For the circuit shown the switch B is open. The switch A is closed for a long time and then opened.

(a) Calculate the charge and potential on capacitors $C_1$ and $C_2$.

$$Q_1 = Q_2 = \frac{Q_{tot}}{2} = \frac{\varepsilon C_1 C_2}{C_1 + C_2} = \varepsilon \frac{170 \times 200}{170 + 200} \times 10^{-12} = 1.29 \times 10^{-8} \text{ C}$$

$$V_1 = \frac{Q_1}{C_1} = \frac{1.29 \times 10^{-8}}{170 \times 10^{-12}} = 75.9 \text{ V}$$

$$V_2 = 140 \text{ V} - 75.9 \text{ V} = 64.1 \text{ V}$$

(b) $Q_{tot}$ is constant.

$$C_{tot} = C_3 + \frac{C_1 C_2}{C_1 + C_2} = 150 + \frac{170 \times 200}{170 + 200} = 242 \text{ pF}$$

$$V_{12} = V_{tot} = \frac{Q_{tot}}{C_{tot}} = \frac{1.29 \times 10^{-8}}{242 \times 10^{-12}} = 53.3 \text{ V}$$

$$Q_2 = Q_1 = Q_2 = C_1 C_2 \cdot V_{12} = \frac{170 \times 200}{170 + 200} \times 53.3 = 4.90 \times 10^{-9} \text{ C}$$

$$V_1 = \frac{Q_1}{C_1} = \frac{4.90 \times 10^{-9}}{170 \times 10^{-12}} = 28.8 \text{ V}$$

$$V_2 = V_{12} - V_1 = 53.3 - 28.8 = 24.5 \text{ V}$$

(c) The total charge is constant $1.29 \times 10^{-8} \text{ C}$.

$$C_{tot} = C_3 + \frac{k C_1 C_2}{C_1 + k C_2} = 287 \text{ pF}$$

$$V_3 = V_{12} = V_{total} = \frac{Q_{tot}}{C_{tot}} = \frac{1.29 \times 10^{-8}}{287 \times 10^{-12}} = 44.9 \text{ V}$$

$$Q_3 = V_3 C_3 = 150 \times 44.9 \times 10^{-12} = 6.74 \times 10^{-9} \text{ C}$$

$$Q_2 = Q_1 = Q_2 = \frac{k C_2 C_1}{k C_2 + C_1} \cdot V_{12} = 6.15 \times 10^{-9} \text{ C}$$

$$V_1 = \frac{Q_1}{C_1} = \frac{6.15 \times 10^{-9}}{170 \times 10^{-12}} = 36.2 \text{ V}$$

$$V_2 = V_{12} - V_1 = 44.9 - 36.2 = 8.7 \text{ V}$$