strong dipole- dipole forces than it has high melting and boiling point.

2. Hydrogen Bonding:-

The interaction of a highly electron deficient hydrogen and lone pair on near by electronegative atom such as 'N' 'O' or 'F' is called hydrogen bond and this process is called hydrogen bonding.

EXERCISE QUESTIONS

Page No. 95 Questions No. 2 (i)

i. State octet and duplet rule?

Ans. Octet Rule:-

The tendency of atoms to acquire eight electron configuration in their valence shell when bonding is called octet rule.

Duplet Rule:-

The tendency of atoms to acquire two electrons configuration in their valence shell when bonding is called duplet rule.

Questions No.2 (ii)

ii. Explain formation of covalent bond between two nitrogen atoms?

Ans. Nitrogen belongs to group V-A of the periodic table so it has five electrons in its valence shell. It needs three more electrons to complete its octet

Two nitrogen atoms combine with each other and share three electrons with each other. In this way both nitrogen atoms complete their octet.

Question No.2 (iii)

iii. How does Al form Cation:-

Ans. Aluminum belongs to group III A of the periodic table so it has three electrons in its valence shell. Its electronic configuration is

$$\underset{13}{Al} = 1s^2, 2s^2, 2p^6, 3s^2, 3p^1$$

$$= K, L, M$$

$$2, 8, 3$$

Aluminum loses three electrons from its valence shell and left with octet. After losing these electrons 'Al^{+3}'cations are formed. The electrons dot structure is

Question No.2 (iv)

iv. How does 'O' form anion?

Ans. Oxygen belongs to group VI-A of the periodic table. So it has six electrons in its valence shell. It needs two more electrons electrons to complete it's octet. The electronic configuration of oxygen is

$$_{8}O = 1s^2, 2s^2, 2p^4,$$
$$= K, L,$$
$$2, 6$$

The electron dot structure is

Question No.2 (v)

v. Draw Electron cross and dot structure for H_2O molecule?

Ans. In water (H_2O) molecule oxygen has six electrons in its valence shell and it needs two more electrons to complete its octet.

In water (H_2O) molecule hydrogen has one electron in its valence shell and it needs one more electron to complete its duplet.

The oxygen atom has more electron's than hydrogen atom therefore oxygen atom is the central atom.

Page No. 95 Question No.3

Qno. 3 – Describe the importance of noble gas electronic configuration?

Ans.

Nobel gases are called stable elements because their valence shell is completely filled. All other elements try to achieve the electronic configuration of noble gases. To get electronic configuration of noble gases elements lose or gain electrons.