Electric field lines

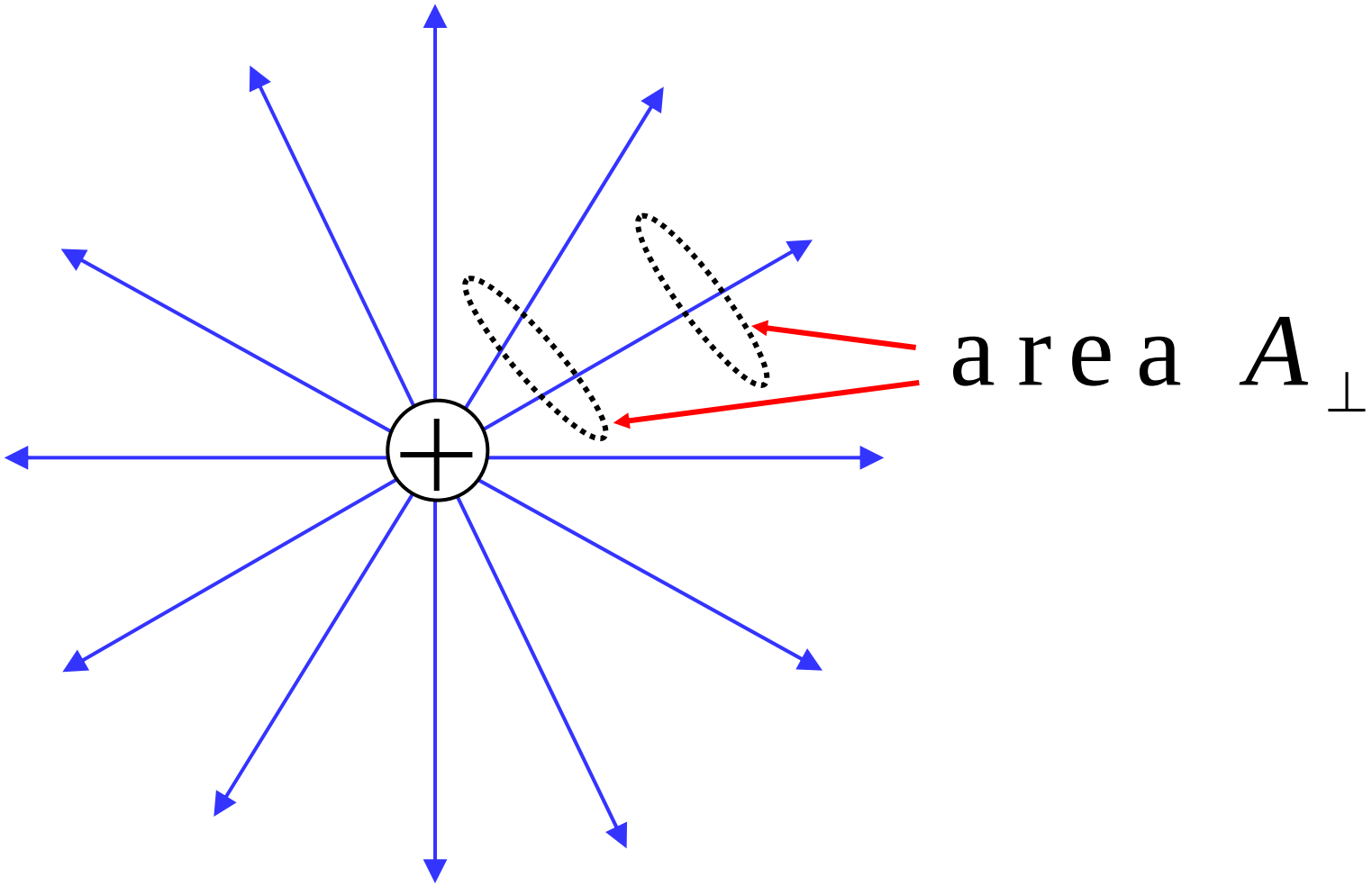
- The electric field is a VECTOR– specified at each point in space according to

