4

STRUCTURE OF MOLECULES

This is a 20 days lesson

After completing this lesson, you will be able to:

- Find the number of valence electrons in an atom using the Periodic Table
- Describe the importance of noble gas electronic configurations.
- Describe the formation of cations from an atom of a metallic element. Describe the formation of anions from an atom of a non-metallic element.
- Describe the ways in which bonds may be formed.
- Describe the formation of a covalent bond between two nonmetallic elements.
- Describe with examples single, double and triple covalent bonds.
- Draw electron cross and dot structures for simple covalent molecules containing single, double and triple covalent bonds.
- Explain how element attain stability.
- Recognize a compound as having ionic bonds. Identify characteristic of ionic compounds.
- State the octet and duplet rules
- State the importance of the noble gas electronic configurations in the formation of ion.

Pre- Reading

All the matter in this world is composed of almost entirely compounds and their mixtures. Human, animal and plant bodies, rocks, soil, petroleum, coal etc. are all complex mixtures of compounds. In compounds different kinds of atom are bounded together. Few elements also consist of unbounded atoms. For instance helium, neon, argon, xenon and krypton present in the atmosphere consist of unbounded atoms. The manner in which various atoms are bonded together has a profound effect on the properties of substances.

Some substances are hard and tough, others are soft and flexible why? Resins are widely used to paint dams, bridges, buildings and automobiles. What makes them sticky? How do adhesives such as glue bind two surfaces together? What is the nature of such linkages? The answer lies in the nature of bonding and structure of their molecules. Therefore, to understand the behaviour of various substances, you must understand the nature of chemical bonding and structure of molecules.

Reading

4.1 WHY DO ATOMS REACT?

In chapter 3, you have learned the arrangement of elements on the periodic table. You noticed that each period on the periodic table starts with alkali metal (except period I that starts

with hydrogen) and ends at a noble gas. The noble gases have ns^2np^6 electronic configuration in the outer most shell. These elements are sometimes called the inert gases. This is because they do not participate in chemical reactions. Electronic configurations of first three noble gases are shown below:

$$He = 1s^2$$

$$Ne = 1s^2 2s^2 2p^6$$

$$Ar = 1s^2\ 2s^2 2p^6 3s^2 3p^6$$

Note that these elements have completely filled outer most s and p sub-shells. Helium contains two electrons and remaining noble gases contain 8 electrons in the valence shell. Because of these configuration noble gases are stable and not active. In 1916 a chemist G.N. Lewis used this fact to explain why atoms undergo chemical reactions. He called his explanations as Octet Rule. An octet is a set of eight. In forming compounds, atoms tend to gain electronic configuration of a noble gas. Remember that each noble gas (except He) has eight electrons configuration in the valence shell. Thus the octet rule takes its name from this fact about noble gases.

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

Helium has two electrons in its valence shell and is also chemically inert. Some elements that are close to He on the periodic table tend to achieve two electron configuration in their valence shell. For example hydrogen, lithium and beryllium etc tend to achieve two electron configuration in the valence shell.

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

Example 4.1: Obtaining the number of valence electrons in an atom using the periodic table.

Find the number of valence electrons in the following atoms using the periodic table.

(a) Carbon (b) Magnesium (c) Phosphorus

Problem Solving Strategy:

Remember that the group number of main group elements indicates the number of valence electrons in an atom. Check the group number of the elements in the periodic table and find the number of valence electrons.

Solution:

(a) Carbon belongs to Group IVA, so it contains four electrons in the valence shell.

(b) Magnesium belongs to Group IIA, so it contains two electrons in the valence shell.

(c) Phosphorus is present in Group VA, so it has five electrons in the valence shell.

Self-Assessment Exercise 4.1

Find the number of electrons in valence shell of the following atoms using the periodic table. (a) Silicon (b) Sulphur (c) Bromine (d) Argon (e) Potassium (f) Nitrogen

Reading

4.2. CHEMICAL BONDS

Atoms combine to form various types of substances. But what holds them together? Fundamentally, some forces of attraction hold atoms together in substances. These forces are called chemical bonds. Basically the forces of attraction that lead to chemical bonding between atoms are electrical in nature. Electronic structure of an atom helps us to understand how atoms are held together to form substances. Atoms other than the noble gases have a tendency to react with other elements. These elements are reactive because they tend to gain stability by loosing or gaining electrons. When atoms gain or lose electron they acquire the configuration of next noble gas element.

Atoms can also acquire the configuration of next noble gas element by sharing electrons.

4.3 TYPES OF BONDS

Depending on the tendency of an atom to lose or gain or share electrons, there are two types of bonds:

1. Ionic bonds
2. Covalent bonds

4.3.1 Ionic Bonds

Ionic bonds are formed between two atoms, when one atom loses electron to form cation and the other atom gains this electron to form anion.

Example 4.2: Describing the formation of cations.

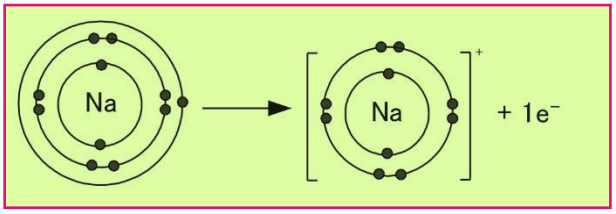
Describe the formation of Na^{+} and Mg^{+2} cations.

Problem Solving Strategy:

1. Sodium belongs to Group IA on the periodic table. It has only one electron in the valence shell. Sodium atom loses its valence electron and is left with an octet. Represent this by drawing the complete electronic configuration or using an electron dot structure.
2. Magnesium belongs to Group IIA in the periodic table. It has two valence electrons. Magnesium atom loses these electrons to achieve noble gas configuration. Represent

this by drawing the complete electronic configuration or using an electron dot structure. This number also corresponds to the Group number in the periodic table.

