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

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CHEMICAL BONDING AND MOLECULAR STRUCTURE

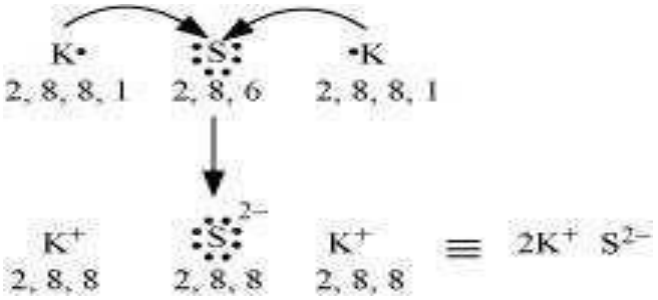
Question 4.14: Use Lewis symbols to show electron transfer between the following atoms to form cations and anions:

(a) K and S (b) Ca and O (c) Al and N.

Answer: (a) K and S:

The electronic configurations of K and S are as follows: K:- 2, 8, 8, 1 S:- 2, 8, 6

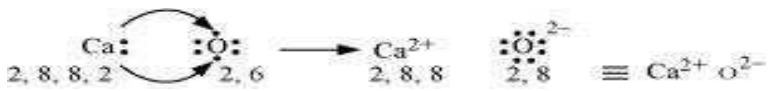
Sulphur (S) requires 2 more electrons to complete its octet. Potassium (K) requires one electron more than the nearest noble gas i.e., Argon. Hence, the electron transfer can be shown as:



(b) Ca and O:

The electronic configurations of Ca and O are as follows: Ca: 2, 8, 8, 2 O: 2, 6

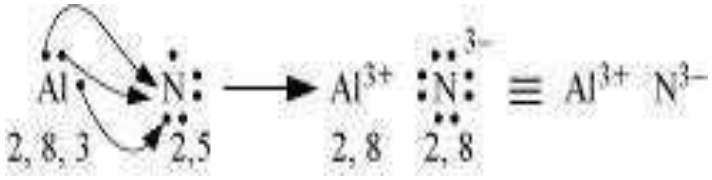
Oxygen requires two electrons more to complete its octet, whereas calcium has two electrons more than the nearest noble gas i.e., Argon. Hence, the electron transfer takes place as:



(c) Al and N:

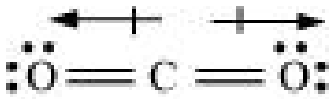
The electronic configurations of Al and N are as follows: Al: 2, 8, 3 N: 2, 5

Nitrogen is three electrons short of the nearest noble gas (Neon), whereas aluminium has three electrons more than Neon. Hence, the electron transference can be shown as:



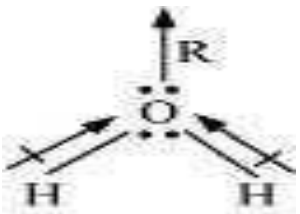
Question 4.15: Although both CO_2 and H_2O are triatomic molecules, the shape of H_2O molecule is bent while that of CO_2 is linear. Explain this on the basis of dipole moment.

Answer: According to experimental results, the dipole moment of carbon dioxide is zero. This is possible only if the molecule is linear so that the dipole moments of C–O bonds are equal and opposite to nullify each other.



Resultant μ = 0 D

H_2O, on the other hand, has a dipole moment value of 1.84 D (though it is a triatomic molecule as CO_2). The value of the dipole moment suggests that the structure of H_2O molecule is bent where the dipole moment of O–H bonds are unequal.



Question 4.16: Write the significance/applications of dipole moment.

