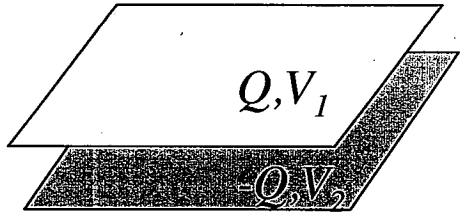
Lecture # 13

Capacitors

The definition of Capacitance is:



1. $C=Q/V_1$
2. $C=V_1/Q$
3. $C=V_2/Q$
4. $C=Q/(V_1-V_2)$

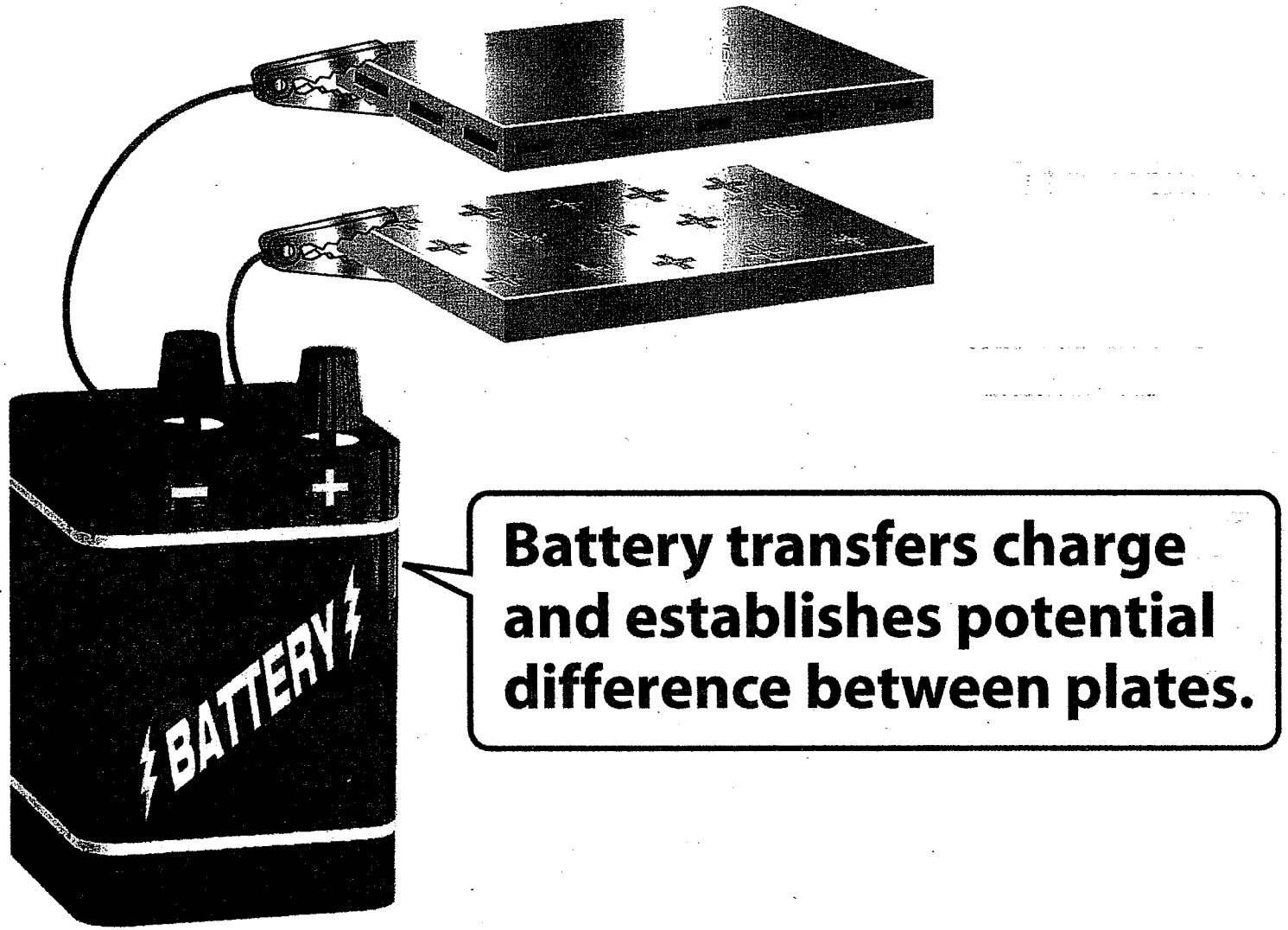


Figure 26-4 Physics for Engineers and Scientists 3/e

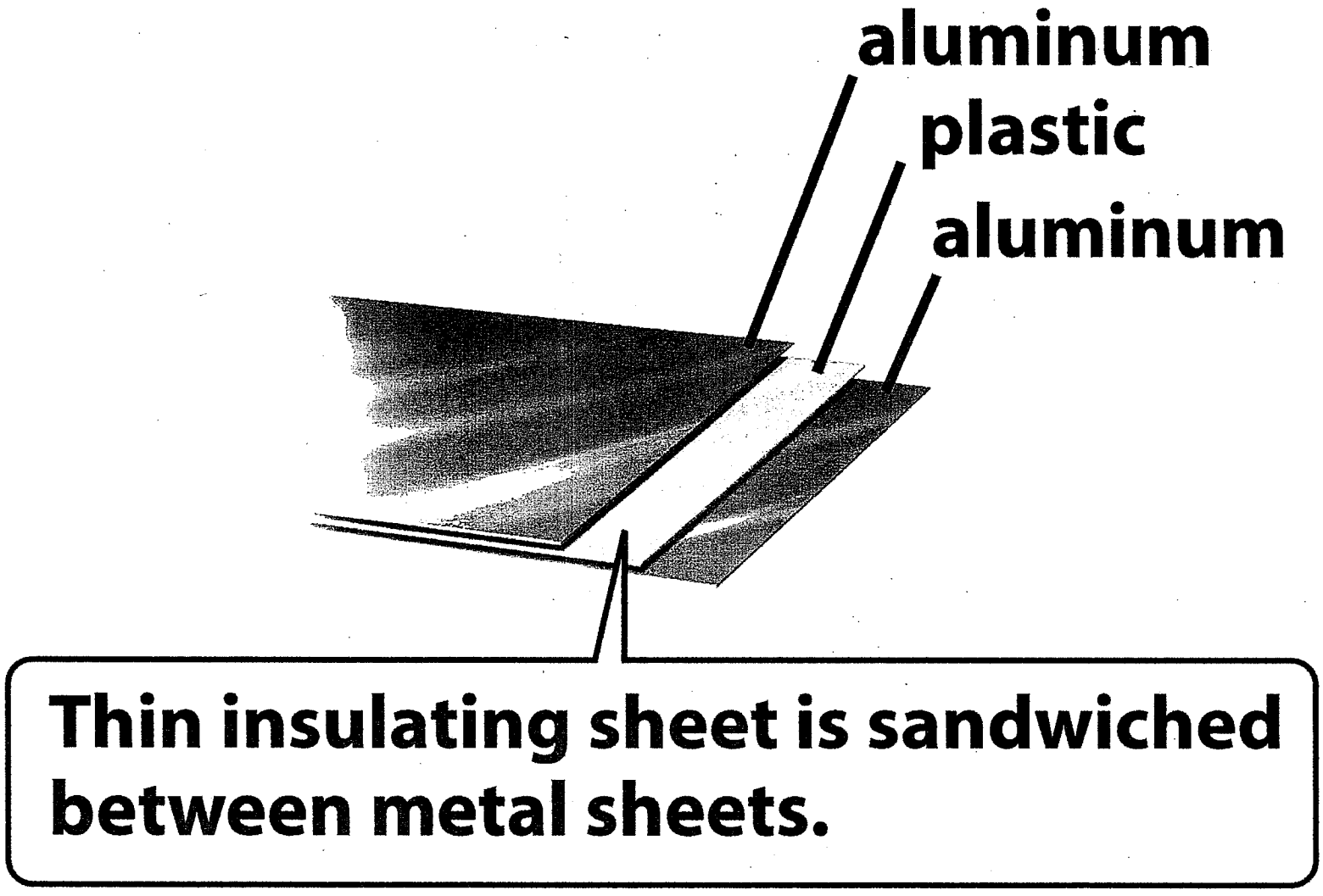


Figure 26-3a Physics for Engineers and Scientists 3/e