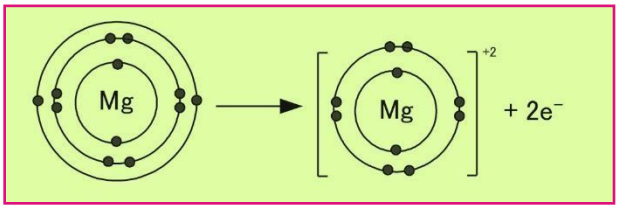
Solution:



(a) Formation of Na^+ ion

$$Na\ 1s^2\ 2s^2\ 2p^6\ 3s^1 \xrightarrow{-\bar{e}} Na^+\ 1s^2\ 2s^2\ 2p^6$$

You can also represent this by following electron dot structure,



(b) Formation of Mg^{+2} ion

$$Mg\ 1s^2\ 2s^2\ 2p^6\ 3s^2 \xrightarrow{-2e} Mg^{+2}\ 1s^2\ 2s^2\ 2p^6$$

You can also represent this by electron dot structure,

Self-Assessment Exercise 4.2

1. Describe the formation of cations for the following metal atoms:
   (a) Li(atomic no 3)
   (b) Al(atomic no. 13)
2. Represent the formation of cations for the following metal atoms using electron dot structures.
   (a) K (b) Ca

Example 4.3: Describing the formation of anions.

Describe the formation of anions for the following non-metal atoms:
(a) Oxygen(atomic no.8) (b) Fluorine (atomic no. 9)

Problem Solving Strategy:

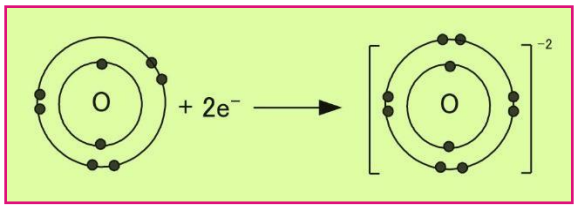
1. Write electronic configuration or dot structure.
2. Find the number of electrons needed to acquire eight electron configuration.
3. Represent addition of electrons.

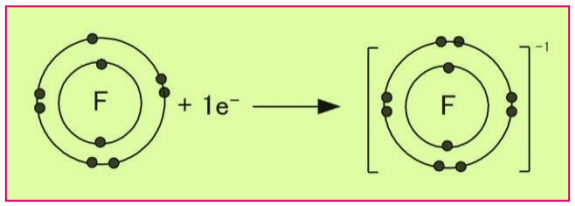
Solution:

(a) Formation of anion by oxygen atom.

Oxygen belongs to Group VIA on the periodic table. So it has six electrons in its valence shell. It needs two electrons to achieve noble gas configuration.

$$O\ 1s^2 2s^2 2p^4 + 2e^- \downarrow\downarrow\rightarrow O^{-2}\ \ 1s^2\underbrace{2s^2\ 2p^6}_{\text{octet}}$$





You can also represent this by electron dot structure,

(b) Formation of anion by fluorine atom

Fluorine belongs to Group VIIA on the periodic table. So it has seven electrons in the valence shell. A fluorine atom therefore, requires only one electron to complete octet.

$$F\quad 1s^2 2s^2 2p^5 + e^- \downarrow\downarrow\rightarrow F\quad 1s^2\underbrace{2s^2\ 2p^6}_{\text{octet}}$$

You can also represent this by electron dot structure,

Self-Assessment Exercise 4.3

1. Describe the formation of anions by the following non-metals.
   (a) Sulphur (atomic No. 16)
   (b) Chlorine(atomic No. 17)
2. Represent the formation of anions by the following non-metals using electron dot structures.
   (a) N (b) P (c) Br (d) H

Anions and cations have opposite charges. They attract one another by electrostatic forces. **"The forces of attraction that bind oppositely charged ions are called ionic bonds"**. 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 as a whole are electrically neutral.

Example 4.4: Representing ionic bond formation.

For each of the following pairs of atoms, use electron dot & electron cross structures to write the equation for the formation of ionic compound.

(a) Na and Cl (b) Mg and F

Problem Solving Strategy:

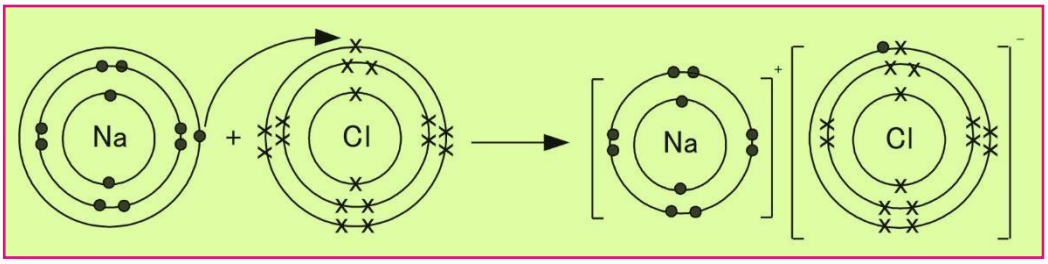
1. The metal atoms form cations and non-metal atoms form anions.
2. The number of electrons lost by metal atoms of group IA, IIA and IIIA equals the group number.

3. To write the final form of the equation, you need to know the simplest ratio of cations to anions that you require for the neutral compound.
4. Write equation using electron dot & electron cross structures.

Solution:

(a) Na is metal and Cl is non-metal.

