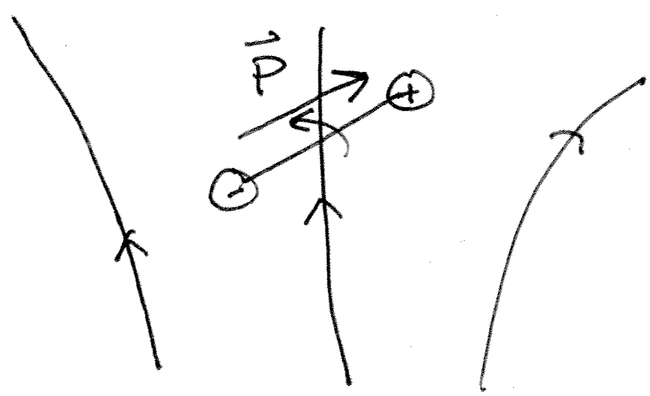
# Dipole Mechanics

For a point dipole, a dipole whose extent is much smaller than the space rate of change of the applied field:

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

Potential Energy $U = \int_{\pi/2}^{\theta} \tau \, d\theta$

$$= -\vec{p} \cdot \vec{E}$$



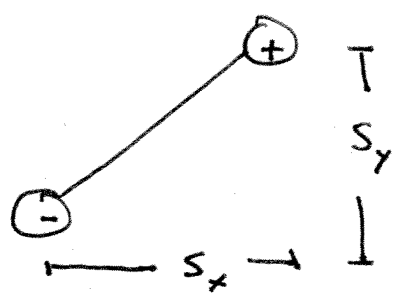

* Dipole rotates to align with field.

## Force

$$\vec{F} = (\vec{p} \cdot \nabla)\vec{E}$$

Look at y component to see

$$F_y = Q\,\Delta E_y = Q \frac{\partial E_y}{\partial y} s_y = p_y \frac{\partial E}{\partial y}$$




But the y component of the field also changes in the x and z directions

$$F_y = p_x \frac{\partial E_y}{\partial x} + p_y \frac{\partial E_y}{\partial y} + p_z \frac{\partial E_y}{\partial z}$$

$\Longrightarrow$ A dipole feels zero net force from a uniform field.