ATOMIC STRUCTURE & CHEMICAL BONDING
SOLVED EXAMPLE

1. State why are noble gases unreactive while atoms of elements other than noble gas are chemically reactive.

Ans. It has been established that if any element has two electrons in all, and these electrons are in the valance shell (duplet structure) or eight electrons in its valance shell, then the element is in the minimum state of energy. Such an element cannot donate/accept/share electrons with other elements and hence does not form a chemical bond.

As noble gases have duplet or octet structure, therefore, they are chemically inactive. However, all other elements do not have structure like that of noble gases. They can donate/accept/share electrons from their valance shell and hence are chemically active.

2. What is the charge on a chloride ion? How does this charge come about?

Ans. (i) The chloride ion has unit negative charge.

(ii) When the chlorine atom (2, 8, 7) accepts one electron so as to have a stable argon like structure, there is one electron in excess, as compared to the number of protons in the nucleus. This in turn makes chloride ion negatively charged.

3. Use the list given below to answer the following questions: List: diamond, sodium chloride, silicon dioxide, methane.

(a) Which substance in the list is an example of a non-polar molecule?

(b) Which substance in the list is an example of an element with giant structure of atoms?

(c) Which substance in the list is an example of giant structure of ions?

(d) Which substance in the list is an example of a compound with giant structure of molecules?

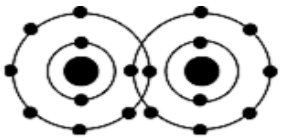
Ans. (a) Methane (b) Diamond (c) Sodium chloride (d) Silicon dioxide

4. Why are metals good conductors of electricity?

Ans. All metals have one to three electrons in their valence shell, which are very loosely held by the nucleus. When an electric p.d. is applied, these almost free electrons start drifting in one particular direction, thereby making the metals good conductor of electricity.

5. Draw a diagram to show valence electrons in a fluorine molecule [F_2].

Ans.



Fluorine molecule [F_2]

6. What is meant by the term "electrovalency"? State why sodium (at.no. 11] has electrovalency +1 and chlorine (at. no. 17) has electrovalency of –1.

Ans. **Electrovalency:**

- ✓ The number of electrons donated (lost) or accepted (gained) by an atom of an element, from its valence shell, such that the ion formed (residual particle) has an electronic configuration of nearest noble gas is called electrovalency of the element.
- ✓ If the electrons are donated, then the electrovalency is said to be positive. If the electrons are accepted, then the electrovalency is said to be negative.
- ✓ Sodium atom [at. no.—11] has 11 protons in its nucleus and its electronic configuration is (2, 8, 1). The sodium atom donates one electron from its valence shell to have the electronic configuration of nearest noble gas neon. However, in doing so, it has 11 protons in its nucleus and 10 electrons. Thus, the residual atom (sodium ion) has a unit positive charge or has electrovalency + 1.
- ✓ Chlorine atom (at. no. 17) has 17 protons in its nucleus and its electronic configuration is [2, 8, 7]. The chlorine atom accepts one electron in its valence shell to have electronic configuration of nearest noble gas argon. However, in doing so, it has 17 protons in its nucleus and 18 electrons. Thus, the residual atom (chloride ion) has a unit negative charge or has electrovalency –1.

7. Why do elements form ions in certain chemical reactions?

Ans. With the exception of noble gases which have eight electrons in their valence shells (He has 2 electrons) and are in the minimum state of energy, all other elements have one to seven electrons in their valence shells. Thus, to attain a state in which they have minimum energy, they either lose or gain electrons, so that their valence shell has eight electrons. However, in doing so their positive and negative charges get unbalanced and hence they form charged ions.

8. Define Electrovalent bond.

Ans. The electrostatic bond formed between two different atoms (usually a metal or a non-metal), such that metallic atom donates all its electrons from the valence shell and the non-metallic atom/atoms accept these donated electrons, with the formation of cations and anions which mutually bind each other is called electrovalent bond or ionic bond.

9. Define Molecular or covalent bond.

Ans. A chemical bond formed between two non-metallic elements by sharing electron pair/pairs from the valence shells of reacting atoms, such that both the atoms acquire the electronic configuration of nearest noble gas is called molecular bond or covalent bond.

10. (a) What do you understand by the term ionic compound?

(b) Name two ionic compounds, stating clearly the charge on each of the participating ion.

(c) Why do ionic compounds have high melting points and high boiling points?

Ans. (a) A compound formed by the donation of electrons from the valence shell of a metal, such that, these electrons are accepted in the valence shell of a non-metal is called ionic compound.

(b) (1) Sodium chloride $Na^{1+}Cl^{1-}$ (2) Zinc oxide $Zn^{2+}O^{2-}$

(c) In an ionic compound the ions are held very strongly due to strong electrostatic forces. Thus, they require a large amount of heat energy, so as to snap the electrostatic bond. Because of this requirement of large amount of energy, ionic compounds have high melting points and high boiling points.

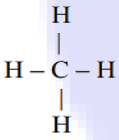
11. (a) What do you understand by the term covalent compound?

(b) Name two covalent compounds, showing clearly the bond/bonds between two participating atoms.

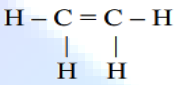
(c) Why do covalent compounds have low melting point and low boiling point?

Ans. (a) A compound formed by mutual sharing of a pair or pairs of electrons by the atoms of two same or different elements, such that each of them has a stable octet structure is called a covalent compound.

(b) (1) Methane [CH_4]



(2) Ethylene



[C_2H_4]

(c) The molecules of a covalent compound are held by weak van der Waals' forces. Thus, a very small amount of energy is required to break the bonding between two molecules. It is because of the requirement of low energy to break molecular bonding, that they have low melting points and low boiling points.

