

## DIPOLE BETWEEN TWO ANGLED CONDUCTING PLANES

Link to: [physicspages home page](#).

To leave a comment or report an error, please use the auxiliary blog.

Reference: Griffiths, David J. (2007) Introduction to Electrodynamics, 3rd Edition; Prentice Hall - Problem 4.30.

Suppose we have two conducting planes that make angles of  $+\theta$  and  $-\theta$  respectively with the  $xy$  plane, and meet along the  $y$  axis (although they are insulated from each other). The top plane is held at a potential of  $+V$  and the bottom plane at  $-V$ .

Since the electric field is always normal to the surface of a conductor, the field lines will bulge outwards in the  $+x$  direction and have a vertical tangent (that is, parallel to the  $z$  axis) when they pass through the  $xy$  plane. Since the field lines travel from positive to negative, the field lines start on the top plane and arc towards the bottom plane.

Now suppose we place a dipole between the planes. The dipole is centred on the  $xy$  plane and the dipole moment  $\mathbf{p}$  points in the  $+z$  direction. What force does this dipole feel?

This depends on whether we are talking about a physical dipole (that is, two charges separated by a finite distance) or an ideal dipole, in which the separation is zero. We've seen that the force felt by an ideal dipole in an electric field is

$$\mathbf{F} = (\mathbf{p} \cdot \nabla) \mathbf{E} \quad (1)$$

Since  $\mathbf{p}$  is parallel to  $\hat{\mathbf{z}}$ ,  $\mathbf{F} = p \frac{\partial}{\partial z} \mathbf{E}$  and since  $\mathbf{E}$  is tangent to the vertical at the location of the dipole,  $\partial \mathbf{E} / \partial z = 0$  and the force is zero.

If we're talking about a physical dipole, then the positive charge is slightly above the  $xy$  plane where the field points slightly to the right of  $-\hat{\mathbf{z}}$ , so the force on the positive charge will be in that direction. Similarly, the negative charge is slightly below the  $xy$  plane, where the field points slightly to the left of  $-\hat{\mathbf{z}}$ . The force on the negative charge will thus be in the opposite direction, or slightly to the right of  $+\hat{\mathbf{z}}$ . From the symmetry of the problem, the vertical components of force cancel and the dipole feels a net force to the right.