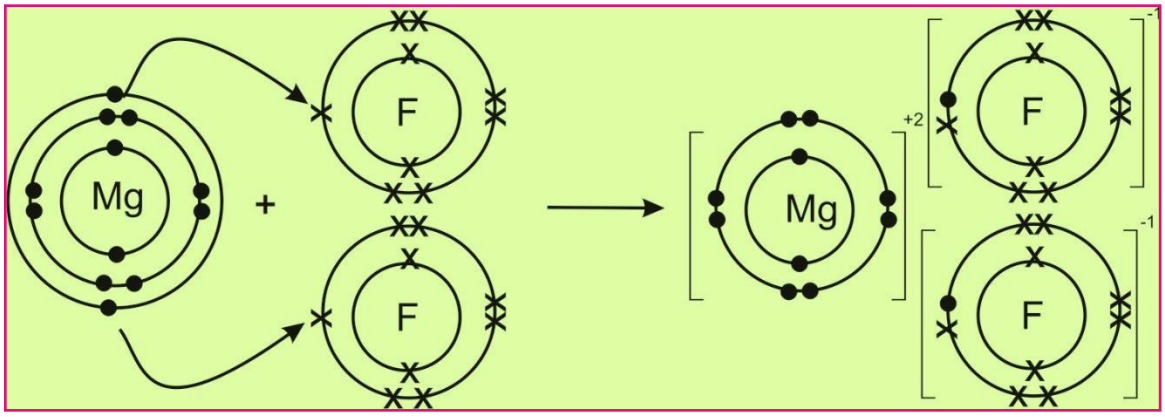
Metal atom tends to lose electrons and non – metal atoms tends to gain electrons to acquire electronic configuration of nearest noble gas. Since Na atom has one electron in the outer most shell. It losses one electron to form Na^+ ion. Since Cl atom has seven electrons in outermost shell, it needs one electron to complete octet. So it gains one electron to form Cl^- ion. For every Na^+ ion, you need one Cl^- ion.



(b) Mg is metal and F is non-metal.

Mg atom has two electrons in the outermost shell. It losses two electrons to form Mg^{+2} ion. Since F atom has seven electrons in the outermost shell, so it gains one electron to form F^- ion.

For every Mg^{+2} ion you need two F^- ions.



Self-Assessment Exercise 4.4

For each of the following pairs of atoms, use electron dot and electron cross structures to write the equation for the formation of ionic compound.

(a) Mg and O (b) Al and Cl

Example 4.5: Recognizing a compound as having ionic bonds.

Recognize the following compounds as having ionic bonds.

(a) MgO (b) NaF

Problem Solving Strategy:

1. The metal atom loses electrons to form cations and non-metal atom gains electrons to form anions.
2. The number of electrons lost by metal atoms of group IA, IIA and IIIA equals the group number. The number of electrons gained by the non-metal atoms is equal to 8 minus group number.
3. Find the simplest ratio of cations to anions, to identify the compound.

Solution:

(a) MgO

Mg is metal and O is non-metal. Mg atom has two electrons in outermost shell. So it loses two electrons to form Mg^{+2} ion. Since O atom has six electrons in outermost shell, so it gains two electrons to form O^{-2} ion. In this way both the atoms acquire nearest noble gas configuration. For every Mg^{+2} ion you need one O^{-2} ion. Chemical formula of resulting compound is MgO. Therefore MgO is an ionic compound.

(b) Na is metal and F is non-metal. Na atom has one electron in outmost shell. So it loses one electron to form Na^{+} ion. Since F atom has seven electrons in outermost shell, so it gains one electron to form F^{-} ion. Na atom by losing one electron and F atom by gaining one electron acquire nearest noble gas electronic configuration. You need one F^{-} ion for each Na^{+} ion. Therefore, NaF is an ionic compound.

Self-Assessment Exercise 4.5

Recognize the following compounds as having ionic bonds:

(a) KCl (b) $AlCl_3$ (c) MgF_2

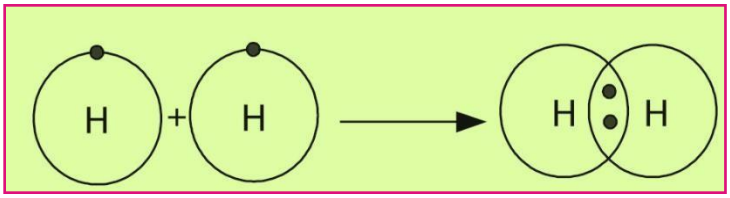
Reading

4.3.2 Covalent Bonds

In the preceding section you have learned the formation of ionic bonds between two atoms. Ionic compounds such as NaCl, are crystalline solids with high melting points. However, some compounds have very different properties. HCl is a gas at room temperature. Water (H_2O) is a liquid. Such compounds are not ionic. These compounds are made up of non-metal atoms. Non–metals have high ionization energies, therefore, they do not lose electrons. Non–metal

atoms tend to share electrons among themselves or with other non–metal atoms to form a chemical bond called covalent bond. **A Covalent bond is formed by mutual sharing of electrons between two atoms.**

Consider the formation of covalent bond in hydrogen molecule. A hydrogen atom has a single valence electron. Two hydrogen atoms share their valence electrons to form a diatomic molecule.

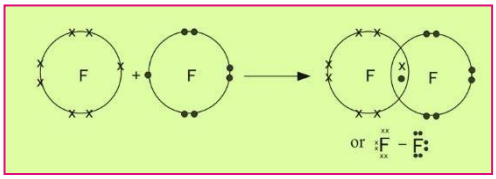


$H^{\cdot} + {}^{\cdot}H \rightarrow H:H$ shared pair of electrons

In the formation of this molecule, each hydrogen atom achieves the electron configuration of the noble gas, helium which has two valence electrons. An electron pair in the region between the two atoms is attracted to both hydrogen nuclei. This means it is a more stable situation than that exists in separate atoms. Because of this stability two atoms form a covalent bond.

