



CHAPTER 2 CHEMICAL BONDING

SOLUTIONS

Textual Questions (Page 28)

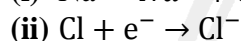
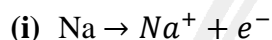
Q1. Which electronic configuration favour inert or noble behaviour of elements?

Ans: The duplet and octet configuration state make the atom stable.

Q2. Why do most element form ions?

Ans: Most elements being unstable in their atomic form accept or donate electrons to become stable attaining the stable configuration of nearest inert gases forming ions.

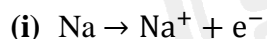
e.g.



Q3. What kinds of elements form cations? Support your answer.

Ans: Metals or electropositive elements which have one or more valence electrons that readily or fairly lose electrons form cations

e.g.



Q4. What kind of element form anions? Support your answer by two examples.

Ans: Non- metals or electronegative element having 5 to 7 valence electrons having tendency of gaining electron(s) form anions.

e.g.

(i) Cl^- ion is formed by accepting one electron and thus gets the electronic configuration of argon.

(ii) O^{2-} is formed by accepting 2 electrons and thus get the electronic configuration of neon.

Q5. Sodium atom reacts vigorously with water but sodium ion does not. Why?

Ans: Sodium atom reacts vigorously with water to get its stable state and form sodium hydroxide solution, NaOH solution and hydrogen gas which is an exothermic process. Hydrogen catches fire in this process.

Sodium ion, Na^+ does not react with water vigorously because it has already achieved its stable state.



Q6. What is an ionic bond? State at least three conditions for its formation?

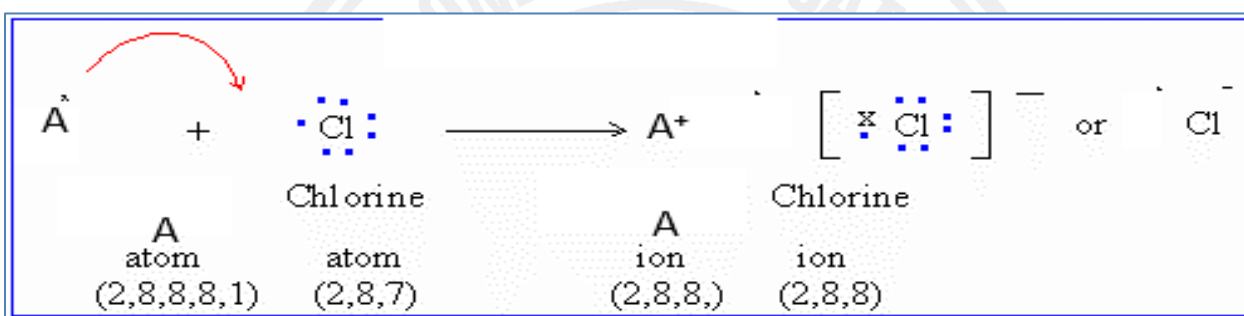
Ans: The type of chemical bond formed by transferring electrons between combining atoms in which oppositely charged ions are held by strong electrostatic force of attraction is called ionic or electrovalent bond.

Three conditions for ionic bond formation are:

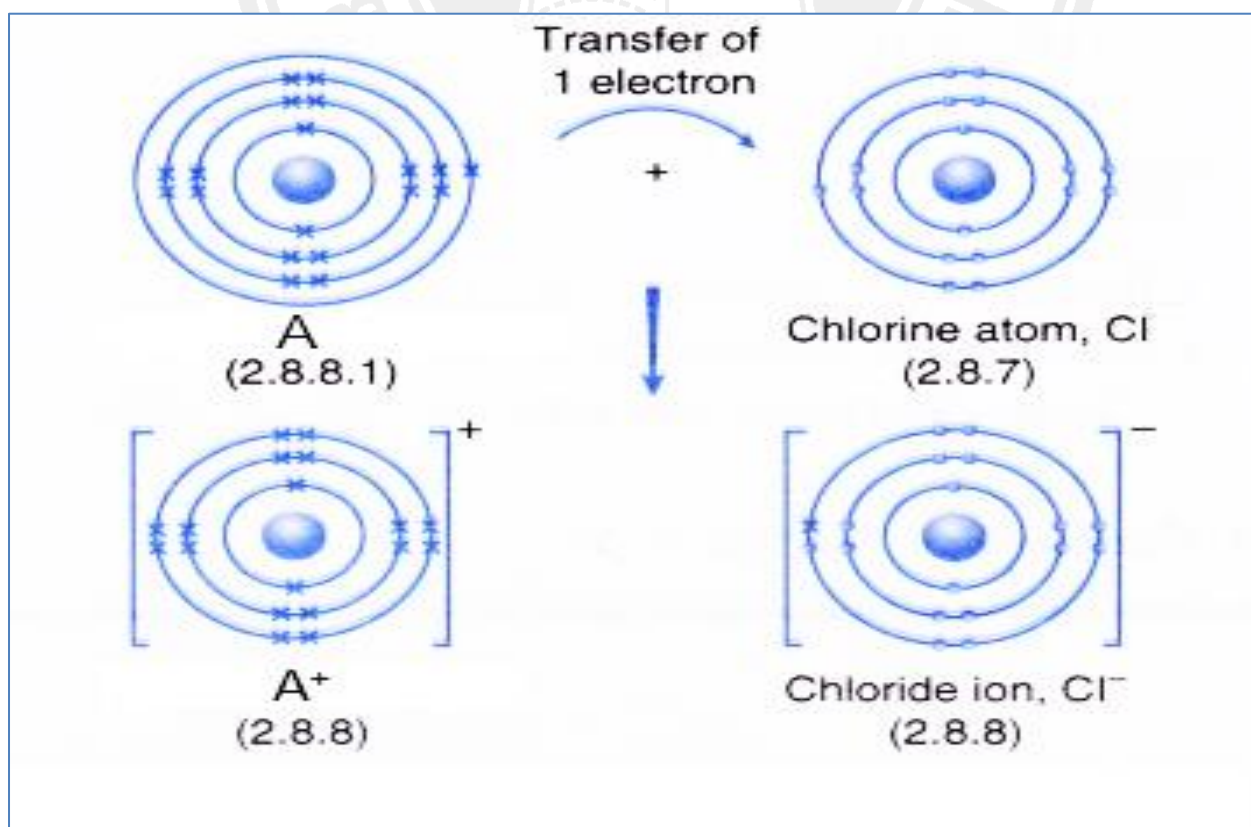
- (i) The two atoms must be oppositely charged
- (ii) One of the atoms must have higher electro-negativity.
- (iii) The metal atom must be highly electropositive to form cations easily.

Q7. A metal A (atomic number 19) burn in chlorine to produce a white solid chloride ACl by means of diagram, show the arrangement of electrons in A before and after the reaction.

Ans:



Or pictorially,



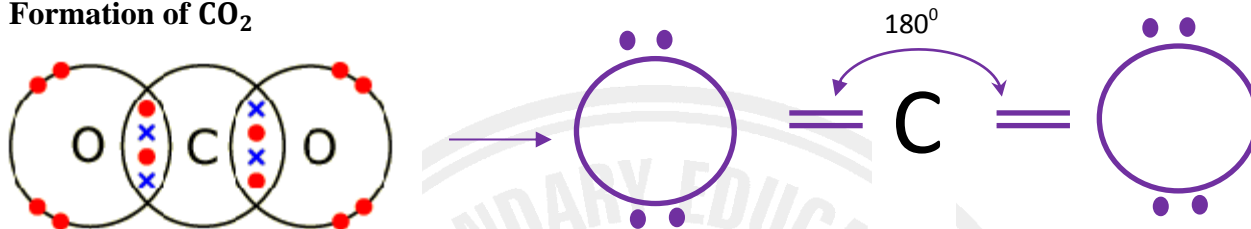


Textual Questions (Page 36)

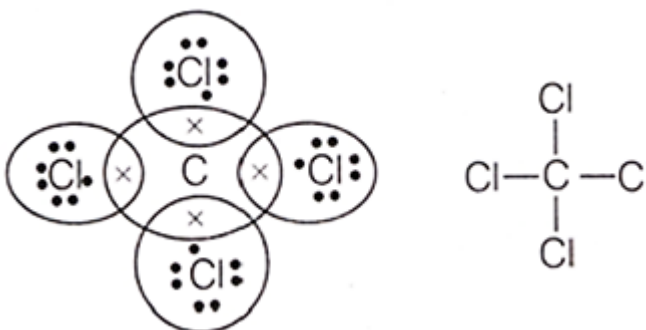
- Q1. Using dots (·) and crosses (X) to present valence electrons, show the formation of covalent bonds in CO_2 and CCl_4 .

Ans:

Formation of CO_2



Formation of CCl_4



- Q2. Why does carbon tetrachloride not conduct electricity?

Ans: Carbon tetrachloride is a covalent compound made of neutral molecules, not ions. So it does not conduct electricity.

- Q3. How does a co-ordinate bond differ from a normal covalent bond?