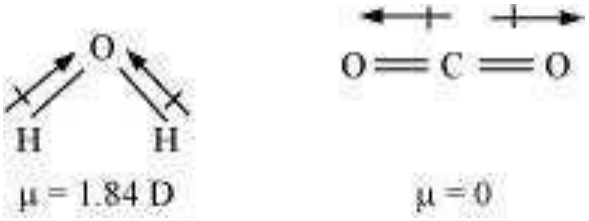
Answer: In heteronuclear molecules, polarization arises due to a difference in the electronegativities of the constituents of atoms. As a result, one end of the molecule acquires a positive charge while the other end becomes negative. Hence, a molecule is said to possess a dipole. The product of the magnitude of the charge and the distance between the centres of positive-negative charges is called the dipole moment (μ) of the molecule.

It is a vector quantity and is represented by an arrow with its tail at the positive centre and head pointing towards a negative centre.

Dipole moment (μ) = charge (Q) × distance of separation (r)

The SI unit of a dipole moment is 'esu'. 1 esu = 3.335×10^{-30} cm

Dipole moment is the measure of the polarity of a bond. It is used to differentiate between polar and non-polar bonds since all non-polar molecules (e.g. H_2, O_2) have zero dipole moments. It is also helpful in calculating the percentage ionic character of a molecule.



Question 4.17: Define electronegativity. How does it differ from electron gain enthalpy?

Answer: Electronegativity is the ability of an atom in a chemical compound to attract a bond pair of electrons towards itself.

Electronegativity of any given element is not constant. It varies according to the element to which it is bound. It is not a measurable quantity. It is only a relative number.

On the other hand, electron gain enthalpy is the enthalpy change that takes place when an electron is added to a neutral gaseous atom to form an anion. It can be negative or positive depending upon whether the electron is added or removed. An element has a constant value of the electron gain enthalpy that can be measured experimentally.

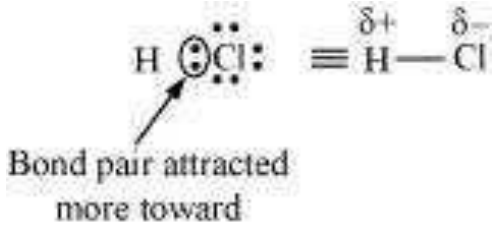
Question 4.18: Explain with the help of suitable example polar covalent bond.

Answer: When two dissimilar atoms having different electronegativities combine to form a covalent bond, the bond pair of electrons is not shared equally.

The bond pair shifts towards the nucleus of the atom having greater electronegativity. As a result, electron distribution gets distorted and the electron cloud is displaced towards the electronegative atom.

As a result, the electronegative atom becomes slightly negatively charged while the other atom becomes slightly positively charged. Thus, opposite poles are developed in the molecule and this type of a bond is called a polar covalent bond.

HCl, for example, contains a polar covalent bond. Chlorine atom is more electronegative than hydrogen atom. Hence, the bond pair lies towards chlorine and therefore, it acquires a partial negative charge.



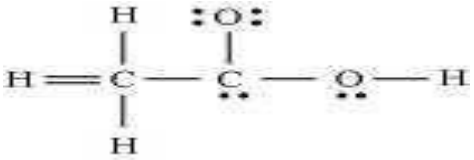
Question 4.19: Arrange the bonds in order of increasing ionic character in the molecules: LiF, K_2O, N_2, SO_2 and ClF_3.

Answer: The ionic character in a molecule is dependent upon the electronegativity difference between the constituting atoms. The greater the difference, the greater will be the ionic character of the molecule.

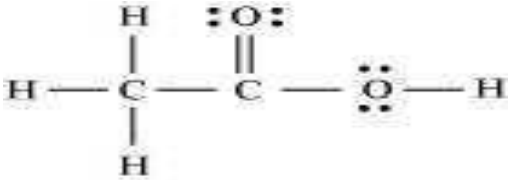
On this basis, the order of increasing ionic character in the given molecules is

$N_2 < SO_2 < ClF_3 < K_2O < LiF$.

Question 4.20: The skeletal structure of CH_3COOH as shown below is correct, but some of the bonds are shown incorrectly. Write the correct Lewis structure for acetic acid.



Answer: The correct Lewis structure for acetic acid is as follows:



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