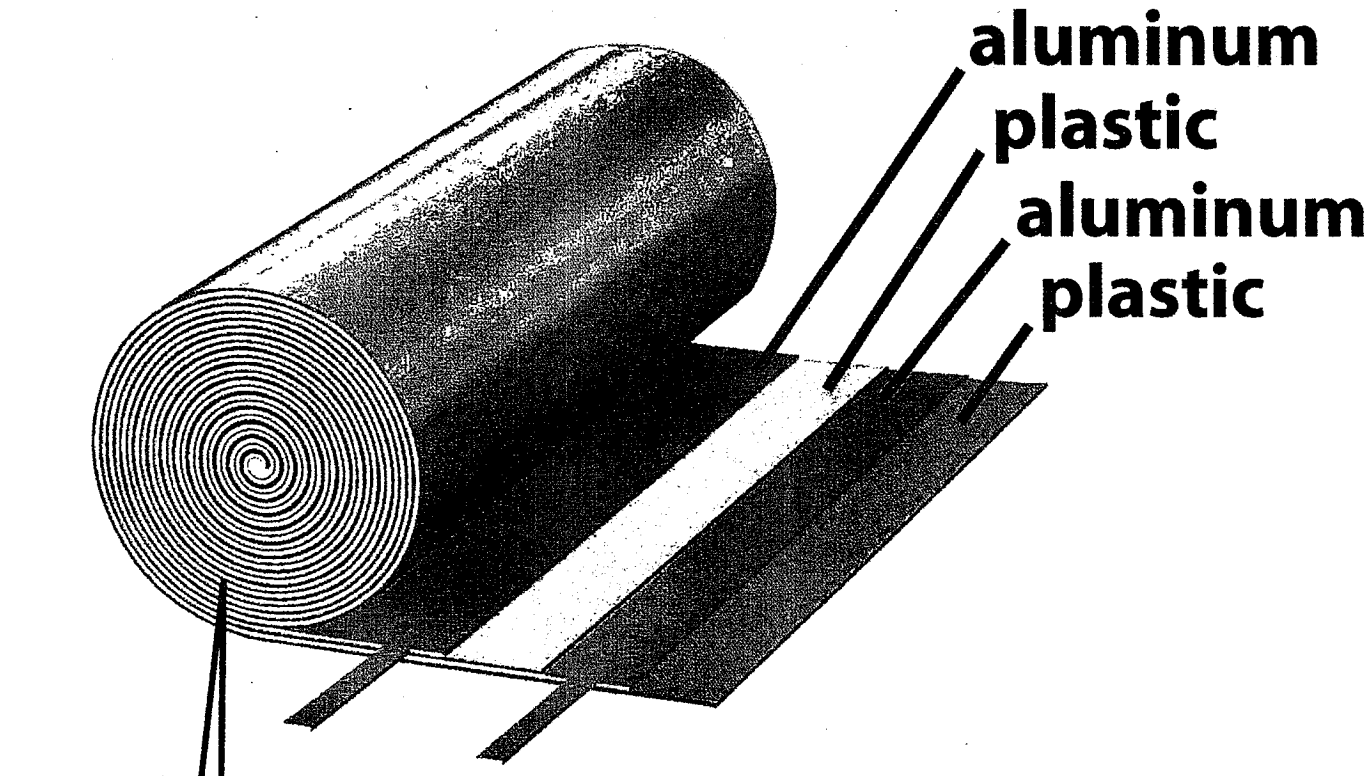


Figure 26-3b Physics for Engineers and Scientists 3/e

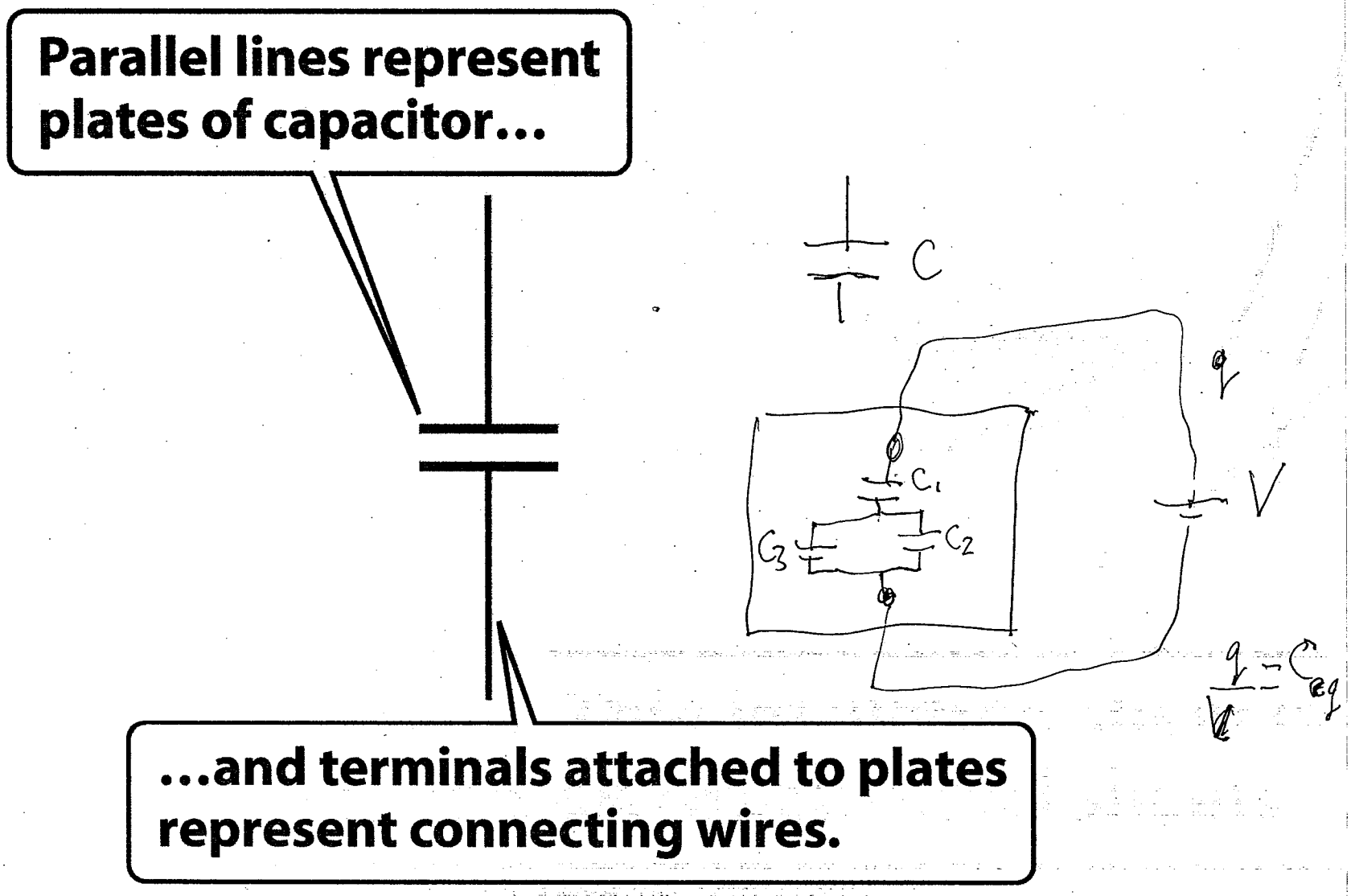
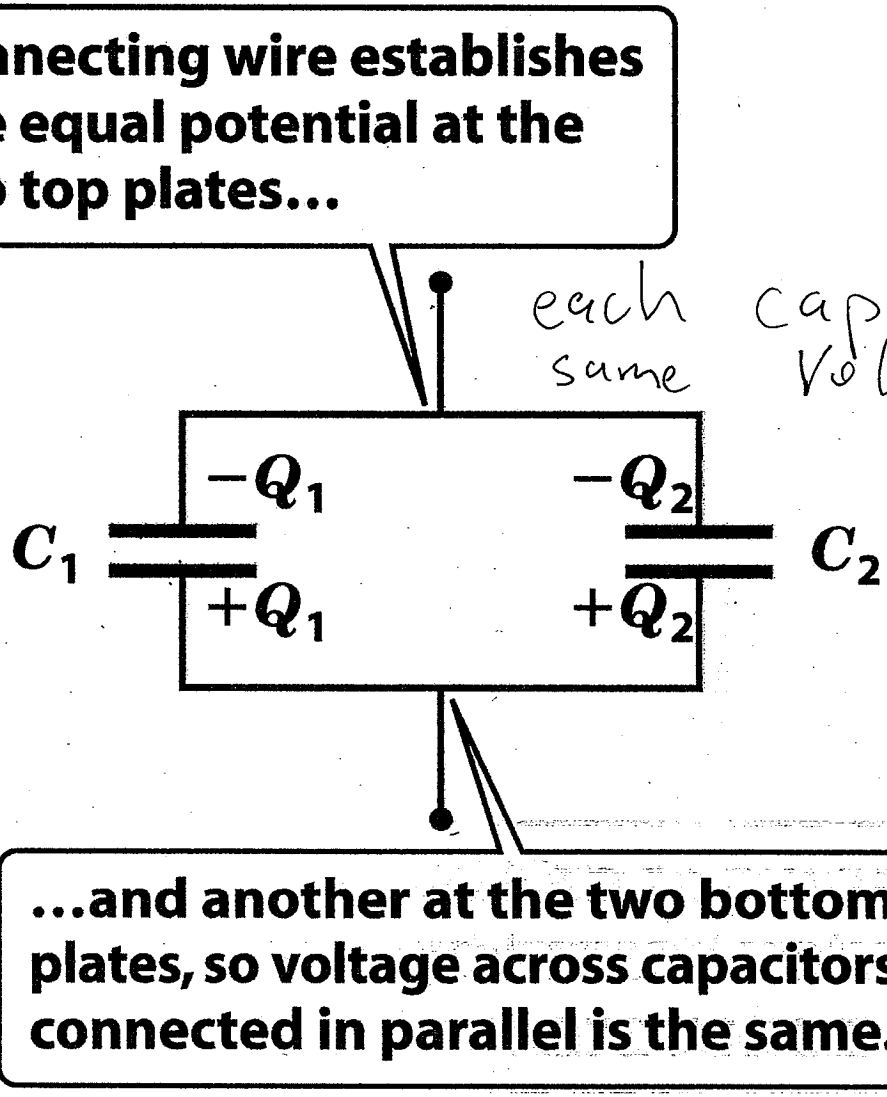