Ans: A **co-ordinate bond** is formed by one sided sharing of electron pair from one atom to the other combining atoms while a **covalent bond** is formed by mutual sharing of valence electrons between the combining atoms.

- Q4. Why does H_2 molecule exist while He_2 does not exist?

Ans: A Hydrogen atom has only one valence electron which is not a stable configuration of k-shell and to attain stable configuration of nearest inert gas configuration, two hydrogen atoms combine forming hydrogen molecule. While Helium has two electrons in its outermost orbit and hence is stable. So, helium does not combine and He_2 does not exist.



Q5. Why is HF polar While H_2 and F_2 are non-polar?

Ans: HF is polar because F has higher electro-negativity than hydrogen and it attracts the shared electrons pair toward itself developing a partially negative charge (δ^-) while hydrogen carries a slightly positive charge (δ^+).

On the other hand, H_2 and F_2 molecule, the shared electron pair between them are equally attracted, hence they are non-polar.

Textual Questions (Page 37)

Q1. Define the terms - valence shell and valence electrons.

Ans:

Valence shell – the valence shell is the outermost shell in the electronic configuration of an atom.

Valence electrons – valence electrons are the number of electrons present in the outermost shell of an atom.

Q2. Why do elements combine chemically?

Ans: Atoms of elements combine chemically in-order to attain the stable configuration of the nearest inert gas.

Q3. What is an electrovalent bond and how is it formed?

Ans: An electrovalent bond is the strong electrostatic force of attraction held between the oppositely charged ions. An electrovalent bond is formed by transferring of one or more electrons from one atom to the other. This bond generally occurs between metals and non-metals. The metals lose electrons and become positive ions (cations) and non-metals gain electrons becoming anions. In both the cases the ions attain stable configuration of inert gases.

Q4. What is a covalent bond and how is it formed?

Ans: A covalent bond is a type of chemical bond formed by mutual sharing of electrons between combining atoms resulting in the formation of a stable molecule.

Q5. How does an ionic bond differ from a covalent bond? Illustrate your answer with two examples of each type of bond.

Ans:

DIFFERENCES	
Ionic Bond	Covalent Bond
(i) Ionic Bond is formed between atoms of different electronegativity.	(i) Covalent Bond is formed between identical atom or atoms of similar chemical nature.
(ii) In ionic bond, transfer of electron takes place from one atom to another to attain stable configuration	(ii) In covalent bond equal sharing of electron(s) takes place between the combining atoms
(iii) It is generally formed between metals and non-metals.	(iii) It is generally formed between non- metal atoms.
(iv) There is formation of cations and anions	(iv) There is no formation of charged ions.

e.g. Ionic bonding in NaCl and $MgCl_2$

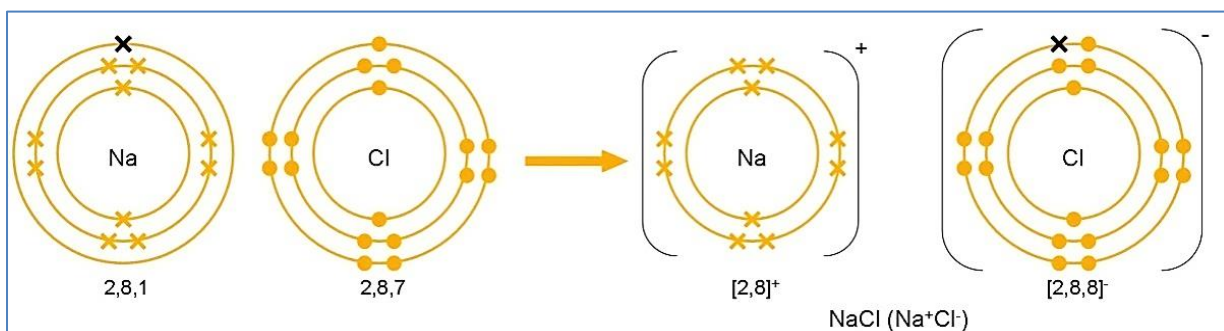


Fig. Sodium reacts with chloride to form Sodium chloride

Also, Magnesium combines with chlorine to form Magnesium chloride as follows:

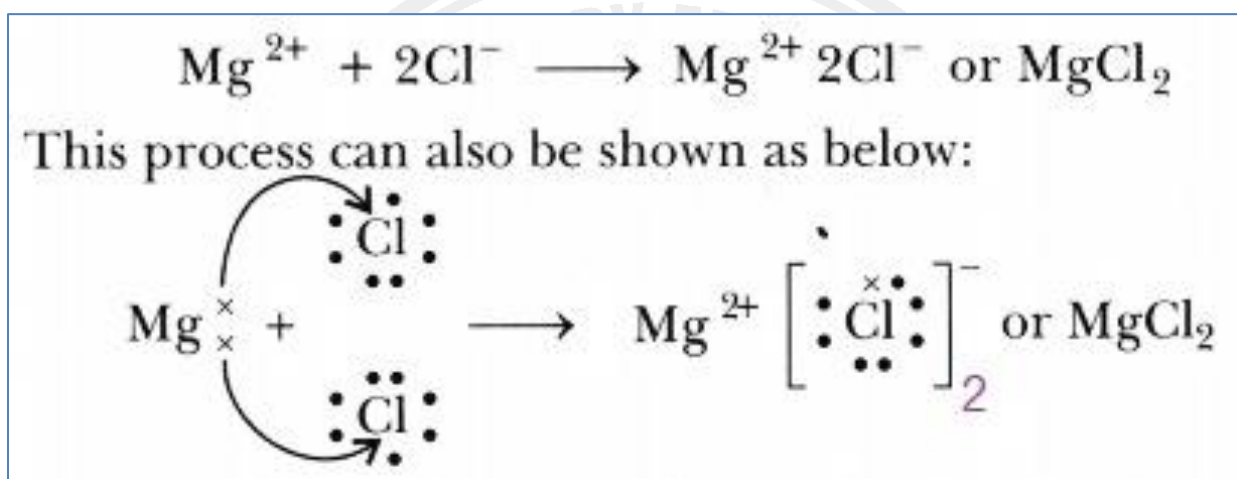
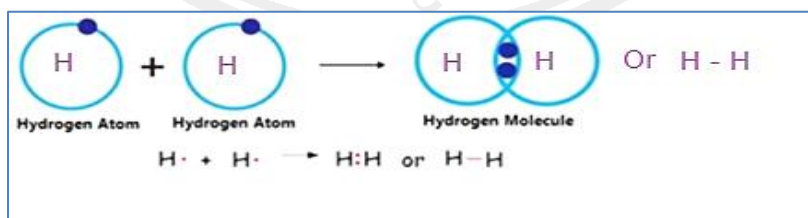


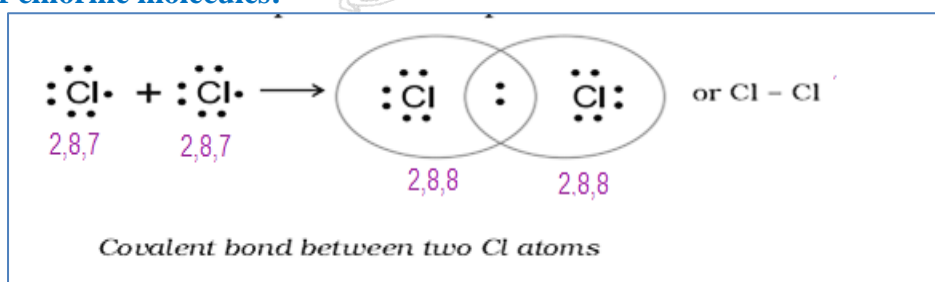
Fig. Magnesium reacts with chloride to form Magnesium chloride

Example of Covalent bond:

i. Formation of hydrogen molecule:



ii. Formation of chlorine molecules:





Q6. What is a polar molecule? Give example.

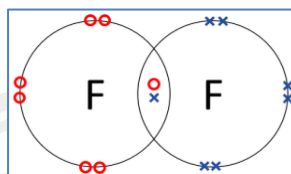
Ans: A polar molecule is a molecule in which the shared pairs of electrons are unequally attracted between the combining atoms due to having different electronegativity.
e.g. Water, Hydrogen chloride and Ammonia

Q7. Give electron dot representation of the following:

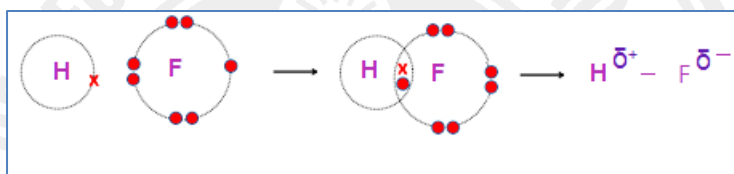
F_2 , HF and H_2O

Ans:

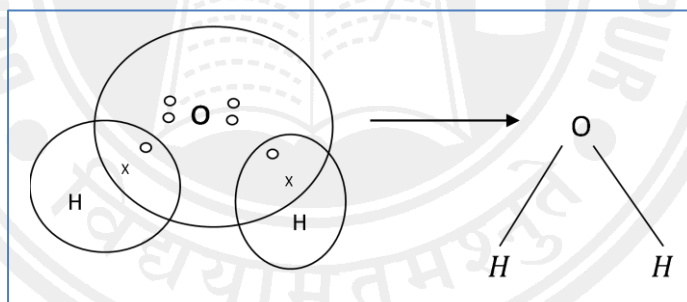
i) Electronic structure of F_2



ii) Electronic structure of HF



iii) Electronic structure of H_2O



Q8. State four properties each of electrovalent and covalent compound.

