307.

Problem 28.49 (RHK)

An electric dipole consists of charge $+2e$ *and* $-2e$ *separated by* 0.78 nm. *It is in an electric field of strength* 3.4×10^{6} N C^{-1}. *We have to calculate the magnitude of the torque on the dipole when the dipole moment is* (a) *parallel*, (b) *at a right angle, and* (c) *opposite to the electric field.*

Solution:

Magnitude of the dipole moment of charge $+2e$ and $-2e$ separated by 0.78 nm will be

$$p = 2ed = 2\times1.6\times10^{-19}\times0.78\times10^{-9}\ \text{C m}$$
$$= 2.496\times10^{-28}\ \text{C m}.$$

Dipole moment is a vector quantity. Its direction is from the negative charge toward the positive charge.

$$\vec{p} = 2.496\times10^{-28}\ \hat{p}\ \text{m C}.$$

In an electric field $\vec{E}$ torque $\vec{\tau}$ on an electric dipole is

$$\vec{\tau} = \vec{p}\times\vec{E}.$$

Electric field strength E is

$$E = 3.4\times10^{6}\ \text{N C}^{-1}.$$

We next calculate the magnitude of torque on the dipole in the three cases.

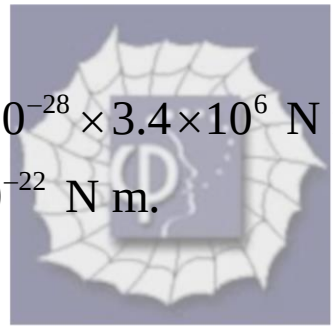
(a)

Electric field vector is parallel to the dipole moment vector. In this case the torque on the dipole will be zero.

(b)

Electric field vector is at right angle to the dipole moment vector. In this case the magnitude of the torque will be

$$\tau = pE = 2.496 \times 10^{-28} \times 3.4 \times 10^{6} \text{ N m}$$
$$= 8.49 \times 10^{-22} \text{ N m.}$$



(c)

Electric field vector is opposite to the dipole moment vector. In this case the torque on the dipole will be zero.