Figure 26-6 Physics for Engineers and Scientists 3/e



$C_{eq} = C_1 + C_2$

each capacitor has same voltage Across

$$C_{eq} = \frac{Q_{tot}}{\Delta V}$$

$$= \frac{Q_1 + Q_2}{\Delta V}$$

$$= C_1 + C_2$$

Figure 26-7 Physics for Engineers and Scientists 3/e

$$\Delta V = \frac{Q_{total}}{C_{eq}} = \frac{Q_1 + Q_2}{C_{eq}}, \quad \frac{Q_1}{\Delta V} = C_1$$

For any number of capacitors connected in parallel, the net capacitance is the sum

$$C = C_1 + C_2 + C_3 + \cdots.$$

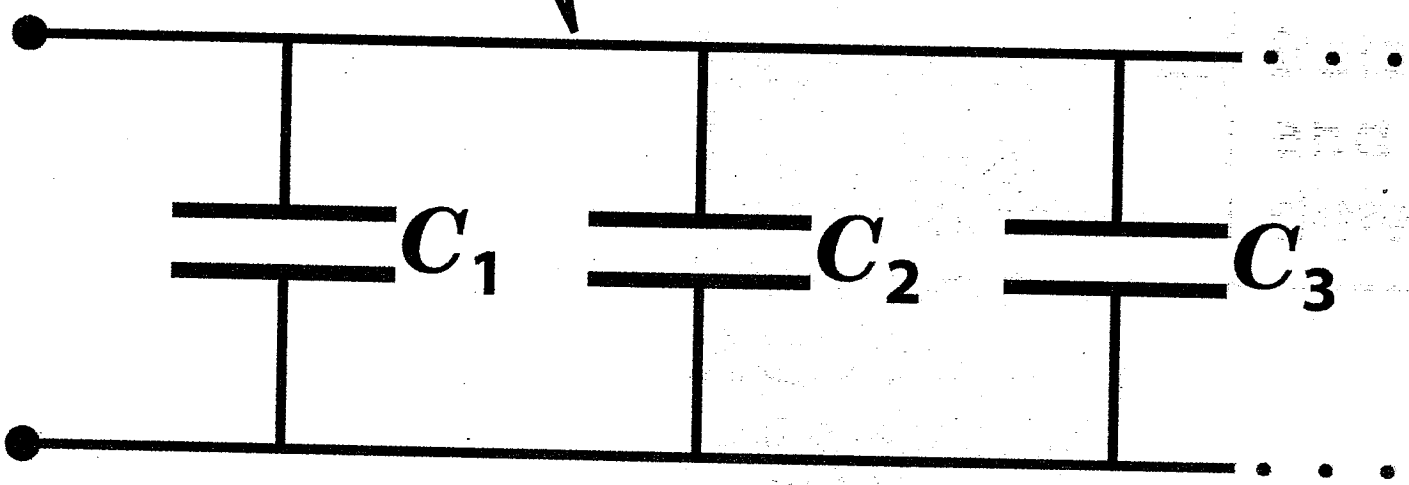
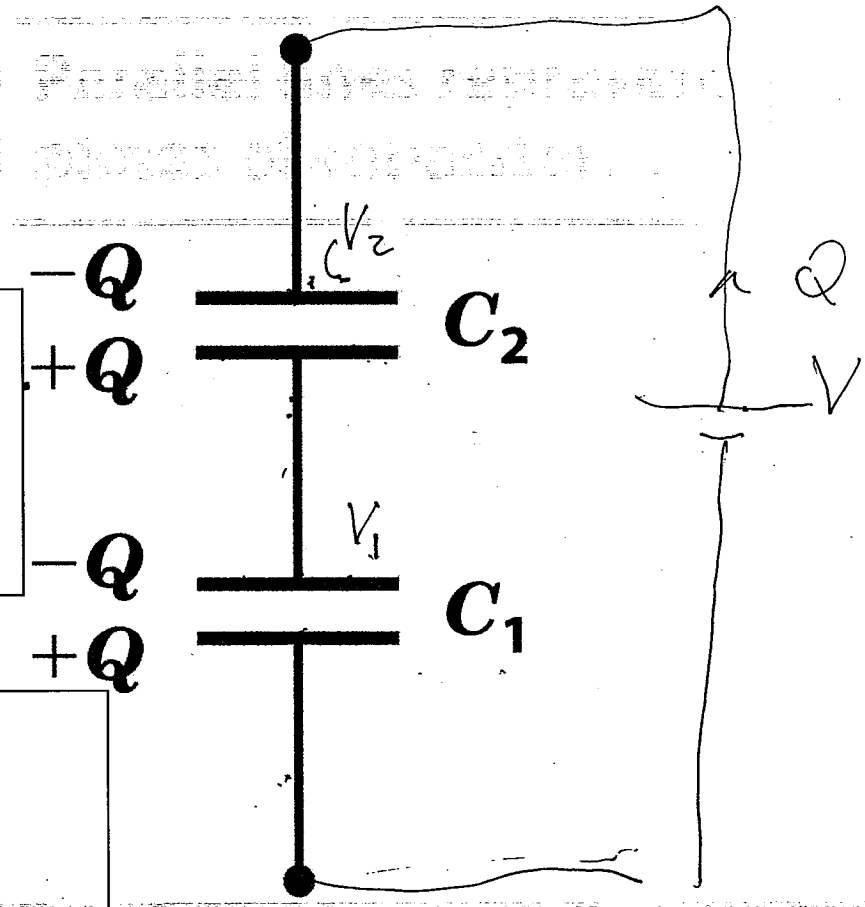