Ans:

Four properties of electrovalent or ionic compounds

- Electrovalent compounds have high melting and boiling points
- Electrovalent compounds are soluble in water because they form ions in aqueous solution
- They exist as crystalline solids.
- They conduct electricity in molten state and in aqueous solution.

Four properties of covalent compounds –

- Covalent compounds can exist as solid, liquid and gas.
- They are generally insoluble in water.
- They have low melting point and boiling point.
- They do not conduct electricity as they do not contain ions.



Q9. The elements w,x,y and z have atomic numbers 7,9,10 and 11 respectively. Write the formula of the molecules that would be formed between the following pairs of elements and indicate the type of bonding present using(·) and cross(x) to represent valence electrons.

a) W and X

b) X and X

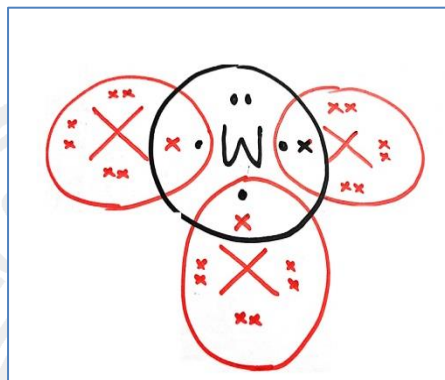
c) W and Z

d) Y and Y

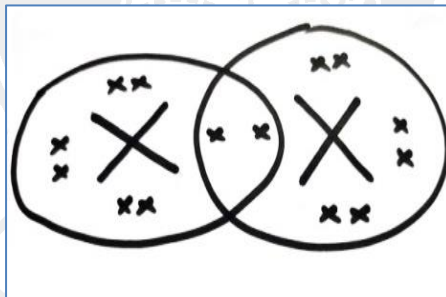
Ans:

Atomic number of W = 7, Atomic number of X = 9, Atomic number of Y = 10, Atomic number of Z = 11

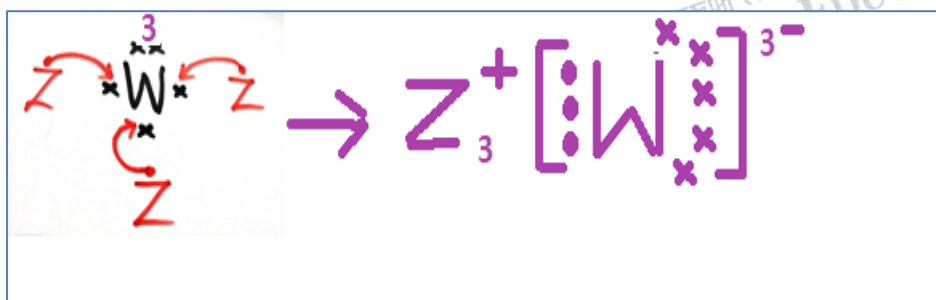
a) W and X – covalent bond is formed between W and X and formula of the compound is WX_3



b) X and X – Covalent bond is formed between two atoms of X as shown in the figure below. The formula of the compound will be X_2 .



c) Z and W – An Ionic compound is formed between Z and W as shown in the figure below and the chemical formula of the compound will be Z_3W .



d) Y and Y – Since the element Y has eight valence electrons, the element will have a stable state. Hence, no bond will be formed between Y and Y.



EXTRA QUESTIONS & ANSWERS

Q1. How an atom can acquire the electronic configuration of the nearest noble gas atom?

Ans: An atom can acquire the electronic configuration of the nearest noble gas atom by

(i) Transfer or acceptance of valence electron(s).

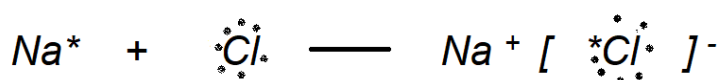
(ii) Sharing of equal number of valence electrons between the combining atoms.

