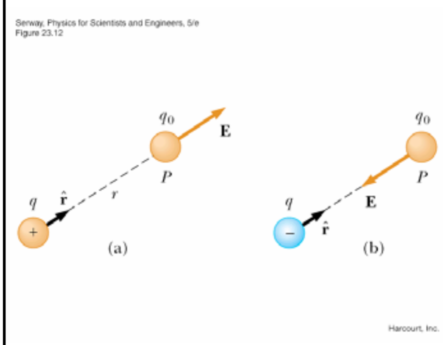


Electric Field due to a charge q

$$\mathbf{F}_e = k_e \frac{q q_o}{r^2}\ \hat{\mathbf{r}}$$

Electric field is the electric force acting on a unit positive charge

$$\mathbf{E} = k_e \frac{q}{r^2}\ \hat{\mathbf{r}}$$

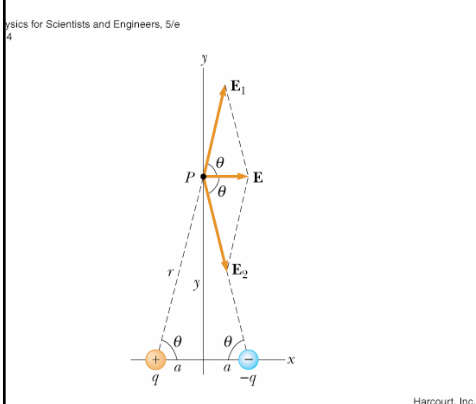
$$\mathbf{E} = \frac{\mathbf{F}_e}{q_o} \quad \longrightarrow \quad \mathbf{F}_e = \mathbf{E}\, q_o$$

Electric Field due to multiple charges

$$\mathbf{E} = k_e \sum_i \frac{q_i}{r_i^2}\ \hat{\mathbf{r}}_\mathbf{i}$$

For the dipole shown, find the electric field $\mathbf{E}$ at a point P due to the charges, where P is a distance $y >> a$ from the origin.

The total filed is $\mathbf{E} = \mathbf{E1} + \mathbf{E2}$ where

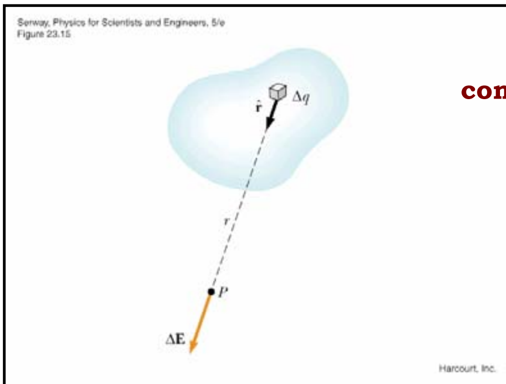


$$E_1 = E_2 = k_e \frac{q}{r^2} = k_e \frac{q}{y^2 + a^2}$$

$$E = 2 \cdot E_1 \cos\theta$$

$$\cos\theta = a/r = a/(y^2 + a^2)^{1/2}$$

$$\begin{aligned} E = 2 \cdot E_1 \cos\theta &= k_e \frac{q}{y^2 + a^2} \cdot \frac{a}{(y^2 + a^2)^{1/2}} \\ &= k_e \frac{2qa}{(y^2 + a^2)^{3/2}} \\ &\approx k_e \frac{2qa}{y^3} \end{aligned}$$



Electric Field due to a continuous charge distribution

The elctric field at P due to one element carrying charge Δq is:

$$\mathbf{E} = k_e \frac{\Delta q}{r^2}\ \hat{\mathbf{r}}$$

$$\mathbf{E} = k_e \sum_i \frac{\Delta q_i}{r_i^2}\ \hat{\mathbf{r}}_\mathbf{i}$$

$$\mathbf{E} = k_e \lim_{\Delta q \to 0} \sum_i \frac{\Delta q_i}{r_i^2}\ \hat{\mathbf{r}}_\mathbf{i} = k_e \int \frac{dq}{r^2}\ \hat{\mathbf{r}}$$