Figure 26-8 Physics for Engineers and Scientists 3/e

Find equivalent Capacitance C_{eq}

$$\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2}$$



$$V_1 = \frac{Q}{C_1}$$

$$C_{eq} = \frac{Q}{V}$$

$$V = \frac{Q}{C_{eq}} = V_1 + V_2$$

$$\frac{Q}{C_{eq}} = \frac{Q}{C_1} + \frac{Q}{C_2}$$

Figure 26-9 Physics for Engineers and Scientists 3/e

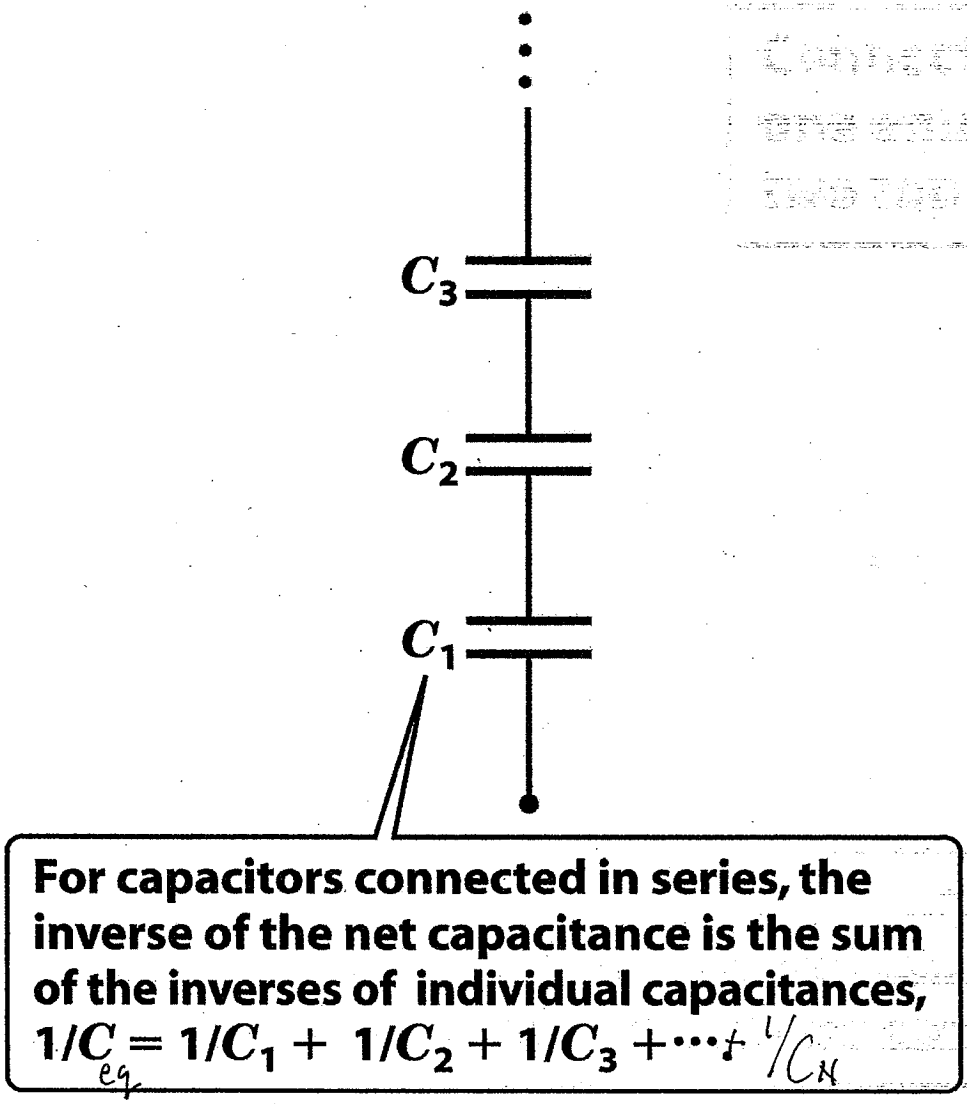
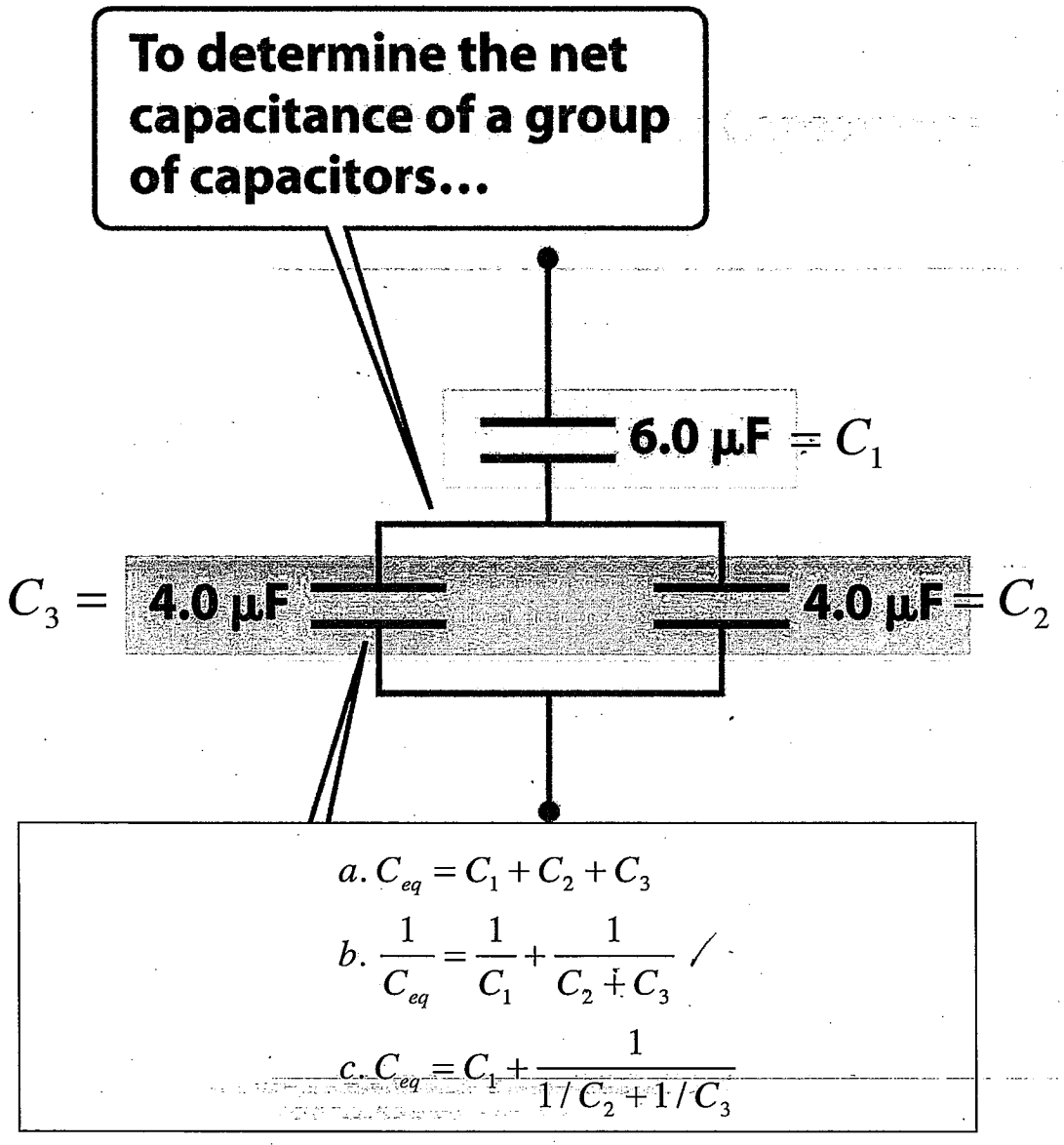
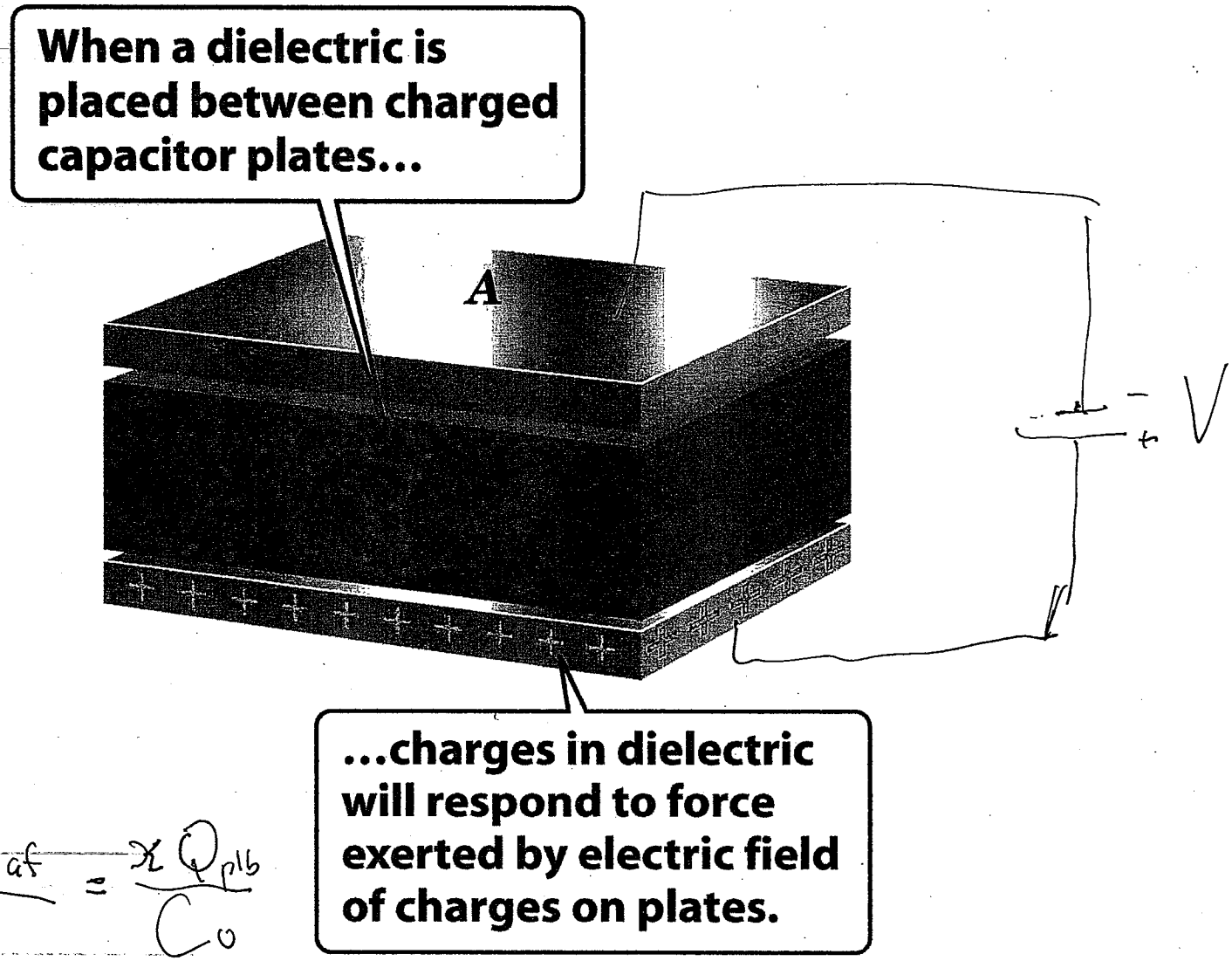


