

CHEMICAL BONDING

SOLVED EXAMPLE

1. Why the melting and boiling points of co-ordinate compounds are higher than covalent compounds and lower than ionic compounds?

Ans. A co-ordinate bond is a union of one electrovalent and one covalent bond, the volatility of these compounds lies between that of covalent and ionic compounds. Thus their melting and boiling points are higher than covalent compounds and lower than ionic compounds.

2. Why is methane molecule regarded as a non-polar covalent compound?

Ans. It has been found that a methane molecule has a three-dimensional tetrahedral structure. The four carbon hydrogen bonds are directed towards the four corners of tetrahedron. In such a configuration, none of the participating atoms is more electrically charged as compared to other atoms. Hence methane molecule is a non-polar covalent compound.

3. Why most of the covalent compounds have density less than that of water?

Ans. The covalent molecules are held very weakly by van der Waal's forces. Thus, there are large inter molecular spaces between the molecules. In other words the number of molecules per unit volume is less. Thus mass per unit is also less and hence, covalent compound have low density.

4. Why hydrogen chloride can be termed as a polar covalent compound?

Ans. Pure covalent bond exists between two elements which have similar electronegativity's. In hydrogen chloride, chlorine being more electronegative attracts the shared pair of electrons towards itself. As a result hydrogen acquires partial positive charge and chlorine gets partial r negative charge. Thus, hydrogen chloride can be termed as a polar covalent compound.

5. Why most of the covalent compounds have density less than that of water?

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6. Why covalent compounds have low melting point and boiling point?

Ans. The force of attraction between the molecules is very weak and so the amount of energy needed to separate them is small, consequently they have low melting points and boiling points.

7. Why all covalent compounds are bad conductor of electricity?

Ans. The covalent compounds do not have positive or negative ions in their fused state. Thus, when electric potential is supplied, no ions migrate to opposite poles and hence no conduction of electric current takes place.

8. Why covalent compounds are generally liquids or gases?

Ans. In covalent compounds, the molecules are held together by weak Van der Waal's forces. In liquids, the molecules are weakly attracted whereas in gases, these forces are almost non-existent. Hence, they are generally liquids or gases.

9. Why molten NaCl conduct electricity but, CCl₄ does not?

Ans. Molten NaCl contains Na⁺ and Cl⁻ ions, which are free to move, hence it conducts electricity. Whereas Liquid CCl₄ does not contain any charged particles to conduct electricity.

10. Why ionic compounds are generally soluble in water, but insoluble in organic solvents?

Ans. The water molecules have high dielectric constant thus; water molecules easily break the ionic bonds between the ions. The ions drift in water in all possible directions and hence, ionic compounds dissolve in water, while organic solvents are non-polar in nature and hence, cannot break the ionic bonds. Thus, the ionic compounds do not dissolve in them.

11. Why electrovalent compounds have high melting, boiling points and low volatility?

Ans. There is a strong force of attraction among the oppositely charged ions in the crystals of electrovalent compounds. Therefore, a large amount of energy is required to separate them. Due to these strong forces of attraction, ionic compounds have high melting and boiling points and low volatility.

12. Why hydrogen ion is called proton?

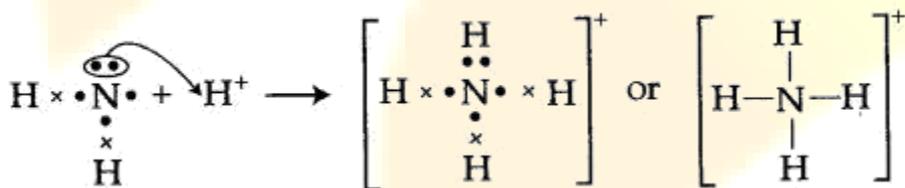
Ans. An atom of hydrogen has one proton in its nucleus and one electron in its valence shell. It donates its valence electron; the residual ion consists of a single proton with number of electron and number of neutron. It is on account of this fact, that hydrogen ion is called proton.

13. Why do certain elements form ions?

Ans. Every particle (molecule, atom or ion) has the tendency to attain the state of lowest energy. As atoms of all elements except the noble gases, have one to seven electrons in their outermost shell, therefore, they are not in the state of minimum energy. They are reactive. In order to attain a minimum state of energy, i.e., to acquire a duplet or octet structure in their valence shell, they either donate or accept electrons. In this process, they become charged particles or ions.

14. By drawing an electron dot diagram, show the lone pair effect leading to the formation of ammonium ion from ammonia gas and hydrogen ion.

Ans.



NH₃ has one lone pair of electrons which is donates to hydrogen atom forming a co-ordinate bond. The arrow represents a co-ordinate bond. The arrow points from donor to acceptor atom.

15. What are the characteristics of co-ordinate compounds?

Ans. The general characteristics of co-ordinate compounds are as follows:

- (i) Co-ordinate compounds are identical to normal covalent compounds.
- (ii) It is rigid and has directional properties.
- (iii) These compounds are soluble in non-polar solvents and insoluble in polar solvent.
- (iv) These compounds behave as non-conductors of electricity.

(v) The melting and boiling points are higher than covalent compounds and lower than ionic compounds.

(vi) These are stable compounds.

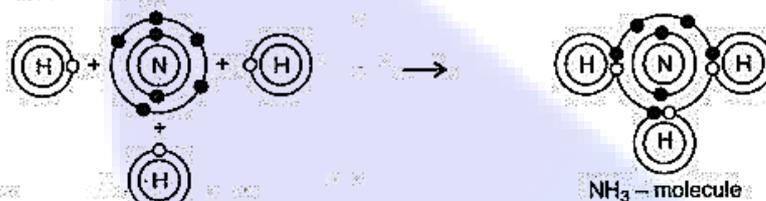
16. Draw dot diagrams to illustrate the structure of the molecules of:

(i) Ammonia (ii) Carbon dioxide

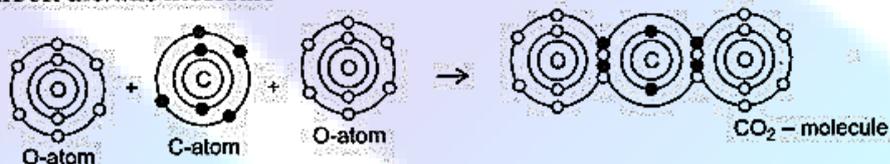
(iii) Methane (iv) Water

Ans.

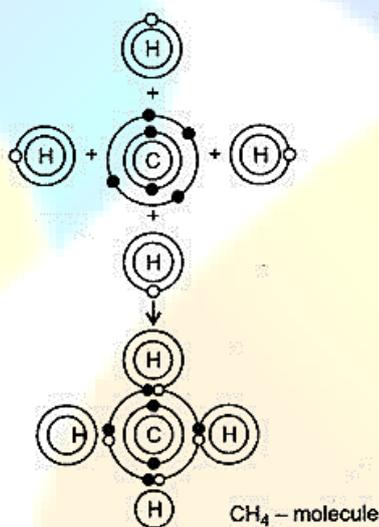
(i) Ammonia molecule



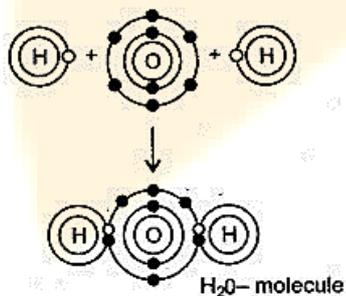
(ii) Carbon dioxide molecule



(iii) Methane molecule



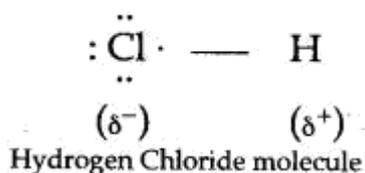
(iv) Water molecule



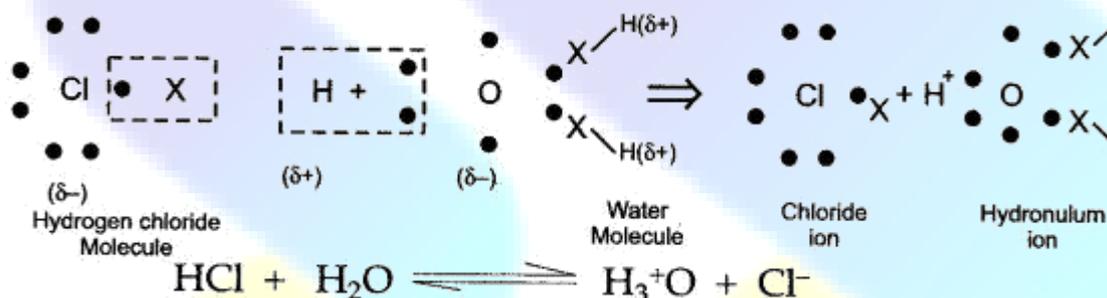
For examination point of view we can only show valence shell electron for overlapping.

