309.

Problem 28.52 (RHK)

We have to find the frequency of oscillation of an electric dipole, of moment p and rotational inertia I, for small amplitudes of oscillation about its equilibrium position in a uniform electric field E.

Solution:

We consider an electric dipole of dipole moment $\vec{p}$ in an electric field $\vec{E}$. When the dipole is disturbed from its equilibrium position in electric field $\vec{E}$, it will experience a restoring torque of magnitude

$\tau = pE\sin\theta.$

If the displacement θ is small we may approximate

$\sin\theta \approx \theta.$

If the moment of inertia of the dipole is I, its equation of motion for small displacements will be

$$I\frac{d^2\theta}{dt^2} = -pE\theta.$$

Equation of motion has the simple harmonic motion form

$$\frac{d^2\theta}{dt^2} + \frac{pE}{I}\theta = 0.$$

The frequency of oscillation will therefore be

$$\nu = \frac{1}{2\pi}\sqrt{\frac{pE}{I}} \quad .$$