Q2. What is a chemical bond? Explain the different ways of chemical combination based on the electronic theory of valency. Which one is non directional?

Ans: A Chemical bond is one which holds the atoms together in a molecule.

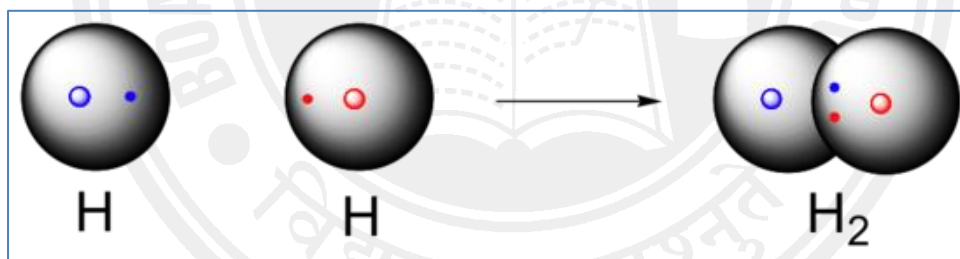
Ionic bond: The type of combination between atoms which depends upon the transfer and acceptance of valence electrons and in which oppositely charged ions are held together by strong electrostatic force of attraction is called electrovalent or ionic bond.

e.g.



N.B. In the formation of NaCl, Na atom totally transferred its valence electron to Cl atom to become Na⁺ and Cl⁻ ions which are held together by strong electrostatic force of attraction.

Covalent bond: The bond formed by mutual sharing of valence electrons between the combining atoms is called covalent bonds.



In the formation of H₂ molecule two H atoms shared one electron each to form a single covalent bond between them.

Co- ordinate Bond: The type of bond which is formed by donating a pair of valence electrons from an atom which already achieved octet configuration after the formation of a covalent bond (donor atom) to another atom which is short of two electrons (acceptor atom) is known as Co-ordinate bond .

e.g. Formation of O₃

In O₂ molecule, each oxygen atoms has two pair of unused valence electrons. Now, if an atom of oxygen having six valence electrons come close to O₂ molecules, the new atom may share a lone pair of electrons of one of the oxygen atom of O₂ molecule. It gives rise to the formation of Co-ordinate bond. Ionic bond is non directional.



Q3. Why do ionic compounds (i) possess crystalline structure and (ii) have high melting and boiling points?

Ans:

(i) Because ionic compounds do not exist as single molecules but as ions which are arranged in well-defined geometric patterns which are held together by strong electrostatic force of attraction.

(ii) Because, large amount of energy is required to break strong electrostatic force of attraction between the large network of ions.

Q4. Give two conditions for making ionic bond to be non-directional.

Ans:

(i) Ionic bonds are formed by oppositely charged ions which are arranged in a well-defined geometric pattern.

(ii) The force of attraction is not restricted to a single unit but due to uniform electric field around an ion, each ion is attracted to a large number of other ions.

Q5. Why do ionic compounds conduct electricity in their molten state and in their aqueous solutions?

Ans: Because, in their molten state and in their aqueous solutions ionic compounds dissociate into ions which can conduct electricity.

Q6. Write three conditions for the formation of ionic bond.

Ans:

(i) Out of the combining atoms one of them should be electropositive in nature and the other should be electronegative in nature.

(ii) Valence electron(s) from the atom of the electropositive element should be totally transferred to the atom of the electronegative element and they should form oppositely charged ions.

(iii) The oppositely charged ions [cation(s) and anion(s)] should be held together by strong electrostatic force of attraction.

Q7. How is covalent bond formed? Why are the covalent compounds non-conducting and have low melting and boiling points?

Ans: A covalent bond is formed by mutual sharing of valence electrons between the combining atoms.

Covalent compounds are made up of neutral molecules and no ions or free electrons are present. Hence they are non-conducting.

Little amount of energy is required to break the weak intermolecular force of attraction between the neutral molecules. Hence they have low melting and boiling points.

Q8. Boron (B) with atomic number 5 is a typical non-metal. How will B combine with H? Write the electron dot and cross structure of the compound. Comment on the possible structure.

Ans: B being a non-metal will combine with H which is also a non-metal by sharing of valence electrons.

As B has 2,3 electronic configuration, it will combine with 3H atoms.