Figure 26-10 Physics for Engineers and Scientists 3/e


To determine the net capacitance of a group of capacitors...
6.0 μF = C_1
C_3 = 4.0 μF
4.0 μF = C_2
$a.\ C_{eq} = C_1 + C_2 + C_3$
$b.\ \frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2 + C_3}$
$c.\ C_{eq} = C_1 + \frac{1}{1/C_2 + 1/C_3}$



before

$$V = \frac{Q_{plb}}{C_0}$$

$$= \frac{Q_{plf}}{C_0} = \frac{\chi Q_{plb}}{C_0}$$

Figure 26-13 Physics for Engineers and Scientists 3/e

$$C_\chi = \chi C_0$$

Dipoles Align Along Electric Field

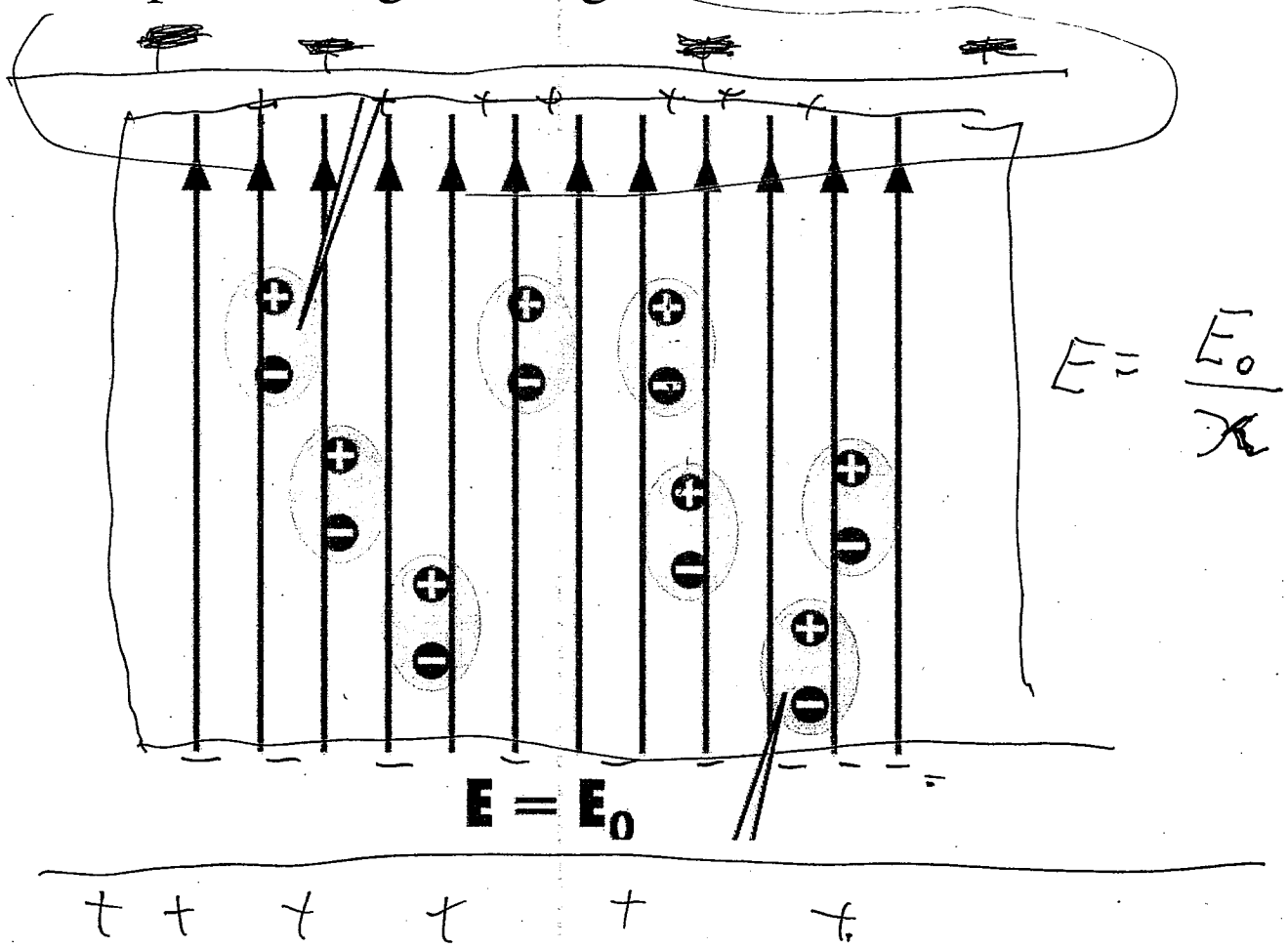
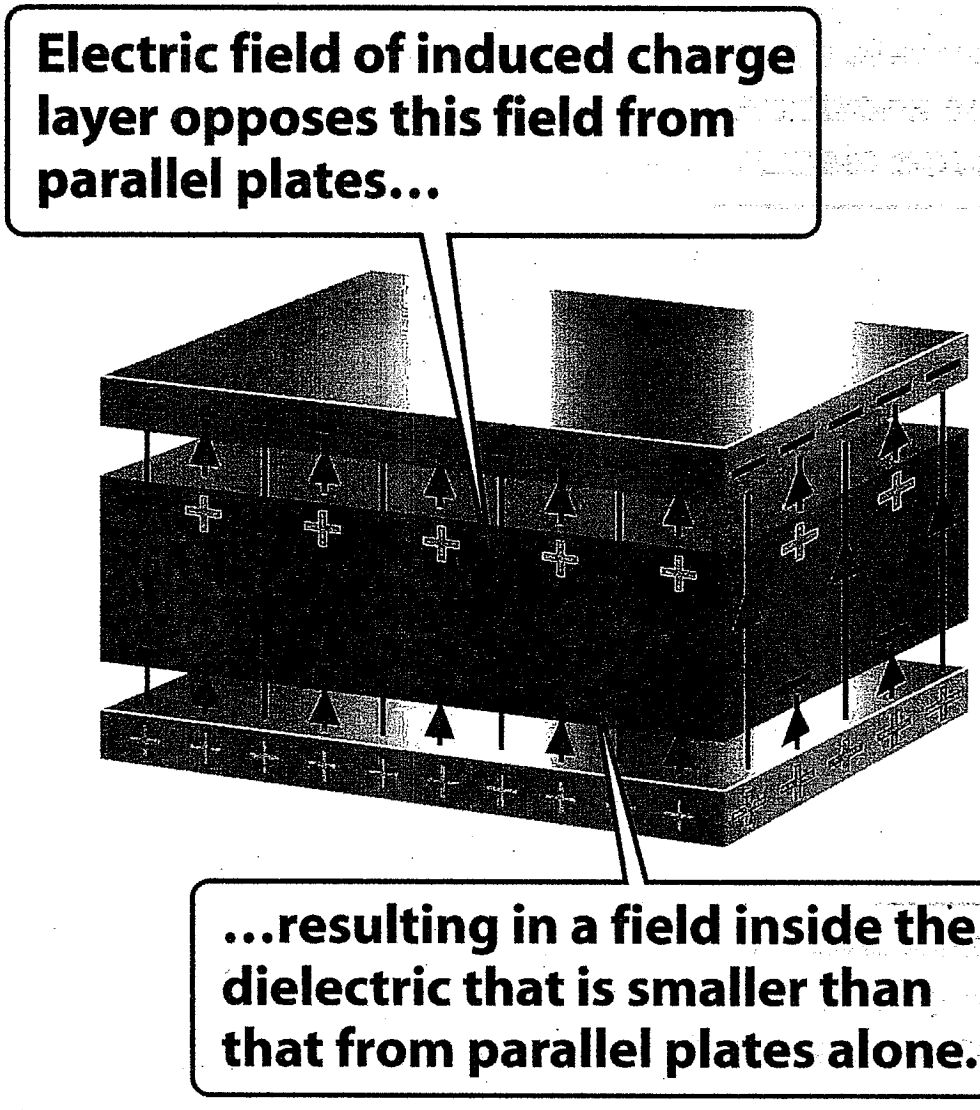


Figure 26-14b Physics for Engineers and Scientists 3/e



$V_0 \rightarrow \frac{V_0}{\kappa}$

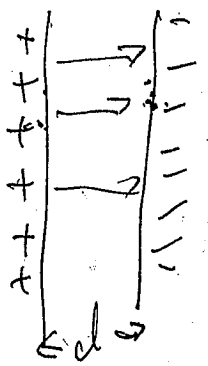
$C_0 \rightarrow \kappa C_0$

$\| $

C

Figure 26-17 Physics for Engineers and Scientists 3/e

$$W = \frac{1}{2}\frac{Q^2}{C} = \frac{1}{2}CV^2 = \frac{1}{2}QV$$



$$\frac{1}{2}QV = W$$

$$\frac{1}{2}\frac{Q^2}{C}$$

$$V = \frac{Q}{C}$$

$$Q = CV$$

$$\frac{1}{2}CV^2$$

$$\frac{Q}{\epsilon_0 A} = E$$

$$\frac{1}{2}QV = \frac{\epsilon_0 E^2}{2} Ad$$

$$Q = \epsilon_0 A E$$

$$V = Ed$$

$$W = \frac{\epsilon_0 E^2}{2} Vol$$

$$\text{Energy Density} = \frac{\text{Energy}}{\text{Volume}}$$

$$= \frac{\epsilon_0 E^2}{2}$$