Chemistry Study Materials for Class 11 (NCERT Questions -Answers of Chapter- 04)

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CHEMICAL BONDING AND MOLECULAR STRUCTURE

Question 4.1: Explain the formation of a chemical bond.

Answer: A chemical bond is defined as an attractive force that holds the constituents (atoms, ions etc.) together in a chemical species.

Various theories have been suggested for the formation of chemical bonds such as the electronic theory, valence shell electron pair repulsion theory, valence bond theory, and molecular orbital theory.

A chemical bond formation is attributed to the tendency of a system to attain stability. It was observed that the inertness of noble gases was because of their fully filled outermost orbitals. Hence, it was postulated that the elements having incomplete outermost shells are unstable (reactive). Atoms, therefore, combine with each other and complete their respective octets or duplets to attain the stable configuration of the nearest noble gases. This combination can occur

either by sharing of electrons or by transferring one or more electrons from one atom to another. The chemical bond formed as a result of sharing of electrons between atoms is called a covalent bond. An ionic bond is formed as a result of the transference of electrons from one atom to another.

Question 4.2:Write Lewis dot symbols for atoms of the following elements: Mg, Na, B, O, N, Br.

Answer:

Mg: There are two valence electrons in Mg atom. Hence, the Lewis dot symbol for Mg is:

Na: There is only one valence electron in an atom of sodium. Hence, the Lewis dot structure is: 

B: There are 3 valence electrons in Boron atom. Hence, the Lewis dot structure is: 

O: There are six valence electrons in an atom of oxygen. Hence, the Lewis dot structure is: 

N: There are five valence electrons in an atom of nitrogen. Hence, the Lewis dot structure is: 

Br: There are seven valence electrons in bromine. Hence, the Lewis dot structure is: 

Question 4.3: Write Lewis symbols for the following atoms and ions:

Al and Al^{3+}; H and H^-

Answer:

(ii) Al and Al^{3+}

The number of valence electrons in aluminium is 3.

The Lewis dot symbol of aluminium (Al) is  .

The tripositive charge on a species infers that it has donated its three electrons.

Hence, the Lewis dot symbol is  .

(ii) H and H^-

The number of valence electrons in hydrogen is 1.

The Lewis dot symbol of hydrogen (H) is  .

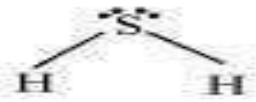
The uninegative charge infers that there will be one electron more in addition to the one valence electron. Hence, the Lewis dot symbol is  .

Question 4.4: Draw the Lewis structures for the following molecules and ions:

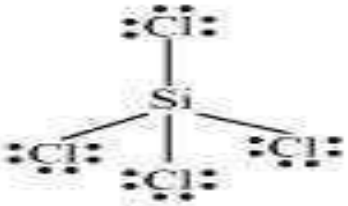
H_2S, $SiCl_4$, BeF_2,HCOOH

Answer

H_2S

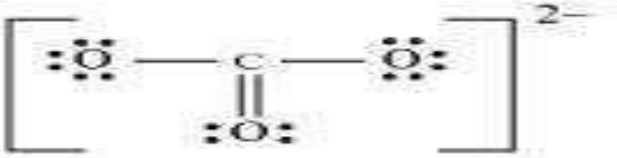


$SiCl_4$



BeF_2

CO_3^{2-}



HCOOH

Question 4.5: Define octet rule. Write its significance and limitations.

Answer The octet rule or the electronic theory of chemical bonding was developed by Kossel and Lewis. According to this rule, atoms can combine either by transfer of valence electrons from one atom to another or by sharing their valence electrons in order to attain the nearest noble gas configuration by having an octet in their valence shell.

The octet rule successfully explained the formation of chemical bonds depending upon the nature of the element.

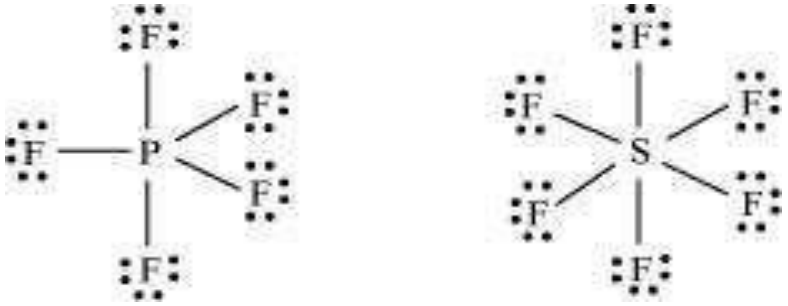
Limitations of the octet theory:

The following are the limitations of the octet rule:

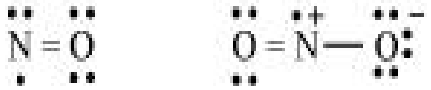
(a) The rule failed to predict the shape and relative stability of molecules.

(b) It is based upon the inert nature of noble gases. However, some noble gases like xenon and krypton form compounds such as XeF_2, KrF_2 etc.

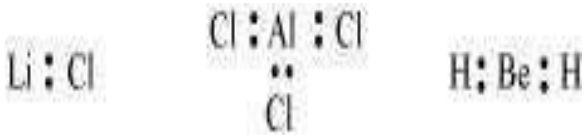
(c) The octet rule cannot be applied to the elements in and beyond the third period of the periodic table. The elements present in these periods have more than eight valence electrons around the central atom. For example: PF_5, SF_6, etc.



(d) The octet rule is not satisfied for all atoms in a molecule having an odd number of electrons. For example, NO and NO_2 do not satisfy the octet rule.



(e) This rule cannot be applied to those compounds in which the number of electrons surrounding the central atom is less than eight. For example, LiCl, BeH_2, $AlCl_3$ etc. do not obey the octet rule.



Question 4.6: Write the favourable factors for the formation of ionic bond.
Answer

An ionic bond is formed by the transfer of one or more electrons from one atom to another. Hence, the formation of ionic bonds depends upon the ease with which neutral atoms can lose or gain electrons. Bond formation also depends upon the lattice energy of the compound formed.

Hence, favourable factors for ionic bond formation are as follows:

(i) Low ionization enthalpy of metal atom.

(ii) High electron gain enthalpy ($\Delta_{eg}H$) of a non-metal atom.

(iii) High lattice energy of the compound formed.

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