17. Explain how polar covalent compound HCl which is a bad conductor in pure and liquid state ionizes in water.

Ans. A molecule of HCl is a polar covalent, i.e., the electron pair shared between hydrogen and chlorine is far away from hydrogen than chlorine, with the result that hydrogen atom has a slight positive charge on it and the atom of chlorine has slight negative charge on it as,



When hydrogen chloride is added to water, then water molecules bombard it from all directions. If the alignment of a water molecule is such that slightly negative oxygen atom faces the slightly positive hydrogen atom of HCl then, the slightly positive hydrogen atom is swallowed by water molecule in the form of single proton to form hydronium ion (H_3O^+). The residual chlorine atom takes away the electron of hydrogen atom along with it so as to form chloride ion as illustrated below:



18. Predict the type of bonding in the following molecules :

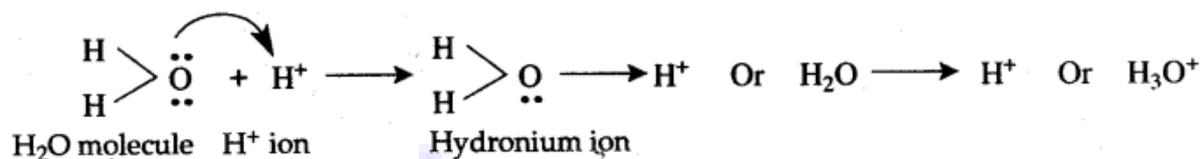
- (i) Oxygen (ii) Calcium oxide
- (iii) Water (iv) Methane
- (v) Ammonium ion (vi) Nitrogen
- (vii) Magnesium chloride (viii) Carbon dioxide
- (ix) Carbon tetra chloride (xi) Hydrogen cyanide (x) Hydrogen chloride

Ans. (i) Covalent bond (ii) Ionic bond
 (iii) Covalent bond (iv) Covalent bond
 (v) Covalent bond (vi) Ionic bond
 (vii) Covalent bond (viii) Covalent bond
 (ix) Covalent bond (xi) Covalent and co-ordinate bonds (x) Covalent bond

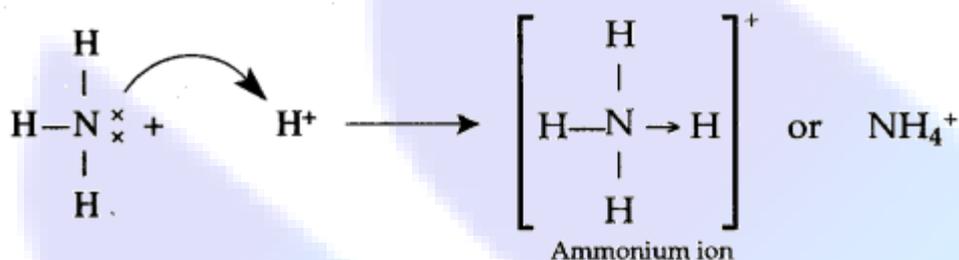
19. Explain the formation of H_3O^+ and NH_4^+ ion.

Ans. Formation of Hydronium ion, H_3O^+ : This ion formed by the combination of H_2O molecule and H^+ ion. The water molecule has two O—H covalent bonds and central oxygen atom has two lone pairs of electrons. During the formation of H_3O^+ , one pair of lone pair from O-atom is donated to the H^+ ion and O — H co-ordinate bond is formed. Thus H_3O^+ ion contains two O—H covalent bonds and one O — H co-ordinate bond. After the formation O → H^+ co-ordinate bond becomes identical to the two O—H covalent bonds.

Hence in H_3O^+ ion all the three bonds are identical.

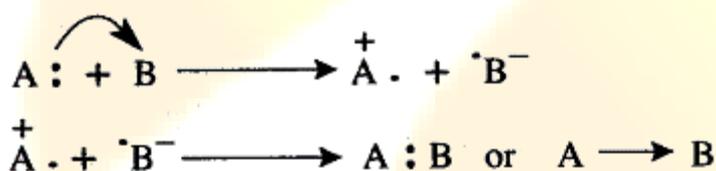


Formation of NH_4^+ , Ammonium ion: This ion formed by the combination of NH_3 molecule and H^+ ion. In NH_3 molecule each of three H-atoms is linked to N-atom by a covalent bond. Thus in this molecule N-atom is left with a lone pair of electrons after completing its octet by sharing three of its valence shell electrons with three H-atoms. The electrons of lone pair on N-atom are donated to H^+ ion and thus an N/EH co-ordinate bond is established in NH_4^+ ion.



20. How is a co-ordinate bond formed?

Ans. The formation of co-ordinate bond between two atoms to occur in the following two steps: E.g. two atoms are A and B—in the first step the donor atom A transfers one electron of its lone pair to the acceptor atom B. This result in that atom A develops unit positive charge and atom B develops a unit negative charge. This charge is known as formal charge. This is similar to the formation of ionic bond. In the second step the two electrons, one each with A and B- are shared by both the ions. This is similar to the formation of covalent bond.



Thus, a co-ordinate bond is equivalent to a combination of an electrovalent bond and a covalent bond. Hence it is also called a semi polar bond or dative bond.