[Trigonal planar]

In this structure, B is surrounded by 6 electrons. **[Note: B does not obey Octet rule]**

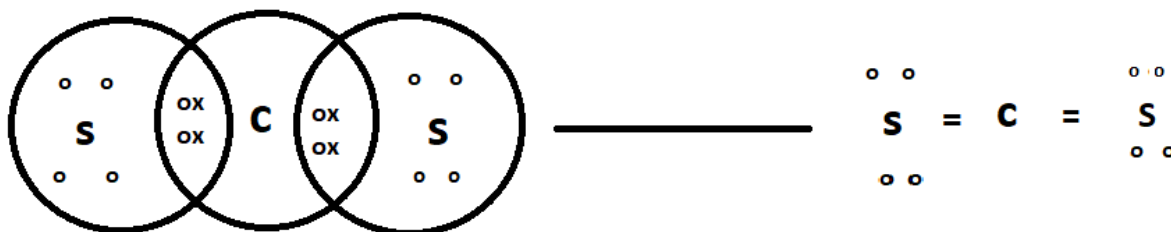


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- Q9.** Write dot (.) and cross (x) structure of the compound formed when carbon and Sulphur combine. What is the covalency of carbon in the molecule?

Ans:



Covalency of Carbon is 4.

- Q10.** Write two point of differences between ionic bond and covalent bond .

Ans:

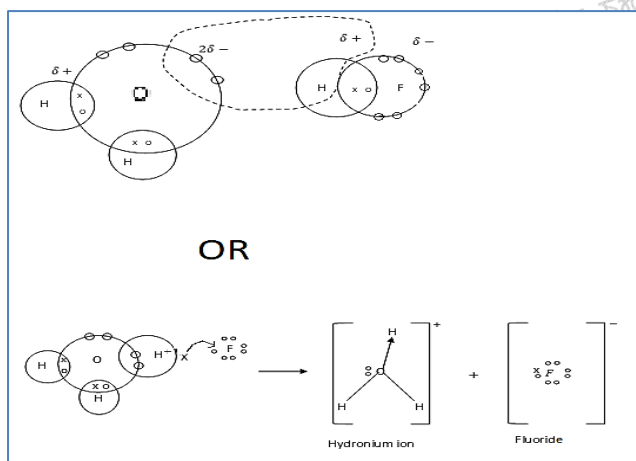
DIFFERENCES	
Ionic Bond	Covalent Bond
(i) Ionic bonds are formed by transfer of valence electron (s) from the atom of electropositive element to the atom of electronegative element.	(i) Covalent bonds are formed by mutual sharing of valence electron (s) between the atoms of electronegative elements.
(ii) Covalent bond is directional.	(ii) Ionic bond is non-directional

- Q11.** Why is HF a polar molecule?

Ans: Because, the shared electron pair is more strongly attracted towards F due to having more electronegativity.

- Q12.** HF and H₂O are polar covalent molecules. Illustrate the possible interaction (attraction or repulsion) between these two molecules

Ans: The positive end of one polar molecule will come nearer to the negative end of another polar molecule and thus same short of attraction (intermolecular attraction) will exist.





Q13. Write three conditions for the formation of polar covalent bond.

Ans:

The combining elements (atoms) should have similar characteristics but different electronegativity.

The shared electron pair should be attracted more strongly by the atom which has more electronegativity.

The atom which has less electronegativity should develop a partial +ve charge called delta positive (δ^+) and the other atom which has more electronegativity should develop an equal and opposite partial -ve charge called delta negative (δ^-).

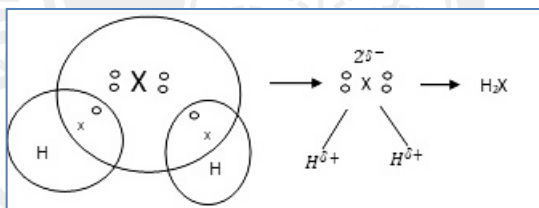
Q14. If the bond angle, H--O--H in water is 180° , Predict one important character of such a water.

Ans: H---O---H will be non-polar, it will have

- i. Low melting point and low boiling point.
- ii. Solubility power will be less.

Q15. If an element X with atomic number 16 combines with hydrogen, what will be the type of bonding and formula of the compound formed?

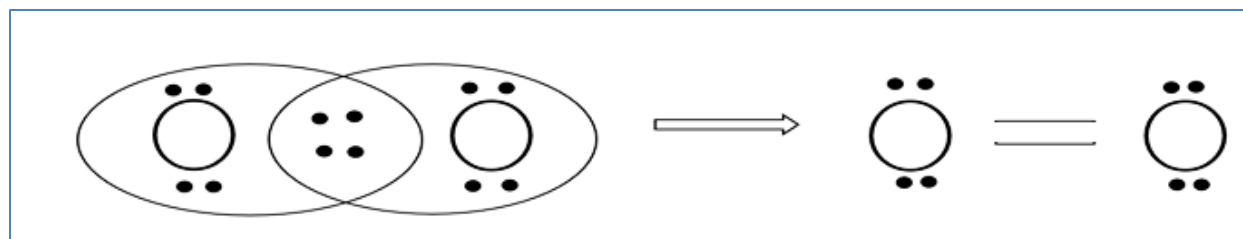
Ans: X=16 \longrightarrow 2,8,6



Type of bond: Polar covalent bond.