We can represent the formation of a covalent bond between two atoms using electron-dot and electron-cross symbols for the atoms and the resulting molecule. As already discussed that valence electrons are represented by dots. Just to understand sharing, we represent valence electrons in one atom by dots and in the other atom by crosses. However, remember that all the electrons are identical and cannot be differentiated. A shared pair of electrons is also represented by a dash (-) in a molecule.

Consider the formation of a bond between two fluorine atoms. Fluorine belongs to Group VIIA, so it has seven electrons in the valence shell. It needs one more electron to attain the electron configuration of a noble gas. Thus two F-atoms share an electron pair and achieve electron configuration of Ne. For sharing each F-atom contributes one electron to complete the octet.

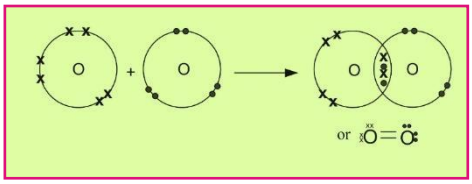


Pairs of valence electrons which are not shared between atoms are called unshared pairs or lone pairs.

Covalent bond that is formed by the sharing of one electron pair is called single covalent bond. So H_2 and F_2 molecules contain a single covalent bond.

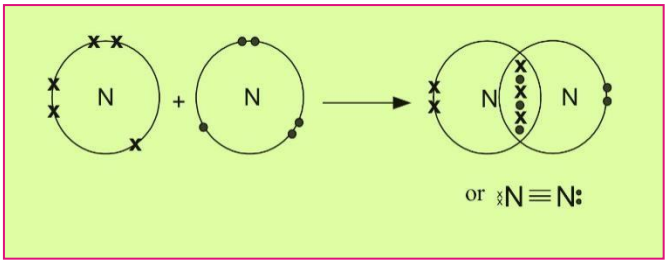
Can you explain the formation of covalent bond between H-atom and a F-atom?

Sometimes atoms may share two or three electron pairs to complete octet. **Double covalent bonds are the bonds that are formed by sharing of two electron pairs. Triple covalent bonds are the bonds that involve three shared pairs of electrons.**



Teacher's Point

A teacher may show bonds to students by balls and springs.



Consider the formation of O_2 molecule. Oxygen is in Group VI A, so it has 6 electrons in the valence shell. It needs two electrons to complete its octet. So for sharing each O-atom contributes two electrons.

Can you explain the formation of N_2 molecule?

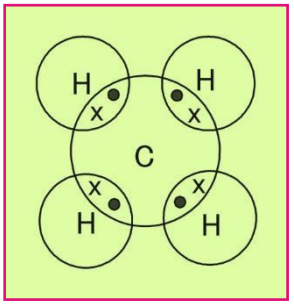
Example 4.6: Drawing electron cross and dot structures for simple covalent molecules containing single covalent bonds

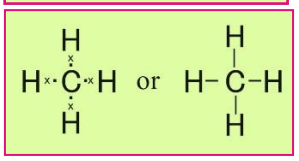
Draw electron cross and dot structures for (a) CH_4 that is a major component of natural gas (b) H_2O that covers about 80% of the earth crust.

Problem Solving Strategy:

1. Decide from the chemical formula which atom is the central atom. An atom that contributes more electrons for sharing is the central atom. Show its valence electrons by dots. Note the number of electrons it needs to complete octet. If the number of electrons needed equals the other atoms, each atom will form a single covalent bond.
2. Arrange other atoms around the central atom. Connect the central atom by single bonds. Use cross to represent electrons of the other atoms.
3. Check whether the arrangement of electron satisfies the octet rule.

Solution:





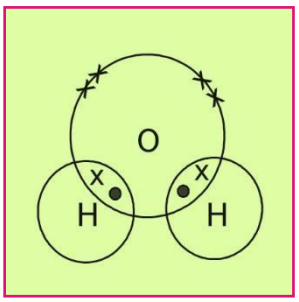
(a) CH_4

(i) C has four electrons in the valence shell and needs four electrons to complete its octet. H has only one valence electron and needs one electron to complete duplet. So C can form four single bonds with four H-atoms. C is the central element.

(ii) Connect the atoms with a dot and a cross

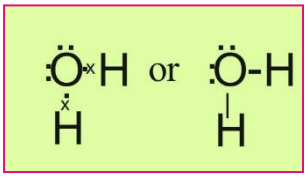
H_2O

(i) O has six valence electrons $:\ddot{O}:$ and each hydrogen atom has one valence electron $\overset{x}{H}$. So O-atom needs two electrons to complete octet. Each H needs one electron to complete duplet.



(ii) O is central atom and will form two single bonds with H-atoms.

(iii) Arrange H-atoms around O and connect them by a pair of electrons (one dot and one cross)



Self-Assessment Exercise 4.6

Draw electron cross and dot structures for the following molecules:

(a) NH_3 that is used to manufacture urea.

(b) CCl_4, a dry cleansing agent.

(c) $SiCl_4$, used to make smoke screens.

(d) H_2S, a poisonous gas.

Example 4.7: Drawing electron cross and dot structures for molecules containing multiple bonds

Draw electron cross and dot structures for the following molecules:

(a) CO_2, a component of air and is responsible for green house effect.

(b) HCN, used as insecticide.

Problem Solving Strategy:

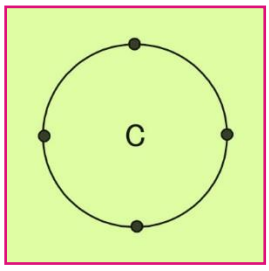
1. Decide from the formula which atom is to be in the center. Show its valence electrons by dots. Note the number of electrons it needs to complete octet.
2. Show valence electron of the other atoms by cross and find the number of electrons each of the atoms needs to complete octet or duplet.
3. Connect central atom with the other atoms by electron pair or pairs to satisfy the octet rule.