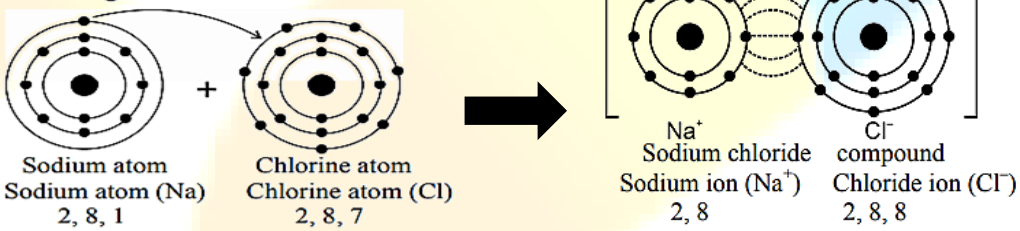
12. Explain with the help of (i) atomic or orbital structural diagram (ii) electron dot diagram, and (iii) ionic equation for the formation of following :

(a) Sodium chloride

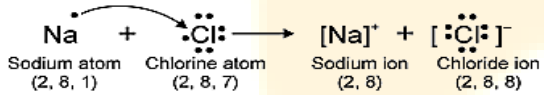
Ans.

(a) Formation of sodium chloride

(i) Structural diagram



(ii) Electron dot diagram



(iii) Ionic Equation :

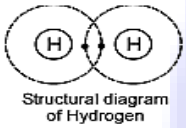
$$Na - e^- \rightarrow Na1^+$$
$$Cl + e^- \rightarrow Cl^{1-}$$
$$Na + Cl \rightarrow Na^{1+}Cl^{1-}$$

13. Explain with the help of (i) orbital or structural diagram, (ii) electron dot diagram, the formation of following molecules, stating the valency of each participating element.

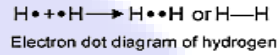
(a) Hydrogen (b) chlorine (c) oxygen

Ans.

(a) Hydrogen (H_2)



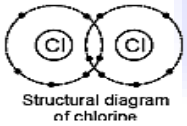
Structural diagram of Hydrogen



Electron dot diagram of hydrogen

Valency of each hydrogen atom in H_2 is 1.

(b) Chlorine (Cl_2)

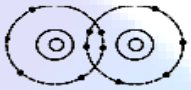


Structural diagram of chlorine

Electron dot diagram of chlorine

Valency of each chlorine atom in Cl_2 is 1.

(c) Oxygen (O_2)



Structural diagram of oxygen

Electron dot diagram of oxygen

Valency of each oxygen atom in O_2 is 2.

14. Why the molecules of hydrogen and chlorine have single covalent bond between their atoms?

Ans. Hydrogen has only one electron in its valence shell, whereas chlorine has 7 electrons in its valence shell. Thus, in order to have a stable electronic configuration of nearest noble gas, they share one electron pair, such that hydrogen has duplet configuration like helium and chlorine has octet configuration like argon.

15. Why the molecules of oxygen have a double covalent bond in between there atoms?

Ans. Oxygen atom has six valence electrons. Thus, in order to have a stable electronic configuration of nearest noble gas neon, each atom of oxygen shares two electron pairs. Thus, a double covalent bond is formed between two atoms of oxygen.

16. Taking sodium chloride as an example of ionic compound and carbon tetrachloride as an example of molecular compound, give two differences between ionic compounds and molecular compounds.

Ans. (1) An ionic compound is a crystalline solid having high m.p., as in case of sodium chloride, whereas molecular compound is a volatile liquid, having low boiling point, as in case of carbon tetrachloride.

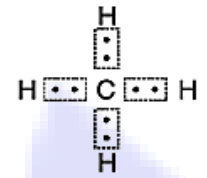
(2) An ionic compound is a good conductor of electricity in its aqueous solution, as in case of sodium chloride, whereas molecular compound is a bad conductor of electricity, as in case of carbon tetrachloride.

17. The hydrogen atom has only one electron and carbon atom has four valence electrons. Write the electronic configuration of:

(i)Methane [CH_4] (ii) Ethylene [C_2H_4]

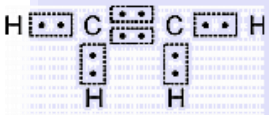
Ans.

(i)



Electronic configuration of methane

(ii)



Electronic configuration of ethylene

18. Sodium atom is highly reactive, but sodium ion is not. Explain.

Ans. Sodium atom has electronic configuration (2, 8, and 1). Because of the presence of one electron in its valence shell, it can easily donate it to any other non-metallic element, and hence is most reactive. Sodium ion has electronic configuration (2, 8…). As its valence shell is of eight electrons like neon gas, therefore, it is non-reactive in nature.

19. What do you understand by the term ionic bond? State at least three conditions for its formation.

Ans. An electrostatic bond formed between a metal and a non-metal, such that the metallic element donates electron/electrons and the non-metallic element accepts electron/electrons, resulting in the formation of cations and anions is called an ionic bond.

Conditions for the formation of ionic bond

1. Electronegativity: More the difference between the values of electronegativity of the combining atoms, more easily the electron transference takes place resulting in the formation of ionic bond.

2. Ionisation potential: Lower the value of ionisation potential of a metallic element, more easily it will form cations and hence result in the formation of ionic bond.

3. Electron affinity: Higher the value of electron affinity of a non-metal, greater the ease with which it accepts electrons in its valence shell to form anions, resulting in the formation of ionic bond.

20. State four periodic properties which are responsible for the formation of ionic compounds.

Ans. (i) Large difference between the values of electronegativity of the combining atoms.

(ii) Large difference between the values of ionisation potential of the combining atoms.

(iii) Large difference between the values of atomic radii of the combining atoms.

(iv) Large difference between the values of electron affinity of the combining atoms.