Q16. Why are co-ordinate bonds considered as special type of covalent bonds? Show the difference between the two types of bonds in the formation of Oxygen (O_2) and Ozone (O_3) molecule.

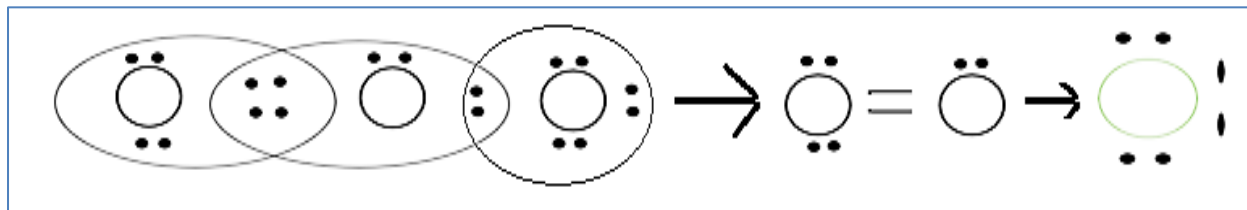
Ans: In both type of bond formation, the idea of sharing electrons among the combining atoms is involved. The difference is that in the formation of covalent bond equal sharing of electrons is involved. But in the formation of co-ordinate bond the shared electron pair is contributed by one atom only and the other acts as acceptor.





In the formation of O_2 molecule, two oxygen atoms equally shared two valence electrons each to form double covalent bond between them.

Bond formation of O_3



In the formation of O_3 , one atom from O_2 molecule which has already completed Octet configuration contributed two valence electrons to another oxygen atom which is short of two electrons to form a co-ordinate bond.

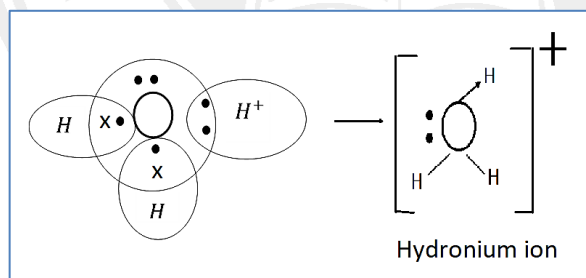
- Q17. Hydrogen forms two compounds with elements A and B having 4 and 5 valence electrons respectively. Which one of the two compounds will be able to form Co-ordinate bond with a proton? Give reason.**

Ans: The compound formed with B will be able to form Co-ordinate bond with H^+ (having one proton).

The B atom has one lone pair of electrons in the compound and can act as donor centre (atom) .

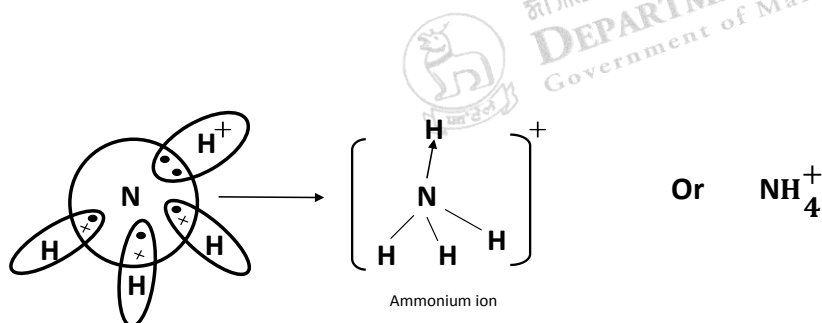
- Q18. How does H_2O molecule combine with H^+ ion to form H_3^+O ion? (2017-P)**

Ans: A pair of valence electrons is contributed by the oxygen atom (donor) of H_2O to H^+ ion (acceptor) forming a co-ordinate bond between them.



- Q19. Depict the formation of ammonium ion from ammonia molecule and hydrogen ion by Co-ordinate bond.**

Ans:





- Q20. Nitrogen (at no.7) and phosphorous (at no.15) belongs to the same group of periodic table. Using the usual symbols describe how N will combine with P to form a simplest compound. Give the name of the compound.

Ans:

