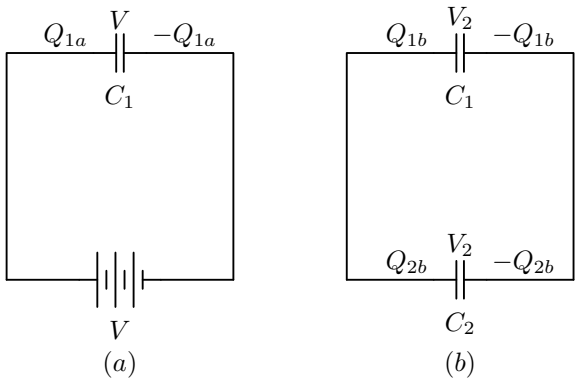
Recitation 4

Chapter 17

Problem 40. A $C_1 = 7.7\ \mu$F capacitor is charged by a $V = 125$ V battery (Fig. 17-29a) and then is disconnected from the battery. When this capacitor (C_1) is cthen connected (Fig. 17-29b) to a second (initially uncharged) capacitor, C_2, the final voltage on each capacitor is $V_2 = 15$ V. What is the value of C_2? [*Hint*: charge is conserved.]



Because the voltage drop across C_1 in situation a is the same as the voltage drop across the battery (V), we have

$$Q_{1a} = C_1 V$$

When we connect C_2 in situation b, this charge redistributes between C_1 and C_2. Because charge is conserved, we know

$$Q_{1a} = Q_{1b} + Q_{2b}$$

We also know that the voltage drop across both capacitors in situation b must be equal (both $= V_2$), so

$$Q_{1b} = C_1 V_2$$
$$Q_{2b} = C_2 V_2$$

Plugging each of these formulas for charge (Q_{1a}, Q_{1b}, and Q_{2b}) into the charge conservation formula yeilds

$$\begin{aligned} C_1 V &= C_1 V_2 + C_2 V_2 \\ C_1(V - V_2) &= C_2 V_2 \\ V_2 C_2 &= C_1(V - V_2) \\ C_2 &= C_1\left(\frac{V}{V_2} - \frac{V_2}{V_2}\right) \\ C_2 &= C_1\left(\frac{V}{V_2} - 1\right) \\ C_2 &= 7.7\ \mu\text{F} \cdot \left(\frac{125\ \text{V}}{15\ \text{V}} - 1\right) = 56\ \mu\text{F} \end{aligned}$$