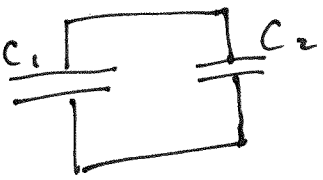
Ch. 8 Prob. 38

$C_1 = 40pF$ $V_0 = 500V$

$C_2 = 10pF$



a) Initially the first capacitor has the following charge

$C_1 = \frac{Q_0}{V_0} \rightarrow Q_0 = C_1 V_0 = (40pF)(500V) = \underline{20{,}000\,pC}$

b) When this capacitor is attached to the second capacitor, some of the charge will be transferred ~~to~~ the from the first capacitor to the second one. The transfer will continue until the voltage across each capacitor matches.

$C_1 = \frac{Q_1}{V_1} \rightarrow V_1 = \frac{Q_1}{C_1}$ where V_1 is the new voltage across the first capacitor and Q_1 is the new amount of charge on the first capacitor.

Likewise for the second capacitor

$$V_2 = \frac{Q_2}{C_2}$$

Set these equations equal to each other

$$\frac{Q_1}{C_1} = \frac{Q_2}{C_2} \rightarrow Q_1 = \frac{C_1}{C_2} Q_2$$

Now the original charge must equal the sum of the new charge on each capacitor

so $Q_0 = Q_1 + Q_2 \rightarrow Q_0 = \frac{C_1}{C_2} Q_2 + Q_2$

Now ~~$Q_0 = C_1 V_1 + C_2 V_2$~~ $Q_0 = \left(1 + \frac{C_1}{C_2}\right) Q_2$

Ch.8 Prob. 38

$$Q_2 = \frac{Q_0}{\left(1+\frac{C_1}{C_2}\right)} = \frac{20{,}000\,pC}{1+\frac{40pF}{10pF}} = \frac{20{,}000\,pC}{5}$$

$$\boxed{Q_2 = 4{,}000\,pC}$$

Charge on the first capacitor is then

$$Q_1 = \frac{C_1}{C_2} Q_2 = \left(\frac{40pF}{10pF}\right) 4{,}000pC$$

$$= 4\,(4{,}000pC) = \boxed{16{,}000pC}$$

c) The new voltage is then

$$V_2 = \frac{Q_2}{C_2} = \frac{4{,}000pC}{10pF} = 400\,V$$

$$V_1 = \frac{Q_1}{C_1} = \frac{16{,}000pC}{40pF} = \boxed{400V}$$

Notice: both voltages ~~math~~ match.