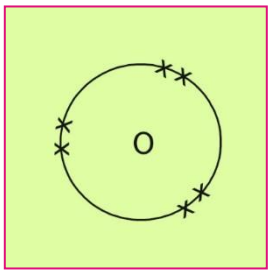
Solution:

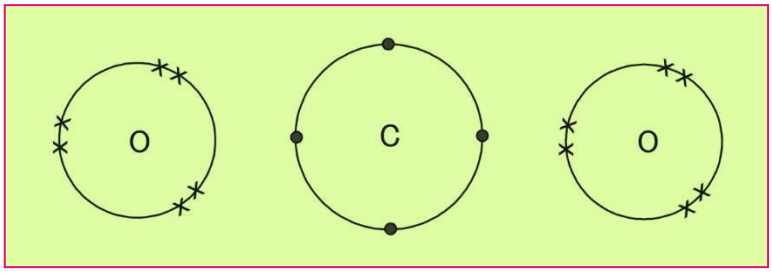
(a) CO_2

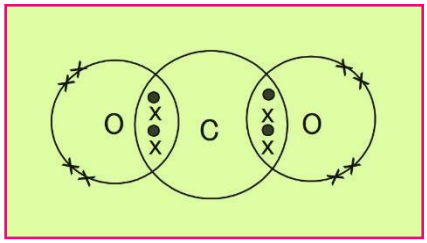
(i) C has four electrons in the valence shell. It needs four electrons to complete octet.

(ii) Each oxygen atom has six valence electrons and needs two electrons to have an octet.









(iii) C is central atom, arrange O-atoms around it.

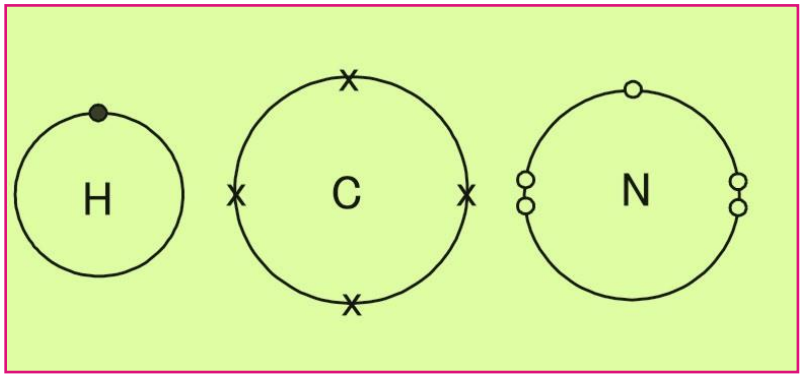
(iv) Since C needs four electrons and there are only two oxygen atoms. So it will share its two electrons with each oxygen atom.

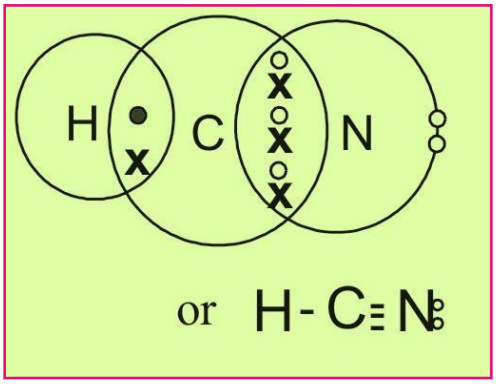
or $\ddot{O}=C=\ddot{O}$

(b) HCN

(i) H has one, C has four and N has five electrons.

(ii) C needs four and N needs three electrons. So C shares one electron with H to form a single bond and three electrons with N to form a triple bond. This will satisfy octet rule.





Self-Assessment Exercise 4.7

Draw electron cross and electron dot structures for the following molecules:

(a) CS_2 an organic solvent that dissolves sulphur, phosphorus etc

(b) N_2 a component of air.

Reading

4.4 INTERMOLECULAR FORCES

A covalent bond can occur between two similar atoms such as in H_2, N_2, O_2, Cl_2 etc. It can also occur between two unlike atoms, such as in HCl, H_2O, NH_3, HCN, CO_2 etc.

When two identical atoms share electron pairs, both the atoms exert same force on the shared electron pairs. Such a covalent bond is called non-polar covalent bond. For example, bond in H-H, O = O, N ≡ N etc are non-polar covalent bonds. On the other hand, when two different atoms share electron pair, both the atoms exert different forces on the shared electron pair. More electronegative atom pulls shared electrons pairs with greater force towards itself then the other. So more electronegative atom partially draws electron density towards itself. This makes it partially negatively charged and other atom partially positively charged. Such a covalent bond is called polar covalent bond. The forces of attraction thus created between the molecules are called intermolecular forces. For example,

$H^{+\delta}-Cl^{-\delta}, H^{+\delta}-\underset{\underset{H^{+\delta}}{|}}{O^{-\delta}}$ etc.

These intermolecular forces are weaker than an ionic or a covalent bond. There are several types of intermolecular forces. We will discuss two of these. Dipole-dipole interactions occur between polar molecules. Figure 4.1 shows these interactions

You know that paints and dyes are used to protect solid surfaces from the atmospheric effects. They also give visual appeal. Resins are used to coat materials that give toughness, flexibility, adhesion and chemical resistance. For example dams, bridges, floors, trains, buses, cars etc are painted with resins. The synthetic resins are used where water resistance is required. Chemically, resins are either adhesive or they form bond linkages with the material being bonded together. What is the nature of these linkages?

