In the figure $V_0 = 12 \text{ V}$ and $C_1 = 4.0 \mu \text{F}$, $C_2 = 6.0 \mu \text{F}$, and $C_3 = 3.0 \mu \text{F}$. The switch is thrown to the left side until capacitor 1 is fully charged. Then the switch is thrown to the right. What is the final charge on
(a) Capacitor 1,
(b) Capacitor 2, and
(c) Capacitor 3?

Switch to the left

$Q_0 = C_1 V_0 = 12 \times 4 = 48 \mu \text{C}$

Switch to the right

$V_1 = \frac{Q_1}{C_1} = \frac{Q_3}{C_3}$

$q_1' + q_2' = q_0$

$\frac{q_1'}{C_1} = \frac{q_0 - q_1'}{C_{13}} \Rightarrow q_1' \left( \frac{1}{C_1} + \frac{1}{C_{23}} \right) = \frac{q_0}{C_{23}}$

$q_1' = 32 \mu \text{C}$

$q_2' = 48 - 32 = 16 \mu \text{C}$

$q_2' = 48 - 32 = 16 \mu \text{C}$

$q_3' = 16 \mu \text{C}$
A parallel-plate air filled capacitor has a capacitance of 50 pF.

(a) If each of its plates has an area of 0.35 m², what is the separation between the plates?

\[ C_1 = \frac{\varepsilon_0 A}{d_1} \Rightarrow d_1 = \frac{\varepsilon_0 A}{C_1} \]

\[ d_1 = \frac{8.85 \times 10^{-12} \times 0.35}{50 \times 10^{-12}} = 0.062 \text{ m} \]

(b) If the region between the plates is now filled with a material having \( \kappa = 5.6 \) and the separation between the plates is doubled, what is the new capacitance?

\[ C_2 = \kappa \varepsilon_0 A \frac{d}{d_2} = \frac{5.6 \times 8.85 \times 10^{-12} \times 0.35}{0.062 \times 2} \]

\[ C_2 = 1.4 \times 10^{-10} \text{ F} \]

(c) What is the energy stored in the new capacitor if the electric potential applied to charge it is 100 V?

\[ U = \frac{1}{2} C_2 V^2 = \frac{1}{2} (1.4 \times 10^{-10}) (100)^2 \]

\[ = 6.99 \times 10^{-7} \approx 7 \times 10^{-7} \text{ J} \]
In the figure, the battery has a potential difference of $V = 200$ V and the four capacitors each having a capacitance of 20 $\mu$F. What is the energy stored in capacitor $C_2$?

$C_{eq} = \frac{1}{\frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}} = \frac{1}{\frac{1}{20} + \frac{1}{20} + \frac{1}{20}} = \frac{30}{12} = 2.5$ F

$\Rightarrow q_{eq} = C_{eq} V = 2400 \mu C$

$\Rightarrow \begin{cases} 
q_{20} = 2400 \mu C \Rightarrow V_{20} = \frac{q_{20}}{C_{20}} = \frac{2400}{20} = 120 V \\
q_{30} = 2400 \mu C \Rightarrow V_{30} = \frac{q_{30}}{C_{30}} = \frac{2400}{30} = 80 V
\end{cases}$

$\Rightarrow V_{20} = V_{10} = V_{30} = 80 V$

$\Rightarrow q_{10} = V_{10} \times C_{10} = 80 \times 10 = 800 \mu C$

$\Rightarrow \text{Charge on } C_2 = 800 \mu C$

Energy stored $U_2 = \frac{1}{2} \frac{q_{10}^2}{C_2} = \frac{1}{2} \frac{(800 \mu C)^2}{20 \mu F} = 0.016 J$