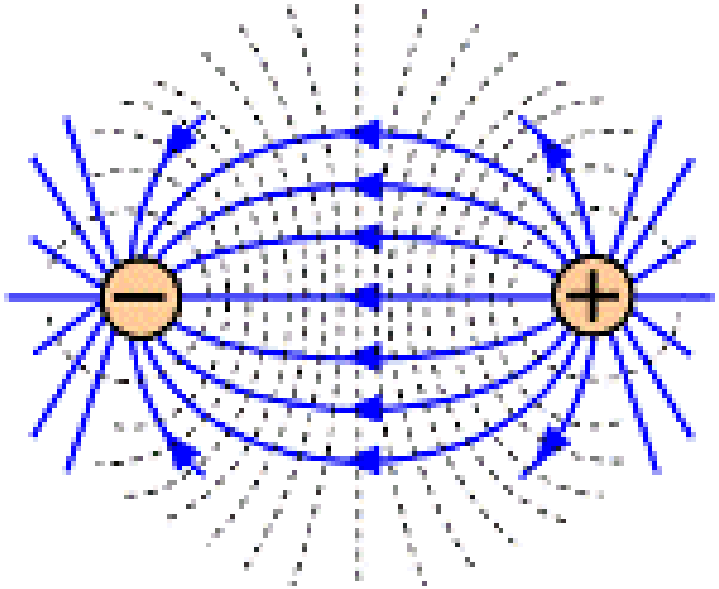
$$\vec{E}(\vec{r}) = \frac{1}{4\pi\varepsilon_o}\int_V \frac{\rho(\vec{r}')}{\left|\vec{r}-\vec{r}'\right|^3}\left(\vec{r}-\vec{r}'\right)d\tau'$$

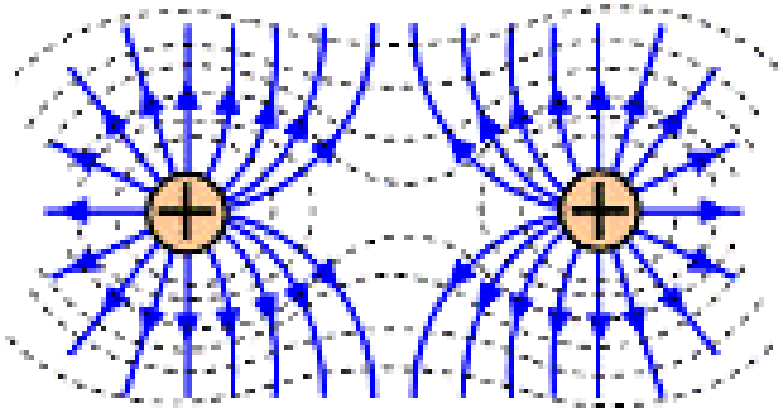
- Electric field 'lines' is a concept introduced by Faraday to help us visualize the electric field
- *The field lines are not the same as the field*

