Mathematical problems ⇒ (Molar polarization)

A liquid of mol. wt. 18 and density 0.995×10^3 Kg m^{-3} at 25°C has a dielectric Constant 78.5 and refractive index 1.383. Calculate the values of its molar polarisation, molar refractance and dipole moments, neglecting atomic polarisation.

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Density, $\rho = 0.995 \times 10^3$ Kg/m^3

$= 0.995 \times 10^3 (10^3 gm) / (10^2 cm)^3$

$= 0.995$ gm/cm^3

∴ Molar polarisation,

$$P_M = \frac{D-1}{D+2} \cdot \frac{M}{\rho}$$ (D = Dielectric Constant)

$$= \frac{78.5-1}{78.5+2} \times \frac{18}{0.995} = 17.416 \text{ cc.}$$

Molar refraction,

$$R_M = \frac{n^2-1}{n^2+2} \cdot \frac{M}{\rho}$$ (n = refractive index of the said liquid)

$$= \frac{(1.383)^2-1}{(1.383)^2+2} \times \frac{18}{0.995}$$

$= 4.2199$ cc.

Orientation polarisation,

$P_o = P_M - R_M$ $\left[(P_M = P_o + P_e + P_a) \right.$ Since P_a is neglected $\left. P_e = R_M \right]$

$= (17.416 - 4.2199)$ c.c

$= 13.1961$ c.c.

Again, $P_o = \frac{4}{3} \pi N_A \left(\frac{\mu^2}{3kT} \right)$

$$\Rightarrow \mu^2 = \frac{9KT P_0}{4\pi N_A}$$

(μ = Dipole moment)

$$\mu = \left(\frac{9KT P_0}{4\pi N_A}\right)^{\frac{1}{2}}$$

$K = 1.38 \times 10^{-16}$ erg K^{-1}
$T = 298$ k,
$N_A = 6.023 \times 10^{23}$ /mole

$$\therefore \mu = \left(\frac{9 \times 1.38 \times 10^{-16} \times 298 \times 13.1961}{4 \times 3.14 \times 6.023 \times 10^{23}}\right)^{\frac{1}{2}}$$

$$= 8.035 \times 10^{-19} \text{ esu} - \text{cm}$$

$$= 0.8035 \times 10^{-18} \text{ esu} - \text{cm}$$

$$= \boxed{0.8035 \text{ D}}$$

Next lecture topic :-

1. Debye equation
2. Molar refraction (Lorentz - Lorentz equation)

Home tasks :-

The refractive index of CCl_4 for Sodium D Light at 20°c is 1.457 and its density is 1.595 gm/cc. Calculate the molar refraction. If the atomic refraction of Carbon be 2.42, Calculate the atomic refraction of chlorine.