Dipole Moment

A molecule is composed of positively charged nuclei and negatively charged electrons. The arrangement of these charged particles is different for different molecules. There are two possibilities :

1. Centre of gravity of positive nuclei coincides with that of negatively charged electrons, the resulting molecule is called *nonpolar molecule*. *e.g.*, H_2, Cl_2, N_2, C_6H_6, etc.

2. The centre of gravity of positive nuclei does not coincide with that of electrons, the resulting molecule is called *polar molecule*. For example, HCl, CH_3Cl, NH_3, H_2O, etc. Since the molecule, as a whole is neutral, we have equal positive ($+q$) and negative ($-q$) charges separated by a certain distance (l) in a polar molecule. Thus a polar molecule behaves like a small magnet and becomes *dipolar* and hence is called an *electric dipole* or simply a *dipole* (two poles). Sidgwick proposed that a dipole may be shown by an arrow with a crossed tail. The arrow is placed parallel to the line of the positive and negative charges and should be from *positive end to negative end* (as a convention) of the dipole. Hence HCl molecule may be represented as

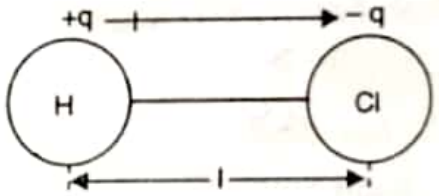

Fig. 8.1. Representation of dipole, where l is the bond length.

The polar molecules have permanent dipoles and nonpolar molecules do not have permanent dipoles.

1. DIPOLE MOMENT OR ELECTRIC MOMENT

I. Definition

The degree of polarity of a molecule can be expressed in terms of dipole moment. *It is the product of the magnitude of the charge (positive or negative) and distance between them, i.e., bond length.* If q is the charge at each end of dipole and l is the distance between the positive and negative centres (*i.e.*, bond length), the dipole moment (μ) is given by

$$\mu = q \times l$$

In a nonpolar molecule, the distance l is zero because centres of gravity of positive and negative charges coincide, hence dipole moment is zero.

The dipole moment is a *vector quantity* and is represented by an arrow showing direction from positive to negative end of the dipole. The

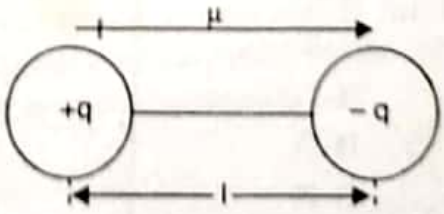

Fig. 8.2. Representation of dipole moment.