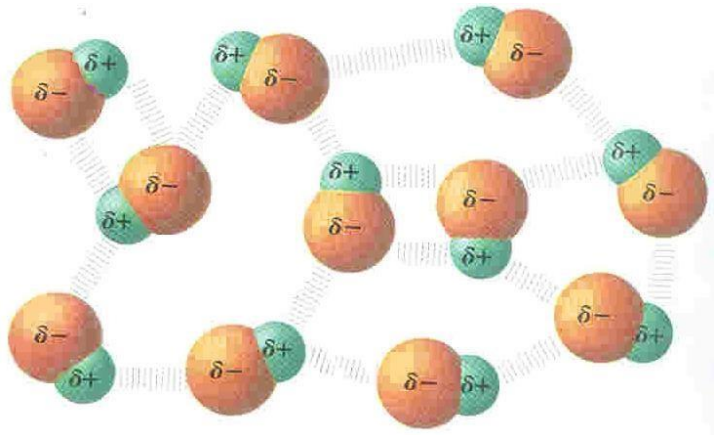


Fig 4.1: Dipole-Dipole interactions

Notice that slightly negative end of polar molecule is weakly attracted to the slightly positive end of another molecule. Such attracting forces are called dipole-dipole interactions.

Molecules in which hydrogen is covalently bonded to a very electronegative atom such as oxygen, nitrogen or fluorine is also weakly bonded to a lone pair of electron of another electronegative atom. This other atom may occur in the same molecule or in a nearby molecule. This intermolecular interaction is called hydrogen bonding. Oxygen, nitrogen or fluorine makes hydrogen very electron-deficient. Thus interaction of such a highly electron deficient hydrogen and lone pair on a nearby electronegative atom compensates for the deficiency. Figure 4.2 shows hydrogen bonding in water molecules.

The interaction of a highly electron deficient hydrogen and lone pair on a nearby highly electronegative atom such as N, O or F is called hydrogen bond. This phenomenon is called hydrogen bonding.

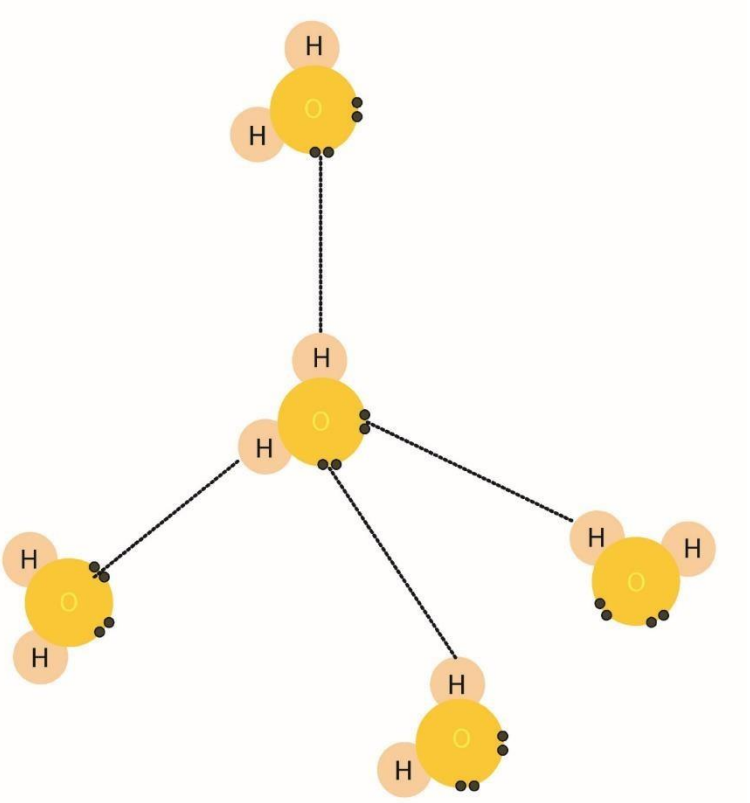


Fig 4.2: Hydrogen bonding in water

Society, Technology and Science

Epoxy adhesives have excellent chemical resistance, good adhesion properties, good heat resistance and they form strong and tough coating. Therefore, propellers and parts of aircraft, boats, cars, trucks etc are held together by epoxy adhesives. Epoxy adhesives contain partially positively charged H-atoms and oxygen atoms containing lone pairs in their molecules. Epoxy adhesives are, therefore, sticky and can make H-bonds with other substances. Modern aircraft, boats and automobiles such as cars, trucks etc and even in space craft epoxy adhesives are used for assembling, saving money and reducing weight. This means glues and adhesives have become an essential item in our daily life.

These intermolecular forces are extremely important in determining properties of water, biological molecules, such as proteins, DNA etc and synthetic materials such as glue, paints, resins etc. The adhesive action of paints and dyes is developed due to hydrogen bonding. Synthetic resins bind two surfaces together by hydrogen bonding or dipole-dipole interactions.

4.5 NATURE OF BONDING AND PROPERTIES

Compounds that consist of ions joined by electrostatic forces are called ionic compounds. At room temperature most of the ionic compounds are crystalline solids. Figure 4.3 shows arrangement of ions in NaCl and CsCl crystals.

