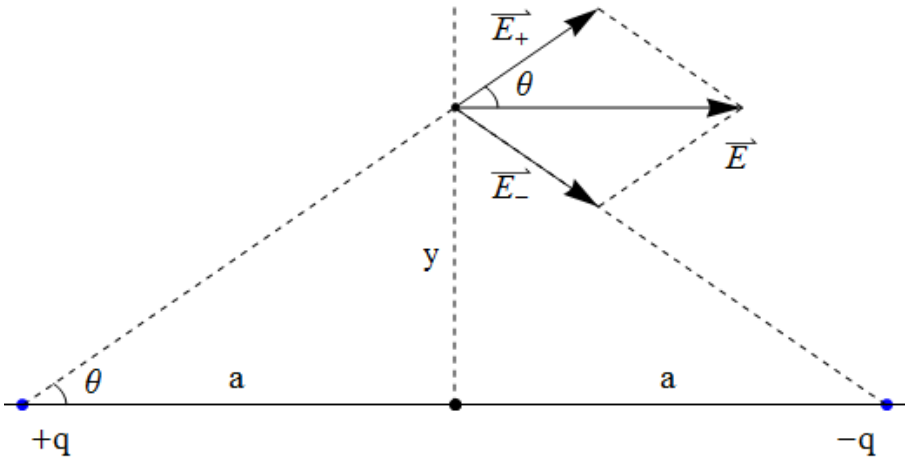
Answer on Question #43772, Physics, Electric Circuits

derive an expression for the electric field at any point on the equatorial line of an electric dipole?

Solution.



Consider the dipole with the charge q and distance 2a between charges.

The electric field in arbitrary point on the equatorial line at a distance y from the center of dipole is sum of intensities from two charges (from the superposition principle):

$$\vec{E} = \vec{E}_+ + \vec{E}_-$$

In projections (X axis to the right, Y axis upwards)

$$E_y = E_+ \sin(\theta) - E_- \sin(\theta) = \frac{1}{4\pi\epsilon_0}\left(\frac{q}{r^2} - \frac{q}{r^2}\right)\sin(\theta) = 0$$

$$E_x = E_+ \cos(\theta) + E_- \cos(\theta) = \frac{1}{4\pi\epsilon_0}\left(\frac{q}{r^2} + \frac{q}{r^2}\right)\cos(\theta) = \frac{2q}{4\pi\epsilon_0 r^2}\cos(\theta)$$

$$r^2 = a^2 + y^2$$

$$\cos(\theta) = \frac{a}{\sqrt{a^2 + y^2}}$$

So:

$$E = E_x = \frac{2q}{4\pi\epsilon_0(a^2 + y^2)} \cdot \frac{a}{\sqrt{a^2 + y^2}} = \frac{qa}{2\pi\epsilon_0(a^2 + y^2)^{\frac{3}{2}}}$$

Answer: $E = \frac{qa}{2\pi\epsilon_0(a^2+y^2)^{\frac{3}{2}}}$