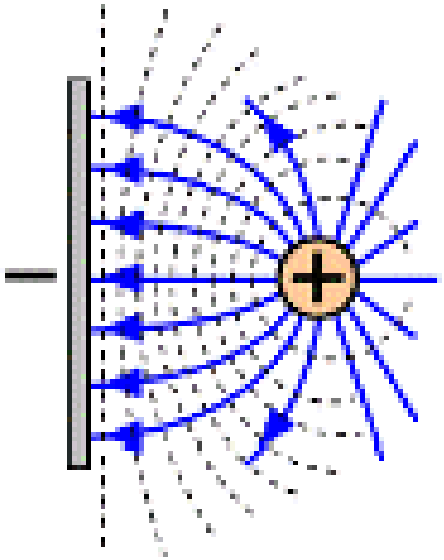
Rules for drawing field lines

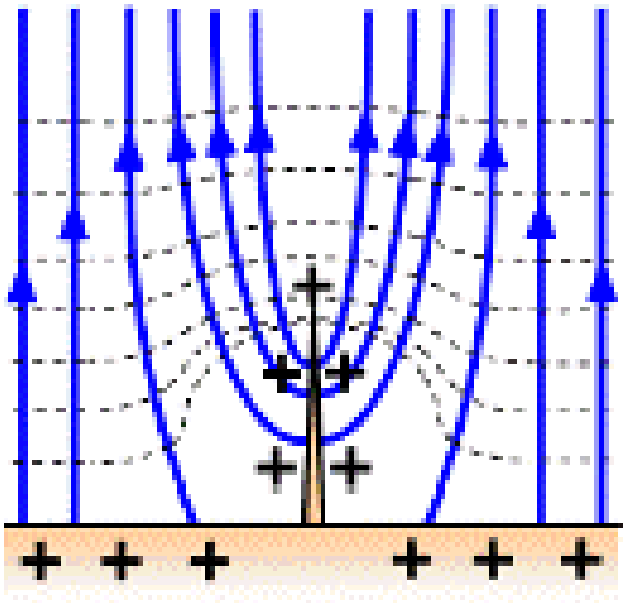
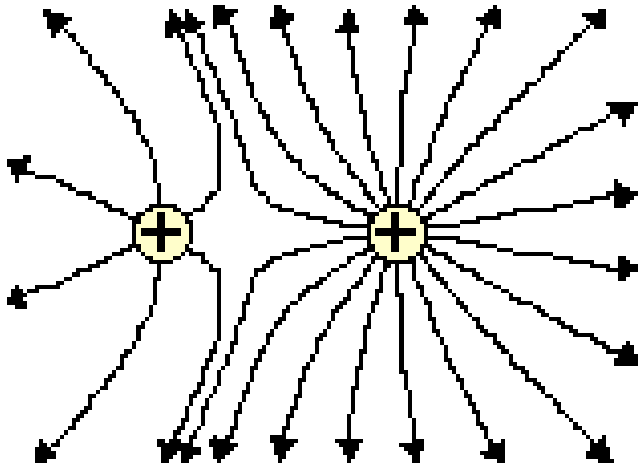
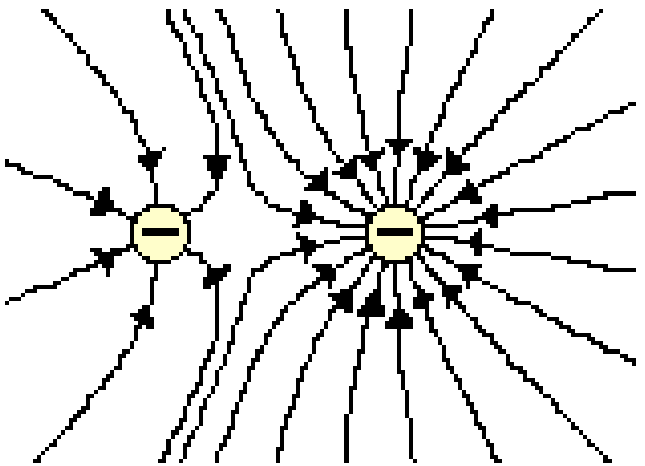
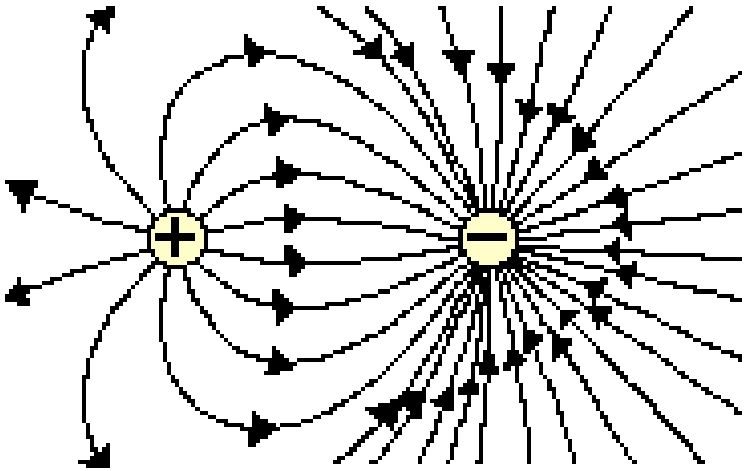
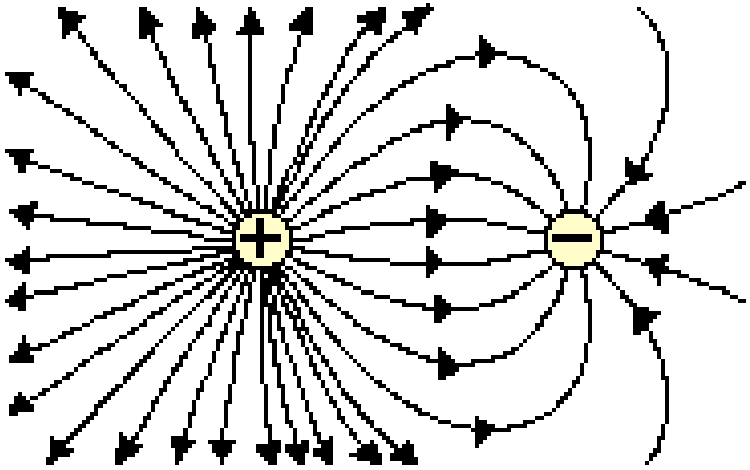
- How many lines? Total number, $N \propto Q$
  - start on a + and end on a – charge
  - start on a + and go out to ∞
  - start at ∞ and stop on a –
- Magnitude of E $\propto$ the number of lines crossing a area perpendicular to E per unit area; $E \propto N/A_{\perp}$, so that $\mathbf{E}\,\mathbf{A}_{\perp} \propto \mathbf{Q}$ (Gauss's Law)
- The electric field is everywhere tangent to the field lines


area $A_\perp$









Electric Field Line Patterns for Objects with Unequal Amounts of Charge