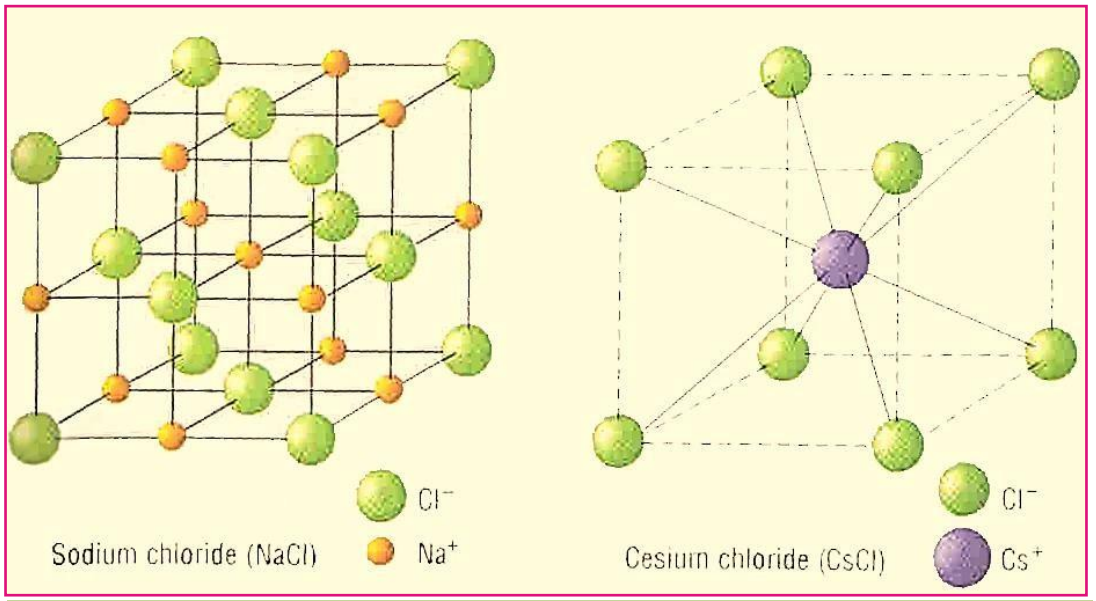


Fig 4.3: Arrangement of ions in NaCl and *CsCl crystals*

Note that both NaCl and CsCl form colorless cubic crystals. Each Na^+ ion is surrounded by six Cl^- ions and each Cl^- ion is surrounded by six Na^+ ions. Internal structure of CsCl is different from NaCl. In CsCl each Cs^+ ion is surrounded by eight Cl^- ions and each Cl^- ion is surrounded by eight Cs^+ ions. Thus in crystals each ion is attracted strongly to each of its neighbours. The large attracting forces result in a very stable structure. So ionic compounds have high melting points. For example, melting point of NaCl is 801°C.

Teacher's Point

A teacher may ask the students to make a model of NaCl

When melted ionic compounds conduct electricity, figure 4.4 shows that NaCl melts and the Na^+ and Cl^- ions are free to move throughout the molten salt. When voltage is applied, Na^+ ions move towards negative electrode. At the same time, Cl^- ions move towards positive electrode. This movement of ions inside a cell is responsible for flow of electricity between the electrodes in the external wire.

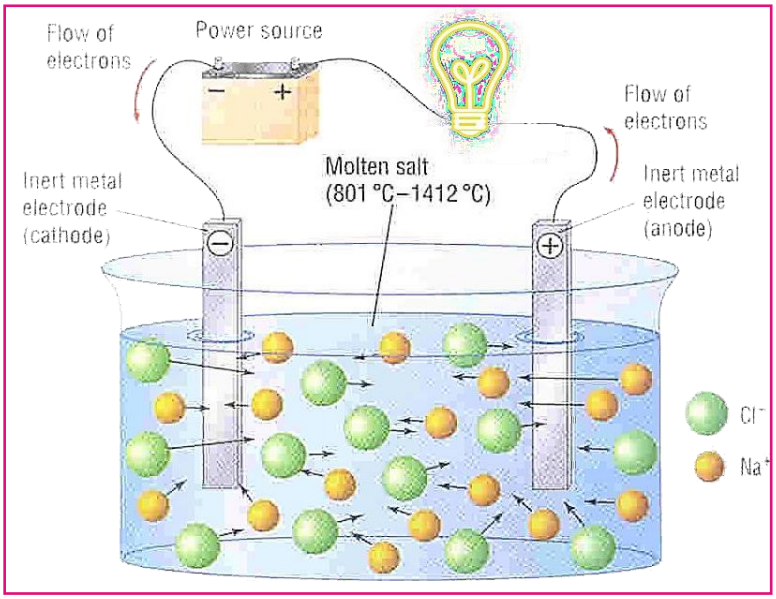


Figure 4.4: conduction of electricity through molten NaCl

Aqueous solutions of ionic compounds also conduct electricity. This is because when an ionic compound dissolves in water, the ions are free to move about in the aqueous solution.

Society, Technology and Science

Synthetic adhesives such as glues and epoxy resins are used in large scale industrial applications. Glues are less costly than synthetic adhesives. Glues are extensively used as an adhesive for veneer, plywood, corrugated cartons and laminated boards. Glues for glass and metal are also available. Epoxy resins are used where water resistance is required. They form strong and tough coating. They also give flexibility and chemical resistance. For these reasons, dams, bridges, thermal power stations are coated with epoxy resins. In modern air craft and automobile epoxy resin adhesives are used for assembling, saving money and reducing weight. Hence there is a need for more adhesives.

Key Points

- An octet is a set of eight. In order to gain stability atoms tend to gain electron configuration of nearest noble gas.
- The tendency of atoms to acquire eight electron configuration in their valence shell, when binding is called octet rule.
- Ionic bonds are formed between two atoms, when one atom loses electrons and other atom gains these electrons. The force of attraction that binds oppositely charged ions is called ionic bonds.
- Ionic compounds have high melting points. They conduct electricity in molten state.
- A bond that is formed by the sharing of electrons between two atoms is called a covalent bond. A covalent bond can be single, double or triple.
- The interaction of a highly electron deficient hydrogen and lone pair on a nearby electronegative atom is called hydrogen-bond.

