SUMMARY

The goal of Chapter 26 has been to learn how to calculate and use the electric field.

GENERAL PRINCIPLES

Sources of $\vec{E}$ (λ or η) and an integration coordinate.

Electric fields are created by charges.

Two major tools for calculating $\vec{E}$ are

- The field of a point charge

$$\vec{E} = \frac{1}{4\pi\epsilon_0}\frac{q}{r^2}\hat{r}$$

- The principle of superposition

Multiple point charges

Use superposition: $\vec{E} = \vec{E}_1 + \vec{E}_2 + \vec{E}_3 + \ldots$

Continuous distribution of charge

- Divide the charge into point-like ΔQ
- Find the field of each ΔQ
- Find $\vec{E}$ by summing the fields of all ΔQ

replacing ΔQ with an expression involving a **charge density**

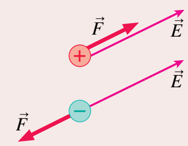
Consequences of $\vec{E}$

The electric field exerts a force on a charged particle.

$$\vec{F} = q\vec{E}$$

The force causes acceleration

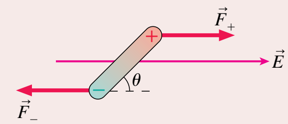
$$\vec{a} = (q/m)\vec{E}$$



Trajectories of charged particles are calculated with kinematics.

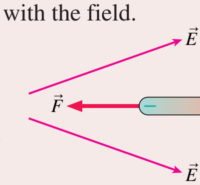
The electric field exerts a torque on a dipole.

$$\tau = pE\sin\theta$$



The torque tends to align the dipoles with the field.

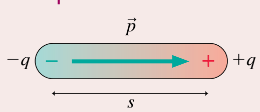
In a nonuniform electric field, a dipole has a net force in the direction of increasing field strength.



APPLICATIONS

The following fields are important models of the electric field:

Electric dipole



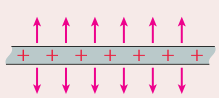
The electric dipole moment is

$\vec{p} = (qs$, from negative to positive$)$

Field on axis $\vec{E} = \frac{1}{4\pi\epsilon_0}\frac{2\vec{p}}{r^3}$

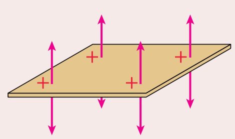
Field in bisecting plane $\vec{E} = -\frac{1}{4\pi\epsilon_0}\frac{\vec{p}}{r^3}$

Infinite line of charge with linear charge density λ



$$\vec{E} = \left(\frac{1}{4\pi\epsilon_0}\frac{2\lambda}{r}, \text{ perpendicular to line}\right)$$

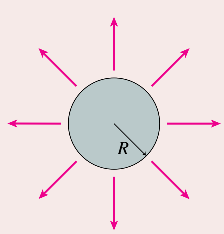
Infinite plane of charge with surface charge density η



$$\vec{E} = \left(\frac{\eta}{2\epsilon_0}, \text{ perpendicular to plane}\right)$$

Sphere of charge

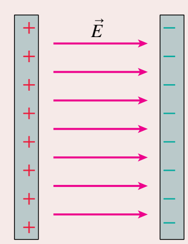
Same as a point charge Q for $r > R$



Parallel-plate capacitor

The electric field inside an ideal capacitor is a **uniform electric field**

$$\vec{E} = \left(\frac{\eta}{\epsilon_0}, \text{ from positive to negative}\right)$$



A real capacitor has a weak **fringe field** around it.