- The adhesive action of paints and dyes is developed due to hydrogen bonding.

REFERENCES FOR ADDITIONAL INFORMATION

- Lawarie Ryan, Chemistry for you.
- Iain Brand and Richard Grime, Chemistry (11-14).
- Silberg, Chemistry.
- Raymond Chang, Essential Chemistry.

Review Questions

1. Encircle the correct answer:

(i) Which of the following atoms will form an ion of charge -2?

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

(ii) Which of the following atoms will not form cation or anion.

a. A (Atomic No. 16)
b. B (Atomic No. 17)
c. C (Atomic No. 18)
d. D (Atomic No. 19)

(iii) Which of the following atoms will form cation.

	Atomic Number		Atomic Number
(a)	20	(b)	18
(c)	17	(d)	15

(vi) Which of the following atoms obey duplet rule?

(a) O_2 (b) F_2 (c) F_2 (d) N_2

(v) Silicon belongs to Group IVA. It has_____electrons in the valence shell

(a) 2 (b) 3 (c) 4 (d) 6

(vi) Phosphorus belongs to third period of Group VA. How many electrons it needs to complete its valence shell.

(a) 2 (b) 3 (c) 4 (d) 5

(vii) In the formation of AlF_3, aluminum atom loses_____electrons.

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

(viii) Which of the following is not true about the formation of Na_2S :

(a) Each sodium atom loses one electron
(b) Sodium forms cation (c) Sulphur forms anion
(d) Each sulphur atom gains one electron

(ix) Identify the covalent compound

(a) NaCl (b) MgO (c) H_2O (d) KF

2. Give short answers

i. State octet and duplet rules.

ii. Explain formation of covalent bond between two nitrogen atoms

iii. How does Al form cation?

iv. How does O from anion?

v. Draw electron cross and dot structure for H_2O molecule.

3. Describe the importance of noble gas electronic configuration.

4. Explain how elements attain stability?

5. Describe the ways in which bonds may be formed.

6. Describe the formation of covalent bond between two non-metallic elements.

7. Explain with examples single, double and triple covalent bond.

8. Find the number of valence electrons in the following atoms using the periodic table:

(a) Boron (b) Neon (c) Rubidium (d) Barium (e) Arsenic

9. Represent the formation of cations for the following metal atoms using electron dot structures.

(a) Al (b) Sr (c) Ba

10. Describe the formation of anions for the following non-metal atoms:

(a) P (b) Br (c) H

11. Represent the formation of cations for the following metal atoms using electron dot structures.

(a) Mg (b) Li (c) Be

12. For each of the following pairs of atoms, use electron dot and electron cross structures to write the equation for the formation of ionic compound.

(a) K and Cl (b) Ca and S(c) Al and N

13. Recognize the following compounds as having ionic bonds.

(a) $MgCl_2$ (b) KBr (c) NaI

14. An atom of an element has atomic number 9 and mass number 19.

(a) State the number of protons and neutrons in the nucleus of this atom.

(b) State the number of electrons in this atom.

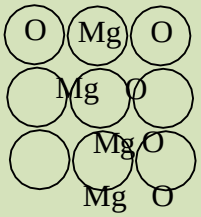
(c) Show with electron cross-dot diagrams, the formation of ions in the reaction of this atom with sodium atom.

15. Is there a need for more adhesives?

16. What is the importance of glues and adhesives in our society?

Think-Tank

1: Magnesium oxide is a compound made up of magnesium ions and oxide ions.

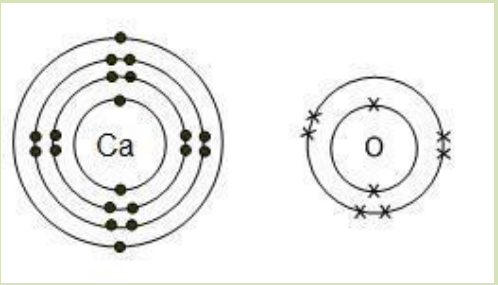


(a) What is the charge on these ions.

(b) How these ions get these charges.

(c) Show with electron cross-dot diagrams the formation of these ions.

2: The diagrams below show the electronic structures of an atom of calcium and an atom of oxygen.



Draw structures of the ions that are formed when these atoms react.

3: Draw electron cross and dot structure for the following molecules:

(a) $COCl_2$, a poisonous gas called phosgene that has been used in World War-II.

(b) HOCl, hypochlorous acid is unstable, decomposes to liberate atomic oxygen that makes HOCl a strong oxidizing agent.

4: The table below shows the properties of four substances:

Substance	Melting point	Electrical Conductivity	
		In solid state	In molten state
A	High	NIL	NIL
B	High	NIL	Good
C	Low	NIL	NIL
D	High	Good	Good

(a) Which substance is a metal?

(b) Which substance is an ionic compound?

(c) Which substance is a covalent compound?

(d) Which substance is a non-metal?

5: Electronic configuration of two elements X and Y are given below:

$X = 1s^2\,2s^2\,2p^6\,3s^2$

$Y = 1s^2\,2s^2\,2p^4$

Predict which of the following compounds is likely to form when X and Y react? Explain.

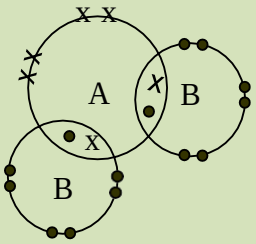
(a) A covalent compound of formula XY_2

(b) An ionic compound of formula XY_2

(c) An ionic compound of formula XY

(d) An ionic compound of formula X_2Y

6: The following figure shows the electron dot and cross diagram of molecule AB_2. Which of the elements could be A and B? Aparise.



7: Illustrate the total number of shared electrons in a molecule of CO_2?